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Mexican American Dementia Nomogram (MADeN): The Development of a Dementia Risk Index for Mexican American Older Adults

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Abstract

OBJECTIVES—Several risk indices to predict dementia in non-Hispanic White populations exist, but no such measure has been developed for older Mexican Americans. The purpose of this study was to create a risk index (Mexican American Dementia Nomogram [MADeN]) that predicts dementia over a 10-year period for Mexican Americans aged 65 and older.

DESIGN—Retrospective cohort study with longitudinal analysis.

SETTING—Texas, New Mexico, Colorado, Arizona, and California

PARTICIPANTS—1,739 participants of the Hispanic Established Populations for the Epidemiologic Study of the Elderly (H-EPESE).

MEASUREMENTS—Dementia was defined as a decline of 3 or more points per year on the Mini Mental Status Exam and inability to perform 1 or more daily activities. Candidate risk factors included demographic characteristics, measures of social engagement, self-reported health conditions, ability to complete daily activities, and physical activity.

RESULTS—The MADeN included age, gender, education, not having friends to count on, not attending community events, diabetes, feeling the blues, pain, impairment in instrumental activities of daily living, and unable to walk a half-mile. The area under the curve was 0.74 (95%

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CI=0.70–0.78) and a score of 16 points or higher had a sensitivity of 0.65 (95% CI=0.59–0.72) and specificity of 0.70 (95% CI=0.67–0.73).

CONCLUSION—The MADeN is able to predict dementia in a population of older Mexican American adults with moderate accuracy. The MADeN has the potential be used to identify older Mexican American adults who may benefit from interventions to reduce dementia risk and to educate this population about risk factors for dementia.

Keywords

Cognition; Minority Aging; Mexican Americans; Dementia

INTRODUCTION

An estimated 46 million people are currently living with dementia worldwide, which contributes to a global economic burden exceeding \$800 billion [1]. Alzheimer's disease (AD) is the most common type of dementia and in 2010 approximately 4.7 million adults aged 65 years in the United States were living with AD [2]. Ethnic disparities in dementia have been reported with higher rates observed for Hispanic compared to non-Hispanic White older adults [3]. Hispanics represent the largest minority population in the United States [4]. Older Hispanics are characterized by high prevalence rates of risk factors for dementia including diabetes [5] and low educational attainment [6]. These health and sociodemographic characteristics make Hispanic older adults a high-risk population for dementia and the number of Hispanics with AD and related dementias could increase from fewer than 200,000 to 1.3 million by 2050 if no preventive measures are undertaken [7].

Administering treatments and interventions before the clinical symptoms of dementia are observed is a potential strategy to reduce the future prevalence of dementia. This has contributed to increased efforts to identify middle-aged and older adults who are high-risk for dementia. Several indices have been developed that have moderate to high accuracy for predicting dementia [8–12]. However, existing indices have been developed using data from non-Hispanic White populations and no indices have been developed specifically for Hispanic older adults. The low educational attainment as well as the unique social and cultural characteristics of Hispanic populations make it necessary to develop dementia risk indices that are specific to these populations. Thus, the objective of the present study was to use data from the Hispanic Established Populations for the Epidemiologic Study of the Elderly (H-EPESE) to create a dementia risk index for older Mexican Americans (Mexican American Dementia Nomogram [MADeN]).

METHODS

Sample Population and Sample Selection

This analysis used data from the H-EPESE collected during five waves of observation (1993–94, 1995–96, 1998–99, 2000–01, 2004–05) [13]. The H-EPESE is a longitudinal study of Mexican Americans aged 65 living in Texas, New Mexico, Colorado, Arizona, and California. A total of 3,050 participants were evaluated during the baseline observation in 1993–94 and the follow-up rate for the baseline sample was 86%. The majority of

participants interviewed at baseline were living in Texas (n=1,932) or California (n=828) and less than 10% of participants were living in New Mexico, Colorado, or Arizona. The final sample for the present analysis included 1,739 participants who scored >23 on the Mini Mental Status Examination (MMSE) [14] during the baseline observation.

Classification of Dementia

The criteria used to classify dementia in the present study are consistent with the guidelines proposed by the Alzheimer's Association and National Institute on Aging Workgroup [15]. Participants were classified as having dementia if they exhibited a decline of 3 points per year on the MMSE and were unable to independently perform 1 activities of daily living (ADL; walk across a small room, bathing, personal grooming, dressing, eating, getting from a bed to a chair, and toileting) or instrumental ADLs (IADL; use a telephone, manage money, manage medications, prepare a meal, go shopping, driving/transportation, and light housework). According to these criteria a participant observed at 1993–94 and 1995–96 would need to decline 6 points on the MMSE and be impaired in 1 ADLs or IADLs to be classified as having dementia. The age of dementia onset was estimated by calculating the mid-point between the last observation in which a participant was non-demented and the first observation in which a participant was classified as having dementia.

Candidate Risk Factors for the Mexican American Dementia Nomogram

Candidate risk factors for the MADeN were selected based on those included previous dementia indices and availability in the baseline observation of the H-EPESE cohort. Risk factors for dementia that may be unique to Mexican American older adults were also selected (e.g., language, country of birth). Candidate risk factors were grouped into six domains: *demographics*: age (continuous), current marital status (married, not married), having been born in the United States or Mexico, having completed < 4 years of education, and English proficiency (low-moderate, high-very high); *social engagement*: having friends you can count on, having friends you can talk to, and participating in community events (e.g., attending social events or church activities); *physical health*: body mass index, having ever been diagnosed by a physician or health professional with diabetes, hypertension, heart attack, or stroke. Additional physical health risk factors included self-reported pain when standing or walking, and poor sleep (difficulty falling or staying asleep, waking up several times per night, or waking up feeling tired); *mental health*: individual items from the Center for Epidemiologic Studies Depression (CES-D) Scale [16]. *IADLs*: impairment in 1 IADLs; and *physical activity*: ability to walk a half-mile.

Statistical Analysis

The demographic and health characteristics of the final sample according to dementia and mortality status (non-impaired, dementia, dead) were evaluated using analysis of variance for continuous variables and χ^2 tests for categorical variables. The relationship between potential risk factors and dementia was examined using competing risk regression models [17]. This approach was used because death is a competing event to dementia and may bias estimates if not accounted for in the analysis [18]. Participants were observed from baseline until the onset of dementia, death, or censoring. Participants were classified as censored if

they did not develop dementia, were alive during the fifth observation, or were known to be alive during their last recorded observation.

Risk factors to be included in the MADeN were selected using two steps. First, competing risk models that controlled for age, gender, and education were used to identify risk factors associated with dementia at $P < 0.20$ level of significance. Risk factors identified in step one were included in a final competing risk model. The beta coefficients from the final model were used to assign a point value to each risk factor and the total value was calculated to obtain the overall risk score [19].

The ability of the MADeN to predict dementia was evaluated by calculating the area under the curve (AUC) for the receiver operator characteristic (ROC). The MADeN was internally validated using 2000 bootstrap samples. A 95% confidence interval of the AUC was calculated using the bias-corrected and adjusted method, which estimates the confidence interval using the distribution of AUC values from the bootstrapped samples [20]. Calibration was assessed by comparing the observed and predicted probability for dementia according deciles of the MADeN using the Hosmer-Lemeshow χ^2 test.

RESULTS

Sample Characteristics

The characteristics of the 1,739 participants included in the final sample according to dementia and mortality status are presented in Supplementary Table 1. A total of 229 participants developed dementia, 550 participants who were not observed to develop dementia between 1993–94 and 2004–05 died over the follow-up period, and 960 participants remained non-impaired. The majority ($n=645$) of the 960 participants who remained non-impaired were observed at the 2005–06 wave and the remaining 315 participants were censored prior to the 2005–06 wave. The follow-up rate at each wave for the final sample was approximately 85% and around 5% of participants in the final sample who missed an interview were re-interviewed at a later wave (e.g., 5% of participants not interviewed in 1995–96 were interviewed in 1998–99).

Compared to participants who remained non-impaired, those with dementia were older and were more likely to have low educational attainment, not be currently married, to not be socially engaged, to have diabetes, heart attack, pain, to be impaired in 1 IADLs, and unable to walk a half-mile ($P < 0.05$). Participants who died were significantly older, and more likely to be male, to have high-very high English proficiency, to not have close friends to talk to, to not be socially engaged, to be normal or underweight, to have diabetes, heart attack, stroke, to report poor sleep, to have high depressive symptoms, to be IADL impaired, and to be unable to walk a half-mile compared to non-impaired participants ($P < 0.05$).

MADeN Risk Index

The results for the final competing risk regression model are provided in Table 1. A summary of the point value for each risk factor used to calculate the total MADeN score is presented in Figure 1. The MADeN included age (1 point for each year >65), female gender (3 points), low education (5 points), not having friends to count on (3 points), not attending

community events (2 points), diabetes (2 points), feeling the blues (4 points), pain (3 points), IADL impaired (3 points), and being unable to walk a half-mile (6 points). The results of the 2000 bootstrap samples estimated the AUC to be 0.74 (95% CI=0.70–0.78). A score of 16 points had a sensitivity of 0.65 (95% CI=0.59–0.72) and specificity of 0.70 (95% CI=0.67–0.73).

The results of the concordance analysis indicated that the MADeN is well calibrated. Approximately 5.3% and 52.1% of participants in the first and tenth deciles, respectively, were observed to develop dementia. The predicted 10-year incidence for dementia was 4.6% for the first decile and 45.0% for the tenth decile. The predicted and observed 10-year incidence was within 10% across all deciles and the Hosmer-Lemeshow χ^2 value was 7.2 ($P=0.52$). This provides evidence that there is not a significant difference between the predicted and observed 10-year incidence of dementia according to deciles of the MADeN.

DISCUSSION

This is the first study to develop a comprehensive risk index to predict dementia among community-dwelling older Mexican American older adults. The MADeN predicted dementia with moderate accuracy (AUC=0.74) and a score of 16 points had a sensitivity of 0.65 (95% CI=0.59–0.72) and specificity of 0.70 (95% CI=0.67–0.73). These results indicate the MADeN can be used to identify Mexican American older adults who are potentially high risk for dementia. The accuracy of the MADeN is sufficient for it to be used as a tool to educate older Mexican American adults about dementia risk, the importance of adopting positive health behaviors, and to identify individuals for health promotion interventions [21].

The majority of risk factors in the MADeN have been consistently included in other dementia indices. Advancing age, low educational attainment, and diabetes are important predictors of dementia, but these risk factors may be especially important for older Mexican Americans because of the high prevalence of diabetes [5], greater life expectancy [22], and significant socioeconomic disadvantages [6] of this population. Risk factors included in the MADeN that are not found in other indices are pain and measures of social support and social engagement. Older adults with severe pain have been observed to exhibit lower cognitive functioning compared to older adults with little or no pain [23]. Pain may contribute to worsening cognition through depressed mood [24] and the potential negative effects of pain medications on cognitive functioning [25]. Social support and engagement can play a significant role in health outcomes for older adults. Greater social engagement can be beneficial for cognitive functioning and is associated with decreased risk for dementia [26]. Social support and social engagement are important constructs of Hispanic culture [27], which may make these protective factors especially important for older Mexican Americans.

This study has important limitations that warrant discussion. First, the H-EPESE does not include a clinical diagnosis of dementia and cases were identified according to a decline on the MMSE and self-reported limitations on ADLs or IADLs. This may decrease the accuracy of the MADeN due to misclassification of dementia status. Additionally,

classifying participants into a broad category of dementia may decrease the accuracy of the MADeN because risk factors for vascular dementia, AD, and other types of dementia may vary. Also, we were unable to determine if the 550 individuals who died had a diagnosis of AD or other dementia at the time of death. This may influence the final results because these individuals were classified as not having dementia at the time of their last observation and it is plausible that these individuals subsequently developed dementia prior to death. A second potential limitation is nearly a third of the 960 participants who did not develop dementia were censored prior to the 2005–06 wave. However, the average score on the MADeN for participants who were censored prior to the 2005–06 wave and those with complete follow up was 13.7 and 13.4 points, respectively. This difference in the average MADeN score was not statistically significant ($p = 0.69$). Third, candidate risk factors were assessed using self-reported data, which is subject to recall bias. Finally, the H-EPESE only includes Hispanics who are Mexican American. The majority of the Hispanic population in the United States are of Mexican origin, but a growing proportion of the population includes people of Puerto Rican, Central and South American, and Cuban descent [28]. This diversity contributes to important differences between Hispanic sub-populations in socioeconomic status [29] and health [30]. This makes it necessary to externally validate the MADeN in other Hispanic populations.

Despite these limitations, a strength of the MADeN is it is comprised of measures that can be collected during a routine physical examination. This means healthcare professionals can use the sociodemographic and health measures collected as part of a routine visit to estimate a patient's risk for developing dementia within a 10-year period according to the MADeN. This information can be used by a healthcare professional to identify older Mexican American adults who may be high-risk for dementia, and to educate patients about risk factors for dementia and ways they may be able to potentially reduce their risk for dementia. In research settings the MADeN can be used to identify older Mexican American adults who may be high-risk for dementia and can be enrolled in preventive interventions.

CONCLUSION

In summary, this study developed a risk index for Mexican Americans that was able to predict dementia in this population with moderate accuracy. The MADeN can be used in research settings to identify participants for lifestyle interventions that are designed to reduce dementia risk by targeting potentially modifiable risk factors. The MADeN also has the potential to be a useful in clinical and research settings to identify individuals who are high-risk for dementia, educate individuals about dementia risk factors, and to promote healthy lifestyles. However, additional research into the effectiveness of the MADeN to educate Mexican American adults about risk factors for dementia and to promote lifestyle changes in this population is necessary before it can be used in clinical settings. Continued research is necessary to externally validate the MADeN in other Hispanic populations and to identify other risk and protective factors that may improve the accuracy of the MADeN.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Employment or Affiliation		X		X		X		X		X		X
Grants/Funds		X		X		X		X		X		X
Honoraria		X		X		X		X		X		X
Speaker Forum		X		X		X		X		X		X
Consultant		X		X		X		X		X		X
Stocks		X		X		X		X		X		X
Royalties		X		X		X		X		X		X
Expert Testimony		X		X		X		X		X		X
Board Member		X		X		X		X		X		X
Patents		X		X		X		X		X		X
Personal Relationship		X		X		X		X		X		X

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Demographics	Points	Social Interaction	Points	Health	Points	Functioning	Points
Age	1 pt. >65	No friends to count on	3	Diabetes	2	*IADL impaired	3
Female	3	Not attend community events	2	Feel the blues	4	Cannot walk ½ mile	6
< 4 yrs edu	5			Pain	3		
*Impaired in 1 or more IADLs (cannot use a telephone, drive a vehicle, go shopping, prepare meals, do light housework, manage medications, or manage money without help)

Calculate the Sum of the Demographics, Social Interaction, Health, and Functioning Scores

MADeN Score	Predicted 10-Year Dementia Risk (%)
0-5	5
6-8	6
9-10	8
11-12	11
13	14
14-16	19
17-18	24
19-22	30
23-27	37
28+	45

Figure 1.

Summary of the Hispanic Dementia Nomogram (MADeN) Risk Score to Obtain Estimated 10-Year Dementia Risk

Note: The nomogram can be used to estimate an older Mexican American adult's 10-year dementia risk by summing the points for his or her demographic, social, health, and functional characteristics.

Table 1

Final Competing Risk Regression Model for Mexican American Dementia Nomogram

Risk Factor	β (SE)	HR (95% CI)
Age	0.06 (0.01)	1.06 (1.04–1.09)
Female	0.19 (0.15)	1.21 (0.91–1.61)
< 4 years edu	0.33 (0.14)	1.39 (1.05–1.84)
Does not have friends to count on	0.20 (0.16)	1.22 (0.90–1.65)
Does not attend community events	0.10 (0.14)	1.11 (0.84–1.46)
Diabetes	0.14 (0.16)	1.15 (0.85–1.57)
Feels the blues	0.26 (0.15)	1.30 (0.97–1.75)
Pain	0.19 (0.15)	1.21 (0.90–1.61)
IADL impaired	0.17 (0.18)	1.18 (0.83–1.68)
Can not walk half-mile	0.38 (0.19)	1.46 (1.02–2.11)

β = coefficient, SE = Standard Error, HR= Hazard Ratio, CI = Confidence Interval