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Relationship between metabolic and vascular conditions and cognitive decline among older Mexican Americans

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Abstract

Objective—Metabolic and vascular conditions have been independently associated with dementia and cognitive decline among older adults, but research on the combined effects that these conditions have on cognitive decline, especially among older Mexican Americans, is lacking. The purpose of this study was to examine the relationship between metabolic and vascular conditions and cognitive decline among older Mexican Americans.

Methods—The final sample included 2767 participants of the Hispanic Established Populations for the Epidemiologic Study of the Elderly. Linear mixed-effects regression was used to model cognitive decline across six examinations (1993–2007) according to the number (zero, one, two, and three to four) of metabolic and vascular conditions (hypertension, diabetes, stroke, and heart attack).

Results—Of the 2767 participants included in the final sample, 777 had zero conditions, 1314 had one condition, 553 had two conditions, and 123 had three to four conditions. Participants with two or three to four conditions had significantly greater cognitive decline compared with participants with zero or one condition. Stroke had the largest effect size on cognitive decline based on the proportion of variance that stroke accounted for in the linear mixed-effects model.

Conclusion—Mexican American older adults with multiple metabolic and vascular conditions exhibit greater cognitive decline than those with zero or one condition. Public health interventions designed to reduce the prevalence of chronic metabolic and vascular conditions, in particular stroke, may limit the severity of cognitive decline among older Mexican Americans.

Keywords

cognition; cognitive decline; Hispanic Americans; minority aging

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Conflict of interest

None declared.

Introduction

Previous research indicates that diabetes, hypertension, stroke, and heart disease are associated with cognitive impairment (Alonso, Jacobs, and Menotti *et al.*, 2009; Elias, Elias, Sullivan, Wolf, and D'Agostino, 2003; Gorelick, Scuteri, and Black *et al.*, 2011; Potluri, Natalwala, Uppal, and Heun, 2008, Wang, Woung, and Tsai *et al.*, 2012; Yaffe, Blackwell, and Kanaya *et al.*, 2004). The majority of this research has focused on non-Hispanic populations, and few studies have examined the relationship between metabolic and vascular conditions and cognitive functioning among Hispanic older adults. A study of 1759 older Mexican Americans from the Hispanic Established Populations for the Epidemiologic Study of the Elderly (H-EPESE) conducted by Nguyen, Black, Ray, Espino, and Markides (2002) reported that participants with a history of diabetes or stroke were more likely to have severe cognitive decline over a 5-year period compared with participants without these conditions. Other studies have observed that stroke and diabetes are associated with major cognitive decline (Wu, Haan, and Liang *et al.*, 2003) and dementia (Haan, Mungas, and Gonzalez *et al.*, 2003) among Hispanic older adults.

Mexican Americans are at an increased risk for metabolic and vascular conditions compared with non-Hispanic Whites (Fryar, Hirsch, Eberhardt, Yoon, and Wright, 2010; Morgenstern, Smith, and Lisabeth *et al.*, 2004; Narayan, Boyle, Thompson, Sorensen, and Williamson, 2003; Sundquist, Winkleby, and Pudaric, 2001). Furthermore, the prevalence of adults living with multiple conditions is highest among Mexican Americans (Mozumdar and Liguori, 2011). While there is evidence that metabolic and vascular conditions are associated with cognitive functioning in Mexican American populations (Haan, Mungas, and Gonzalez *et al.*, 2003; Nguyen, Black, Ray, Espino, and Markides, 2002; Wu, Haan, and Liang *et al.*, 2003), the cumulative effect that these conditions have on cognitive decline is less known. Also, it is not clear which condition has the greatest impact on cognitive decline. This study aims to address these questions using data from the H-EPESE to examine the cumulative effects of diabetes, hypertension, heart disease, and stroke on cognitive decline and determine which condition has the largest effect size on cognitive decline.

Methods

The Hispanic established populations for the epidemiologic study of the elderly

The present study used data collected from participants of the H-EPESE. A detailed description of the sampling procedures and characteristics of the H-EPESE has been provided previously (Markides, Rudkin, Angel, and Espino, 1997). Briefly, the H-EPESE is a longitudinal study of community-dwelling Mexican Americans age 65 and over residing in Texas, New Mexico, Colorado, Arizona, and California. The study was initiated in 1993–1994 and included 3050 Mexican American adults who were aged 65 and over. Participants have been interviewed during six examinations from 1993–1994 to 2006–2007, and all examinations include measures for sociodemographic characteristics, health conditions, family structure, mental health, cognition, and social support. The present analysis used cognitive data collected during six examinations (1993–1994 to 2006–2007) using the Mini-mental state examination (MMSE) (Folstein, Folstein, and McHugh, 1975) and sociodemographic and health status data collected during the baseline examination.

Assessment of cognitive function

Cognition was measured during each examination using the MMSE. This is a commonly used screening tool for cognitive impairment that measures orientation, registration, attention, calculation, recall, and language (Folstein, Folstein, and McHugh, 1975).

Metabolic and vascular conditions

Diabetes, hypertension, heart disease, and stroke were assessed during the baseline examination. Participants were classified as having diabetes if they responded yes to the question, “Have you ever been told by a doctor that you have diabetes, sugar in your urine or high blood sugar?” or if they were taking insulin. Participants were classified as having hypertension if they met one or more of the following criteria: (1) responding yes to the question, “Has a doctor ever told you that you have high blood pressure?” (2) were taking antihypertensive medications; or (3) had an average systolic blood pressure >140 mmHg or average diastolic blood pressure >90 mmHG during the baseline examination. Participants who responded yes to the question, “Has a doctor ever told you that you had a stroke, a blood clot in the brain, or brain hemorrhage?” or “Has a doctor ever told you that you had a heart attack, myocardial infarction, coronary infarction, or coronary thrombosis?” were classified as having a stroke and heart disease, respectively.

Metabolic and vascular condition summary score

The metabolic and vascular condition summary score was obtained by summing the number of metabolic and vascular conditions reported by each participant during the baseline examination. Only 13 participants had all four conditions and were combined with participants who had three conditions ($n=110$).

Covariates

Covariates were chosen based on evidence from prior research on cognitive functioning (Aggarwal, Bienias, and Bennett *et al.*, 2006; Lenoir, Dufouil, and Auriacombe *et al.*, 2011; van Gelder, Tijhuis, and Kalmijn *et al.*, 2006; Wright, Elkind, Luo, Paik, and Sacco, 2006). Age during the baseline examination, education (0 years, 1–4 years, 5–8 years, 9+ years), and sex were included as covariates in all adjusted analyses. Additional covariates assessed during the baseline examination included smoking, alcohol consumption, marital status, depressive symptoms, and the language in which the participant chose the interview to be conducted (English or Spanish). Smoking status was defined as never (<100 cigarettes lifetime), former (>100 cigarettes lifetime but not currently smoking), and current (>100 cigarettes lifetime and currently smoking). Alcohol consumption was defined as abstainer (never consumed alcohol), former (no alcohol consumed in the past year), and current (consumed alcohol in the past year). Marital status was categorized as never married, not married (separated, divorced, or separated), and currently married. Depressive symptoms were measured using the Center for Epidemiologic Studies Depression Scale (Radloff, 1977). Participants who scored >16 on the Center for Epidemiologic Studies Depression Scale were classified as having high depressive symptoms.

Statistical analysis

Comparisons for demographic characteristics according to the number of metabolic and vascular conditions during the baseline examination were made using analysis of variance and chi-square for continuous and categorical variables, respectively. Longitudinal trajectories of cognition according to the number of baseline metabolic and vascular conditions were modeled using linear mixed-effects regression (Fitzmaurice, Laird, and Ware, 2011). This is a commonly used approach because it provides valid estimates when data are unbalanced because of differences in the number and timing of observations for each participant. Time was measured as the number of years following the baseline examination. Random effects for time and intercept were included to allow for the trajectory and baseline values for cognition to vary for each participant. Twoway interaction terms between time and the number of metabolic and vascular conditions were included to assess if the cognitive trajectories varied according to the number of metabolic and vascular conditions.

The effect size of each metabolic and vascular condition on cognitive decline was based on the percent change in marginal variance (PCMV) for each condition. This measure was obtained by first determining the marginal variance of the linear mixed-effects model that included time, age, sex, and education (reference model). Next, a condition (diabetes, hypertension, heart disease, or stroke) was added to the reference model, and the marginal variance was recalculated. The PCMV for each condition was calculated according to the following general equation:

$$PCMV = [(MVAR_{risk\ factor} - MVAR_{ref}) / MVAR_{ref}] \times 100$$

where MVAR is the marginal variance of the model, the riskfactor subscript represents the marginal variance for the model that includes one of the four conditions, and the subscript ref represents the marginal variance estimate for the reference model.

Results

A total of 3050 participants were evaluated during the first examination, of which 2873 received an in-person interview and 2852 completed the MMSE. Remaining participants who had missing data for education, nativity (being born in the USA), smoking, alcohol consumption, marital status, language, or depressive symptoms ($n=85$) were excluded from the final sample ($n=2767$). Participants excluded from the final sample were older, less educated, less likely to consume alcohol or to be married, and more likely to have experienced a stroke but less likely to have hypertension compared with participants included in the final sample ($p<0.05$).

Characteristics of the Hispanic established populations for the epidemiologic study of the elderly

A descriptive summary of the final sample is provided in Table 1. The final sample was composed mostly of women ($n=1614$, 58.3%), and most participants completed 1–4 years of

education ($n=1010$, 36.5%). Hypertension was the most prevalent condition ($n=1741$, 62.9%), and diabetes was the second most prevalent ($n=672$, 24.3%). Considerably fewer participants had a self-reported history of heart disease ($n=244$, 8.8%) or stroke ($n=145$, 5.2%). A total of 777 participants had zero conditions, 1314 had one condition, 553 had two conditions, and 123 had three to four conditions.

Significant differences for sex, education, smoking, alcohol consumption, nativity, and depressive symptoms according to the number of metabolic and vascular conditions were detected. Women were more likely to have one or two conditions compared with men. Compared with participants with no education, those with 1–4 years of education were more likely to have one or two conditions. Current smokers were less likely to have one, two, or three to four conditions compared with never smokers. Current alcohol consumers were less likely to have one or two conditions, but former alcohol consumers were more likely to have three to four conditions compared with abstainers. Participants born in the USA were more likely to have two conditions compared with participants born outside the USA. Participants who had high depressive symptoms were more likely to have two or three to four conditions compared with participants without depressive symptoms.

Association between metabolic and vascular conditions and cognitive decline

Significant differences in the longitudinal cognitive trajectories according to the number of metabolic and vascular conditions were detected. Participants with two conditions declined 0.17 more points per year on the MMSE, and those with three to four conditions declined 0.56 more points per year on the MMSE compared with participants with zero conditions (Table 2). These results remained consistent after adjusting for demographic characteristics, smoking, alcohol consumption, language, and depressive symptoms (Table 2).

A subsequent analysis was conducted to determine if the cognitive decline observed for participants with two or three to four conditions was significantly greater than participants with one condition. Participants with two ($\hat{\beta}=-0.16$, standard error (SE)=0.05, $p<0.01$) or three to four ($\hat{\beta}=-0.55$, SE=0.11, $p<0.01$) conditions had significantly greater cognitive decline compared with participants with one condition. After adjusting for all confounders, participants with two conditions declined 0.16 (SE=0.05, $p<0.01$) more points per year on the MMSE, and participants with three to four conditions declined 0.54 (SE=0.11, $p<0.01$) more points per year on the MMSE compared with participants with one condition.

Sensitivity analysis

A limitation of the MMSE is the occurrence of a floor effect (Tombaugh and McIntyre, 1992), which causes the MMSE to underestimate the rate of cognitive decline among participants with low cognitive functioning when first examined (Galasko, Gould, Abramson, and Salmon, 2000). Therefore, the initial analysis was repeated with participants who scored <21 points on the baseline MMSE being excluded from the model ($n=572$, 20.7%). Participants who scored <21 points on the baseline MMSE were significantly older and were more likely to have zero years of education, be born outside of the USA, abstain from consuming alcohol, not be currently married, have the interview conducted in Spanish,

have high depressive symptoms, and report having a stroke compared with participants who scored >22 points on the MMSE during the baseline examination (Table 3).

The results from the linear mixed-effects model that excluded participants who scored <21 points on the MMSE were not qualitatively different from the initial unadjusted and adjusted analyses (Table 4). After adjusting for all covariates, participants with two or three to four conditions declined 0.25 and 0.57 points more per year on the MMSE, respectively, compared with participants with zero conditions. Also, participants with two ($\hat{\beta}=-0.23$, $SE=0.06$, $p<0.01$) or three to four ($\hat{\beta}=-0.55$, $SE=0.12$, $p<0.01$) conditions exhibited greater cognitive decline than participants with one condition.

Effect sizes of metabolic and vascular conditions on cognitive decline

The marginal variance for the model that included time, age, sex, and education (reference model) was 1.22. The addition of hypertension, diabetes, heart disease, and stroke all significantly improved the relative fit of the reference model based on the reduction in Akaike Information Criterion value. However, none of the conditions increased the marginal variance by more than 2%. Stroke increased the marginal variance by 1.9%, diabetes increased the marginal variance by 1.4%, and both hypertension and heart attack increased the marginal variance by less than 1%. A full model that included all four conditions increased the marginal variance of the reference model by 3.0%. The majority of marginal variance was explained by educational attainment, which increased the marginal variance of the full model by 40.7%. The percentage increase in marginal variance for age in the full model was 5.3%, and sex increased the marginal variance of the full model by less than 1%.

Discussion

This study presents new evidence that the rate of cognitive decline increases with the number of metabolic and vascular conditions. Participants with two or three to four conditions exhibited greater cognitive decline compared with participants with zero or one condition. Stroke and diabetes had the greatest effect on cognitive decline among the four metabolic and vascular conditions. Prior studies have reported associations between metabolic and vascular conditions and subsequent cognitive impairment (Exalto, Quesenberry, and Barnes *et al.*, 2014; Whitmer, Sidney, Selby, Johnston, and Yaffe, 2005), but this is the first known study to present evidence for an association between increasing number of metabolic and vascular conditions and greater severity in cognitive decline in a cohort of community-dwelling Mexican American older adults.

The present analyses also detected that Mexican Americans with high depressive symptoms were more likely to have been diagnosed with multiple metabolic and vascular health conditions compared with participants who did not exhibit depressive symptoms. This finding is consistent with prior research that indicates that there is a reciprocal relationship between mental and physical health. For instance, older adults with depression have been reported to be at greater risk for diabetes (Knol, Twisk, and Beekman *et al.*, 2006) and hypertension (Jonas, Franks, and Ingram, 1997), whereas older adults who have been diagnosed with diabetes or hypertension are more likely to become depressed compared

with older adults who do not have chronic health conditions (Garcia-Fabela, Melano-Carranza, and Aguilar-Navarro *et al.*, 2009; Zimmerman, Mast, Miles, and Markides, 2009). Because depression has been identified as a risk factor for cognitive impairment (Byers and Yaffe, 2011), it is important for research to be conducted that focuses on the role that depression and depressive symptoms has on the relationship between physical health conditions and cognitive decline among older adults.

Hypertension, diabetes, stroke, and heart disease are frequently comorbid conditions (Wong, Lopez, and L'Italien *et al.*, 2007), and these conditions may influence cognition through similar mechanisms. Hypertension and diabetes decrease blood flow to the brain by contributing to the formation of atherosclerotic plaques to important blood vessels that supply blood to the brain (Beckman, Creager, and Libby, 2002; Ladecola and Davisson, 2008). Older adults diagnosed with Alzheimer's disease are frequently observed to have atherosclerosis in the Circle of Willis (Roher, Tyas, and Maarouf *et al.*, 2011), which are arteries that supply blood to the brain. Furthermore, atherosclerosis is associated with white matter lesions (de Leeuw, De Groot, and Oudkerk *et al.*, 2000) and silent brain infarcts (Inoue, Matsumoto, Shono, Toyokawa, and Moriki, 2007), which increase the risk for cognitive impairment (Vermeer, Prins, and den Heijer *et al.*, 2003).

Diabetes is a highly prevalent condition among Mexican Americans (Cowie, Rust, and Byrd-Holt *et al.*, 2010), and diabetes was the second most prevalent condition in the current study. The high prevalence of diabetes in this population is concerning because this had the second highest effect size on cognitive decline. Previous research suggests that older adults with treated diabetes are at less risk for cognitive impairment compared with older adults with untreated diabetes (Awad, Gagnon, and Messier, 2004; Debling, Amelang, Hasselbach, and Sturmer, 2006). However, a longitudinal study of older Mexican Americans (Mayeda, Haan, Kanaya, Yaffe, and Neuhaus, 2013) reported that diabetes was a risk factor for dementia, but there was no significant difference in dementia risk for subjects who reported receiving treatment for diabetes compared with those with untreated diabetes. Ethnic and racial differences may contribute to these contradicting findings. Diabetes may also have a cumulative effect on cognition, and treatment for diabetes may need to be initiated earlier in life for any benefits to cognitive functioning later in life to be observed.

This study has important limitations. First, hypertension, diabetes, heart disease, and stroke were determined primarily by self-report. It has been suggested that the relationship between metabolic and vascular conditions and cognitive decline may be weakened when using self-reported measures for these conditions (Hayden, Zandi, and Lyketsos *et al.*, 2006). Self-reported measures of health conditions are reliable (Martin, Leff, Calonge, Garrett, and Nelson, 2000), but advancing age and minority status are associated with less agreement between self-report and medical records (Hunt and Bhopal, 2004; Okura, Urban, Mahoney, Jacobsen, and Rodeheffer, 2004). Therefore, it is possible that some participants were misclassified as having or not having a condition. A second limitation is that MMSE is the only cognitive measure included in the H-EPESE. The MMSE is frequently used in epidemiological studies but has known limitations including low specificity among minority older adults and participants who speak English as a second language (Ortiz, LaRue,

Romero, Sassaman, and Lindeman, 1997; Ramirez, Teresi, Holmes, Gurland, and Lantigua, 2006).

Despite these limitations, the findings from the present study have important clinical and public health implications. The finding that older Mexican Americans with only one health condition did not exhibit greater cognitive decline compared with those who did not have any of the four health conditions suggests that preventing and properly managing highly prevalent health conditions such as diabetes, hypertension, heart attack, and stroke can be beneficial to the cognitive health of older adults. This is supported by the findings from a study that reported a 10% reduction in the global prevalence of diabetes, and hypertension could prevent an estimated 81,000 and 160,000 global cases of Alzheimer's disease, respectively (Barnes and Yaffe, 2011). Future research on the effect that public health and clinical interventions targeted to older adults diagnosed with multiple health conditions have on cognitive outcomes is warranted.

Conclusion

In summary, this study observed that older Mexican Americans with multiple metabolic and vascular conditions experienced greater cognitive decline compared with those with zero or one condition. Also, stroke and diabetes had the greatest influence on cognitive decline. Public health and clinical interventions designed to reduce the prevalence of metabolic and vascular conditions, in particular diabetes and stroke, may decrease the severity of cognitive decline later in life among older Mexican Americans.

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References

- Aggarwal NT, Bienias JL, Bennett DA, et al. The relation of cigarette smoking to incident Alzheimer's disease in a biracial urban community population. *Neuroepidemiology*. 2006; 26:140–146. [PubMed: 16493200]
- Alonso A, Jacobs DR Jr, Menotti A, et al. Cardiovascular risk factors and dementia mortality: 40 years of follow-up in the Seven Countries Study. *J Neurol Sci*. 2009; 280:79–83. [PubMed: 19251275]
- Awad N, Gagnon M, Messier C. The relationship between impaired glucose tolerance, type 2 diabetes, and cognitive function. *J Clin Exp Neuropsychol*. 2004; 26:1044–1080. [PubMed: 15590460]
- Barnes DE, Yaffe K. The projected effect of risk factor reduction on Alzheimer's disease prevalence. *Lancet Neurol*. 2011; 10:819–828. [PubMed: 21775213]
- Beckman JA, Creager MA, Libby P. Diabetes and atherosclerosis: epidemiology, pathophysiology, and management. *JAMA*. 2002; 287:2570–2581. [PubMed: 12020339]
- Byers AL, Yaffe K. Depression and risk of developing dementia. *Nat Rev Neurol*. 2011; 7:323–331. [PubMed: 21537355]
- Cowie CC, Rust KF, Byrd-Holt DD, et al. Prevalence of diabetes and high risk for diabetes using A1C criteria in the U.S. population in 1988-2006. *Diabetes Care*. 2010; 33:562–568. [PubMed: 20067953]
- de Leeuw FE, De Groot JC, Oudkerk M, et al. Aortic atherosclerosis at middle age predicts cerebral white matter lesions in the elderly. *Stroke*. 2000; 31:425–429. [PubMed: 10657417]

- Debling D, Amelang M, Hasselbach P, Sturmer T. Diabetes and cognitive function in a population-based study of elderly women and men. *J Diabetes Complications*. 2006; 20:238–245. [PubMed: 16798475]
- Elias MF, Elias PK, Sullivan LM, Wolf PA, D'Agostino RB. Lower cognitive function in the presence of obesity and hypertension: the Framingham heart study. *International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity*. 2003; 27:260–268.
- Exalto LG, Quesenberry CP, Barnes D, et al. Midlife risk score for the prediction of dementia four decades later. *Alzheimers Dement*. 2014; 10:562–570. [PubMed: 24035147]
- Fitzmaurice, G.; Laird, N.; Ware, J. *Applied Longitudinal Analysis*. 2nd. John Wiley & Sons; Hoboken: 2011.
- Folstein MF, Folstein SE, McHugh PR. Mini-mental state. A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1975; 12:189–198. [PubMed: 1202204]
- Fryar CD, Hirsch R, Eberhardt MS, Yoon SS, Wright JD. Hypertension, high serum total cholesterol, and diabetes: racial and ethnic prevalence differences in U.S. adults, 1999–2006. *NCHS data brief*. 2010:1–8. [PubMed: 20423605]
- Galasko DR, Gould RL, Abramson IS, Salmon DP. Measuring cognitive change in a cohort of patients with Alzheimer's disease. *Stat Med*. 2000; 19:1421–32. [PubMed: 10844707]
- Garcia-Fabela L, Melano-Carranza E, Aguilar-Navarro S, et al. Hypertension as a risk factor for developing depressive symptoms among community-dwelling elders. *Rev Invest Clin*. 2009; 61:274–280. [PubMed: 19848303]
- Gorelick PB, Scuteri A, Black SE, et al. Vascular contributions to cognitive impairment and dementia: a statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2011; 42:2672–2713. [PubMed: 21778438]
- Haan MN, Mungas DM, Gonzalez HM, et al. Prevalence of dementia in older latinos: the influence of type 2 diabetes mellitus, stroke and genetic factors. *J Am Geriatr Soc*. 2003; 51:169–177. [PubMed: 12558712]
- Hayden KM, Zandi PP, Lyketsos CG, et al. Vascular risk factors for incident Alzheimer disease and vascular dementia: the Cache County study. *Alzheimer Dis Assoc Disord*. 2006; 20:93–100. [PubMed: 16772744]
- Hunt SM, Bhopal R. Self report in clinical and epidemiological studies with non-English speakers: the challenge of language and culture. *J Epidemiol Community Health*. 2004; 58:618–622. [PubMed: 15194728]
- Inoue K, Matsumoto M, Shono T, Toyokawa S, Moriki A. Increased intima media thickness and atherosclerotic plaques in the carotid artery as risk factors for silent brain infarcts. *J Stroke Cerebrovasc Dis*. 2007; 16:14–20. [PubMed: 17689386]
- Jonas BS, Franks P, Ingram DD. Are symptoms of anxiety and depression risk factors for hypertension? Longitudinal evidence from the National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study. *Arch Fam Med*. 1997; 6:43–49. [PubMed: 9003169]
- Knol MJ, Twisk JW, Beekman AT, et al. Depression as a risk factor for the onset of type 2 diabetes mellitus. A meta-analysis. *Diabetologia*. 2006; 49:837–45. [PubMed: 16520921]
- Ladecola C, Davisson RL. Hypertension and cerebrovascular dysfunction. *Cell Metab*. 2008; 7:476–484. [PubMed: 18522829]
- Lenoir H, Dufouil C, Auriacombe S, et al. Depression history, depressive symptoms, and incident dementia: the 3C study. *J Alzheimers Dis*. 2011; 26:27–38. [PubMed: 21558646]
- Markides, KS.; Rudkin, L.; Angel, RJ.; Espino, DV. Health status of Hispanic elderly. In: Martin, LG.; Soldo, BJ., editors. *Racial and Ethnic Differences in the Health of Older Americans*. National Academy Press; Washington DC: 1997. p. 285–300.
- Martin LM, Leff M, Calonge N, Garrett C, Nelson DE. Validation of self-reported chronic conditions and health services in a managed care population. *Am J Prev Med*. 2000; 18:215–218. [PubMed: 10722987]

- 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; 36:2600–2606. [PubMed: 23514732]
- Morgenstern LB, Smith MA, Lisabeth LD, et al. Excess stroke in Mexican Americans compared with non-Hispanic Whites: the Brain Attack Surveillance in Corpus Christi Project. *Am J Epidemiol*. 2004; 160:376–383. [PubMed: 15286023]
- Mozumdar A, Liguori G. Persistent increase of prevalence of metabolic syndrome among U.S. adults: NHANES III to NHANES 1999–2006. *Diabetes Care*. 2011; 34:216–219. [PubMed: 20889854]
- Narayan KM, Boyle JP, Thompson TJ, Sorensen SW, Williamson DF. Lifetime risk for diabetes mellitus in the United States. *JAMA*. 2003; 290:1884–1890. [PubMed: 14532317]
- Nguyen HT, Black SA, Ray LA, Espino DV, Markides KS. Predictors of decline in MMSE scores among older Mexican Americans. *J Gerontol A Biol Sci Med Sci*. 2002; 57:M181–5. [PubMed: 11867656]
- Okura Y, Urban LH, Mahoney DW, Jacobsen SJ, Rodeheffer RJ. Agreement between self-report questionnaires and medical record data was substantial for diabetes, hypertension, myocardial infarction and stroke but not for heart failure. *J Clin Epidemiol*. 2004; 57:1096–1103. [PubMed: 15528061]
- Ortiz IE, LaRue A, Romero LJ, Sassaman MF, Lindeman RD. Comparison of cultural bias in two cognitive screening instruments in elderly Hispanic patients in New Mexico. *Am J Geriatr Psychiatry*. 1997; 5:333–338. [PubMed: 9363290]
- Potluri R, Natalwala A, Uppal H, Heun R. Cardiovascular risk factors in vascular dementia and ischaemic stroke. *Neuroepidemiology*. 2008; 31:67. discussion 68. [PubMed: 18560245]
- Radloff LS. The CES-D Scale: a self-report depression scale for research in the general population. *Applied Psychological Measurement*. 1977; 1:385–401.
- Ramirez M, Teresi JA, Holmes D, Gurland B, Lantigua R. Differential item functioning (DIF) and the Mini-mental state examination (MMSE). Overview, sample, and issues of translation. *Med Care*. 2006; 44:S95–S106. [PubMed: 17060840]
- Roher AE, Tyas SL, Maarouf CL, et al. Intracranial atherosclerosis as a contributing factor to Alzheimer's disease dementia. *Alzheimer's & Dementia: The Journal of the Alzheimer's Association*. 2011; 7:436–444.
- Sundquist J, Winkleby MA, Pudaric S. Cardiovascular disease risk factors among older black, Mexican-American, and white women and men: an analysis of NHANES III, 1988–1994. Third National Health and Nutrition Examination Survey. *J Am Geriatr Soc*. 2001; 49:109–116. [PubMed: 11207863]
- Tombaugh TN, McIntyre NJ. The Mini-mental state examination: a comprehensive review. *J Am Geriatr Soc*. 1992; 40:922–935. [PubMed: 1512391]
- van Gelder BM, Tijhuis M, Kalmijn S, et al. Marital status and living situation during a 5-year period are associated with a subsequent 10-year cognitive decline in older men: the FINE study. *J Gerontol B Psychol Sci Soc Sci*. 2006; 61:P213–219. [PubMed: 16855033]
- Vermeer SE, Prins ND, den Heijer T, et al. Silent brain infarcts and the risk of dementia and cognitive decline. *N Engl J Med*. 2003; 348:1215–1222. [PubMed: 12660385]
- Wang KC, Woung LC, Tsai MT, et al. Risk of Alzheimer's disease in relation to diabetes: a population-based cohort study. *Neuroepidemiology*. 2012; 38:237–244. [PubMed: 22572745]
- Whitmer RA, Sidney S, Selby J, Johnston SC, Yaffe K. Midlife cardiovascular risk factors and risk of dementia in late life. *Neurology*. 2005; 64:277–281. [PubMed: 15668425]
- Wong ND, Lopez VA, L'Italien G, et al. Inadequate control of hypertension in US adults with cardiovascular disease comorbidities in 2003–2004. *Arch Intern Med*. 2007; 167:2431–2436. [PubMed: 18071164]
- Wright CB, Elkind MS, Luo X, Paik MC, Sacco RL. Reported alcohol consumption and cognitive decline: the northern Manhattan study. *Neuroepidemiology*. 2006; 27:201–207. [PubMed: 17047373]
- Wu JH, Haan MN, Liang J, et al. Impact of diabetes on cognitive function among older Latinos: a population-based cohort study. *J Clin Epidemiol*. 2003; 56:686–693. [PubMed: 12921938]

- Yaffe K, Blackwell T, Kanaya AM, et al. Diabetes, impaired fasting glucose, and development of cognitive impairment in older women. *Neurology*. 2004; 63:658–663. [PubMed: 15326238]
- Zimmerman JA, Mast BT, Miles T, Markides KS. Vascular risk and depression in the Hispanic Established Population for the Epidemiologic Study of the Elderly (EPSE). *Int J Geriatr Psychiatry*. 2009; 24:409–416. [PubMed: 18821725]

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Key points

- Older Mexico American adults with multiple comorbid conditions exhibit greater cognitive decline compared with older Mexican American adults with no comorbid conditions.
- Stroke accounted for the largest proportion of variance among the other risk factors (hypertension, diabetes, and heart attack).

Table 1

Descriptive characteristics of final sample according to the number of metabolic and vascular conditions

Characteristic	Total population (<i>n</i> = 2767)	Number of metabolic/vascular conditions				F-value/ χ^2 -value	<i>p</i>
		Zero (<i>n</i> = 777)	One (<i>n</i> = 1314)	Two (<i>n</i> = 553)	Three to four (<i>n</i> = 123)		
Age, mean (SD)	73.2 (6.5)	73.2 (6.4)	73.2 (6.6)	73.1 (6.3)	74.2 (6.1)	1.13	0.33
Sex, <i>n</i> (%)						15.0	<0.01
Male	1153 (41.7)	364 (31.6)	515 (44.7)	216 (18.7)	58 (5.0)		
Female	1614 (58.3)	413 (25.6)	799 (49.5)	337 (20.9)	65 (4.0)		
Education, <i>n</i> (%)						23.0	0.01
0	460 (16.7)	152 (33.0)	199 (43.3)	91 (19.8)	18 (3.9)		
1–4	1010 (36.5)	243 (24.1)	512 (50.7)	220 (21.8)	35 (3.5)		
5–8	841 (30.4)	246 (41.0)	395 (47.0)	155 (18.4)	45 (5.4)		
9+	456 (16.5)	136 (29.8)	208 (45.6)	87 (19.1)	25 (5.5)		
Smoking, <i>n</i> (%)						37.4	<0.01
Never	1615 (58.4)	413 (25.6)	796 (49.3)	337 (20.9)	69 (4.3)		
Former	798 (28.8)	218 (27.3)	376 (47.1)	163 (20.4)	41 (5.1)		
Current	354 (12.8)	146 (41.2)	142 (40.1)	53 (15.0)	13 (3.7)		
USA born, <i>n</i> (%)						9.0	0.03
No	1214 (43.9)	345 (28.4)	605 (49.8)	217 (17.9)	47 (3.9)		
Yes	1553 (56.1)	432 (27.8)	709 (45.7)	336 (21.6)	76 (4.9)		
Alcohol consumption, <i>n</i> (%)						29.9	<0.01
Abstainer	1513 (54.7)	403 (26.6)	737 (48.7)	310 (20.5)	63 (4.2)		
Former	675 (24.4)	172 (25.5)	307 (45.5)	154 (22.8)	42 (6.2)		
Current	579 (20.9)	202 (34.9)	270 (46.6)	89 (15.4)	18 (3.1)		
Marital status, <i>n</i> (%)						2.2	0.90
Never married	135 (4.9)	36 (26.7)	71 (52.6)	22 (16.3)	6 (4.4)		
Not currently married	1088 (39.3)	301 (27.7)	519 (47.7)	218 (20.0)	50 (4.6)		
Currently married	1544 (55.8)	440 (28.5)	724 (46.9)	313 (20.3)	67 (4.3)		
Language, <i>n</i> (%)						2.86	0.41
English	607 (21.9)	156 (25.7)	291 (47.9)	132 (21.7)	28 (4.6)		
Spanish	2160 (78.1)	621 (28.7)	1023 (47.4)	421 (19.5)	95 (4.4)		
Depression symptoms, <i>n</i> (%)						28.4	<0.01
No	2108 (76.2)	622 (29.5)	1018 (48.3)	390 (18.5)	78 (3.7)		
Yes	659 (23.8)	155 (23.5)	296 (44.9)	163 (24.7)	45 (6.8)		
Baseline cognition, mean (SD)	24.8 (4.5)	25.2 (4.4)	24.8 (4.4)	24.5 (4.9)	24.1 (5.1)	3.8	0.01

SD, standard deviation.

Bold indicates statistical significance $p < 0.05$. Analysis of variance was used for continuous characteristics and chi-squares for categorical characteristics. Percentages based on row totals.

Table 2

Relationship between metabolic and vascular conditions and cognitive decline

Variable	Model 1			Model 2			Model 3		
	β (SE)	t-value	p	β (SE)	t-value	p	β (SE)	t-value	p
Time Conditions	-0.56 (0.03)	-17.4	<0.01	-0.55 (0.03)	-17.2	<0.01	-0.55 (0.03)	-17.2	<0.01
0 (ref)									
1	-0.25 (0.19)	-1.3	0.19	-0.22 (0.17)	-1.3	0.18	-0.19 (0.16)	-1.2	0.24
2	-0.25 (0.23)	-1.1	0.28	-0.17 (0.21)	-0.84	0.40	-0.06 (0.21)	-0.28	0.78
3-4	-0.39 (0.42)	-0.93	0.35	-0.47 (0.37)	-1.3	0.20	-0.26 (0.37)	-0.70	0.48
Time $\times$ conditions									
0 (ref)									
1	-0.01 (0.04)	-0.19	0.85	0.003 (0.04)	0.08	0.94	0.003 (0.04)	0.08	0.94
2	-0.17 (0.05)	-3.2	<0.01	-0.16 (0.05)	-3.0	<0.01	-0.17 (0.05)	-3.01	<0.01
3-4	-0.56 (0.11)	-5.1	<0.01	-0.53 (0.11)	-4.9	<0.01	-0.53 (0.11)	-4.93	<0.01

SE, standard error.

p, p-value.

Model 1 only included time, condition summary score, and time by condition summary score interaction.

Model 2 adjusted for the effects of age, educational attainment, and gender.

Model 3 included covariates from model 2, nativity, smoking, alcohol consumption, language, and depressive symptoms.

Table 3

Differences between participants with impaired and normal Mini-mental state examination (MMSE) scores during the baseline examination

Characteristic	Baseline MMSE score		F-value/ χ^2 -value	p
	<21 (n = 572)	>21 (n = 2195)		
Age, mean (SD)	75.9 (7.3)	72.5 (6.0)	136.54	<0.01
Sex, n (%)			2.73	0.10
Male	221 (19.2)	932 (80.8)		
Female	351 (21.7)	1263 (78.3)		
Education, n (%)			286.58	<0.01
0	204 (44.3)	256 (55.7)		
1–4	254 (25.1)	756 (74.9)		
5–8	90 (10.7)	751 (89.3)		
9+	24 (5.3)	432 (94.7)		
Smoking, n (%)			1.90	0.39
Never	320 (19.8)	1295 (80.2)		
Former	172 (21.6)	626 (78.4)		
Current	80 (22.6)	274 (77.4)		
USA born, n (%)			18.97	<0.01
No	297 (24.5)	917 (75.5)		
Yes	275 (17.7)	1278 (82.3)		
Alcohol consumption, n (%)			25.77	<0.01
Abstainer	353 (23.3)	1160 (76.7)		
Former	142 (21.0)	533 (79.9)		
Current	77 (13.3)	502 (86.7)		
Marital status, n (%)			28.26	<0.01
Never married	33 (24.4)	102 (75.6)		
Not currently married	276 (25.4)	812 (74.6)		
Currently married	263 (17.0)	1281 (83.0)		
Language			9.02	<0.01
English	99 (16.3)	508 (83.7)		
Spanish	473 (21.9)	1687 (78.1)		
High depressive symptoms, n (%)			17.33	<0.01
No	398 (18.9)	1710 (81.1)		
Yes	174 (26.4)	485 (73.6)		
Hypertension, n (%)			0.35	0.55
No	206 (20.1)	820 (79.9)		
Yes	366 (21.0)	1375 (79.0)		
Diabetes, n (%)			1.47	0.23
No	422 (20.1)	1673 (79.9)		
Yes	150 (22.3)	522 (77.7)		
Heart disease, n (%)			1.57	0.21

Characteristic	Baseline MMSE score		F-value/ χ^2 -value	p
	<21 (n = 572)	>21 (n = 2195)		
No	514 (20.4)	2009 (79.6)		
Yes	58 (23.8)	186 (76.2)		
Stroke, n (%)			16.06	<0.01
No	523 (19.9)	2099 (80.1)		
Yes	49 (33.8)	96 (66.2)		

SD, standard deviation.

Bold indicates statistical significance $p < 0.05$. Analysis of variance was used for continuous characteristics and chi-squares for categorical characteristics. Percentages based on row totals.

Table 4

Relationship between metabolic and vascular conditions and cognitive decline excluding participants with impaired cognition during the baseline examination

Variable	Model 1			Model 2			Model 3		
	β (SE)	<i>t</i> -value	<i>p</i>	β (SE)	<i>t</i> -value	<i>p</i>	β (SE)	<i>t</i> -value	<i>p</i>
Time Conditions	−0.57 (0.04)	−15.7	<0.01	−0.58 (0.04)	15.6	<0.01	−0.58 (0.04)	31.3	<0.01
0 (ref)									
1	−0.18 (0.16)	−1.2	0.24	−0.19 (0.15)	−1.3	0.20	−0.18 (0.15)	−1.2	0.22
2	0.24 (0.20)	1.2	0.22	0.24 (0.19)	1.3	0.20	0.32 (0.19)	1.7	0.10
3–4	0.43 (0.37)	1.2	0.25	0.22 (0.35)	0.63	0.53	0.37 (0.35)	1.1	0.29
Time × conditions									
0 (ref)									
1	−0.02 (0.05)	−0.45	0.65	−0.01 (0.05)	−0.27	0.78	−0.01 (0.05)	−0.28	0.78
2	−0.25 (0.06)	−4.1	<0.01	−0.24 (0.06)	−3.9	<0.01	−0.24 (0.06)	−3.9	<0.01
3–4	−0.57 (0.13)	−4.5	<0.01	−0.56 (0.13)	−4.5	<0.01	−0.57 (0.13)	−4.5	<0.01

SE, standard error.

p, *p*-value.

These models excluded 572 participants who scored <21 on the baseline Mini-mental state examination.

Model 1 only included time, condition summary score, and time by condition summary score interaction.

Model 2 adjusted for the effects of age, educational attainment, and gender.

Model 3 included covariates from model 2, nativity, smoking, alcohol consumption, language, and depressive symptoms.