# MINI-MENTAL STATE EXAM DOMAINS PREDICT FALLS IN AN ELDERLY POPULATION: FOLLOW-UP FROM THE HISPANIC ESTABLISHED POPULATIONS FOR EPIDEMIOLOGIC STUDIES OF THE ELDERLY (H-EPESE) STUDY

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**Objectives:** Assessment of the predictive ability of the Mini-Mental Status Exam (MMSE) domains (orientation to time, orientation to place, registration, attention and calculation, recall, language, and visual construction) for falls in Mexican American elders tested the hypothesis that low MMSE domain scores are related to an increased number of falls.

**Design:** Data were obtained from the 1998–99 re-survey (Wave 3) Hispanic Established Populations for the Epidemiologic Study of the Elderly (H-EPESE), a population-based study of older Mexican Americans residing in the southwestern United States.

**Methodology:** We used a retrospective case control study design; 926 subjects who were aged ≥77 years at Wave 3 were examined. MMSE scores were utilized to predict falls two years later. Measurements included sociodemographic characteristics, MMSE scores, activities of daily living (ADL), instrumental activities of daily living (IADL), and fall rates.

**Main Outcome Measures:** Relationships between MMSE domain scores and falls.

**Results:** Of the 681 subjects examined two years later, 35.7% experienced at least one fall. Subjects with errors on orientation to place (OR = 2.01) and visual construction (OR = 1.9) were most likely to fall.

**Conclusions:** MMSE domains with poor scores and most predictive of falls in Mexican Americans elders were orientation to place and visual construction. Further evaluation for confusion level and visual ability in elders presenting with dysfunction on these domains may lead to a reduction of falls in this ethnic group. (*Ethn Dis.* 2010;20:48–52)

**Key Words:** Cognition, Frailty, Mexican American, Elderly

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## INTRODUCTION

Falls are a serious problem among the elderly. The World Health Organization classifies falls as the third leading cause of chronic disability worldwide.[1] The annual incidence of falls in community-dwelling individuals aged ≥ 65 years is approximately 30%; the incidence rate increases up to 50% in persons aged >80 years.[2] About 30% of community-living older persons > aged 65 years fall each year, and this proportion increases to 50% in those aged >75 years.[3–5] Direct medical costs for fall-related injuries in 2000 totaled approximately $19 billion.[6] Falls are the main cause of injury-related deaths in the elderly population,[7] with roughly 10,000 deaths each year that are associated with falls in elder persons living in the United States.[8]

It is well-established that cognitive impairment and dementia are significant risk factors for falls.[4,9,10] Harrison and colleagues demonstrated that an increase in the number of falls and corresponding needed assistance among nursing home residents is associated with cognitive decline.[11] When compared to people without dementia, elders with dementia are four times more likely to sustain a hip fracture as a result of a fall, and have a three-fold increase of mortality within six months after the hip fracture.[12] Low Mini-Mental State Exam (MMSE) scores have also been associated with an increased falls risk in older adults.[13–15]

*The purpose of this study was to assess the predictive ability of MMSE domains for future falls in a Mexican American community-based sample.*

The association between cognitive function and falls is of particular interest to the Hispanic community because Mexican Americans have high cognitive impairment and hip fracture rates.[16–18] Current available studies detailing the relationship between falls and MMSE-associated cognitive impairment have disproportionately concentrated on the MMSE aggregate score as risk factors for falls vs than on each cognitive domain.

The purpose of this study was to assess the predictive ability of MMSE domains for future falls in a Mexican American community-based sample.

## METHODS

### Sample

For this study, we used data from the Hispanic Established Populations for the Epidemiologic Study of the Elderly (H-EPESE) study. This ongoing, longitudinal, population-based study of self-identified Mexican Americans residing in one of the five southwestern states of Texas, New Mexico, Colorado, Arizona, or California began in 1991. Sampling and data

**Table 1. Sociodemographic variables of sample aged ≥77 years at Wave 3**

| | N | Mean ± SEM | Range |
|---|---|---|---|
| Age | 926 | 82.5 ± .158 | 77–104 |
| | *N* | Weighted% | |
| Sex | | | |
| Female | 558 | 59.5% | |
| Male | 368 | 40.5% | |
| Marital Status (married) | 350 | 38.8% | |
| Highest Grade | | 4.0 ± 0.2 | |
| Diabetes (diagnosed) | 202 | 23.5% | |
| Heart Attack (diagnosed) | 71 | 9.4% | |
| Hypertension (diagnosed) | 529 | 60.2% | |
| Stroke (diagnosed) | 71 | 7.3% | |
| Cancer (diagnosed) | 70 | 7.6% | |
| Hip Fractures (diagnosed) | 36 | 3.6% | |
| Other Fractures (diagnosed) | 62 | 7.0% | |
| Activities of Daily Living (need assistance) | 314 | 34.3% | |
| Instrumental Activities of Daily Living (need assistance) | 593 | 69.4% | |
| Performance Oriented Mobility Assessment (POMA) (score < 5) | 345 | 42.4% | |
| Mini-Mental State Exam (scored <24) | 602 | 69.7% | |

collection methods can be found elsewhere.[19] We used data from wave 3, which occurred during 1998–1999 and wave 4, which occurred in 2000–2001. We examined subjects in Wave 3 aged ≥ 77 years ($n$=926) most likely to experience a prospective fall.[4] By Wave 4, 169 subjects had died and 56 were missing (due to refusal or relocation), resulting in 681 subjects who had information about falls. Of the 681, only 618 had usable MMSE data and comprised the sample to predict falls two years later. (Table 1)

## Measures

Cognitive function was assessed in Wave 3 (1998–1999) using the MMSE.[20] The MMSE contains seven domains, each with an assigned point value totaling 30: orientation to time (5 points), orientation to place (5 points), three word registration (3 points), attention and calculation (5 points), three word recall (3 points), language (8 points), and visual construction (pentagon copying where the subject draws two intersecting pentagons, 1 point). An MMSE score ≥24 was considered normal cognitive function, while scores <24 indicated cognitive impairment. For analysis purposes, each domain score was constructed by contrasting any error against a perfect score.

Falls information was obtained from wave 4 (2000–2001) using the following question: ''During the past 12 months, how many times did you fall and land on the floor or ground?''

Fall status was dichotomized as no falls vs one or more falls. The single falls question has been used in numerous epidemiologic studies.[21,22]

## Other Variables

Sociodemographic characteristics, an elder's age, sex, and marital status, were recorded.

Medical conditions were assessed by self report regarding diabetes mellitus, myocardial infarction, hypertension, cerebrovascular accident, neoplasm, hip fractures or other fractures.

Functional status was assessed by measures of activities of daily living (ADL),[23] and instrumental activities of daily living (IADL).[24] Both ADLs and IADLs were scored either zero or one for any assistance.

Lower body performance was assessed utilizing Tinetti's Performance Oriented Mobility Assessment (POMA), which uses three measures: a standing balance task, a timed eight-foot walk, and a timed repeated-chair-stands task.[25] The subjects received a score ranging from 0 to 4 for each task performed. The subjects received a 0 score if they were unable to complete the task, and assigned a 1–4 score if they were able to perform the task. Scores for the independent measures were summed to calculate an overall performance score ranging from 0 to 12, with higher scores representing better lower extremity function.

Depressive symptomatology was assessed using the Center for Epidemiological Studies Depression Scale (CES-D).[26] A score of ≥16 indicated depression.

## Data Analysis

Data were analyzed using the complex sample survey weights and compiled into descriptive statistics, simple 2-way cross classification tables, and finally the results of a series of logistic regressions. A cross tabulations table was constructed with odds ratios, their corresponding 95% confidence intervals, and $P$ values from Pearson chi-square tests. This table helped identify a significant association of each MMSE domain score between subjects who reported having experienced a fall and those who reported no falls. All MMSE domains with $P$ values of ≤.25 were selected into the first model of a series of logistic regressions to determine the likelihood of experiencing a fall. The least significant predictor MMSE domain was discarded and the logistic model was re-tested until the remaining terms had a $P$ value ≤.05. All analyses were performed using STATA SE (v8.2, 2008, College Station, TX, STATA-Corp LP) as the statistical program.

**Table 2. Weighted likelihood for falling by MMSE domain errors in 618 subjects, 35.7% of whom experienced falls in the most recent 12 months**

| Mini-Mental State Exam | Odds Ratio | 95 % Confidence Interval (Lower–Upper) | *P* value |
|---|---|---|---|
| Total MMSE Score | | | |
| 0 thru 23 vs 24 thru 30 | 1.64 | 1.04–2.58 | .035 |
| MMSE Domains | | | |
| Orientation to time | 1.58 | 0.99–2.52 | .054 |
| Orientation to place‡ | 2.01 | 1.32–3.05 | .001 |
| Registration | .964 | 0.48–1.93 | .917 |
| Attention and calculation* | 1.77 | 1.07–2.93 | .026 |
| Recall | 1.19 | 0.79–1.77 | .409 |
| Language | 1.06 | 0.6–1.86 | .851 |
| Visual construction† (pentagon) | 1.9 | 1.12–3.08 | .01 |

* $P \leq .05$
† $P \leq .01$
‡ $P \leq .001$

## RESULTS

Of the 618 subjects available at the follow-up in wave 4 two years later, 246 (35.7%) reported having experienced one or more falls in the past 12 months. This incidence rate is similar to other community-based older cohorts.[4,16] Mean age of the sample was 82.5 years. Subjects with MMSE scores <24 were more likely to fall (OR = 1.64).

### Comparison of falls and MMSE domain errors

Table 2 represents the association of the MMSE domain errors with having fallen in the past 12 months of those who had usable MMSE data ($n$=618). Of significance, subjects who made at least one error on MMSE domain orientation to place were 2.01 times more likely to have fallen compared to those who made no errors on this MMSE domain (95% CI, 1.32–3.05). Compared to subjects who scored perfectly on the attention and calculation domains of the MMSE, subjects who did not score perfectly were 1.77 times more likely to have fallen in the past 12 months (95% CI, 1.07–2.93). Subjects who made an error on the visual construction domain (pentagon copying) were almost twice as likely (OR = 1.9) to have fallen in the past 12 months when compared to subjects who made no errors (95% CI, 1.12–3.08).

The results for the Pearson chi-square test used to analyze the association between falls and MMSE domains indicate there were significant or near significant differences between those who had fallen and those who had not fallen on the MMSE domains of orientation to time ($P$ =.054), orientation to place ($P$ <.001), attention and calculation ($P$ =0.026) and visual construction ($P$ <.01). However, there were no significant differences between those who had fallen and those who had not fallen on the MMSE domains of registration ($P$ =.917) and recall ($P$ =.409) or language ($P$=.851). The domains that demonstrated significance at an alpha criteria of 0.25 or less were selected to be analyzed in the series of logistic regressions.[27]

*The findings indicate that older Mexican Americans are at an increased falls risk when they score poorly on the MMSE domain for visual construction and, to a lesser degree, orientation to place.*

The logistic regression model contained the domains for orientation to time, orientation to place, attention/calculation, and visual construction. The final model retained only the domains for orientation to place and visual construction (Table 3). The goodness of fit statistic $P$ value for this model was .76, indicating that there was no difference between the predicted values from the model and the actual data.

## DISCUSSION

To our knowledge, this appears to be the first study to examine the association between falls and MMSE domain errors in a community-based elder sample. The findings indicate that older Mexican Americans are at an increased falls risk when they score poorly on the MMSE domain for visual construction and, to a lesser degree, orientation to place. Only two out of seven domains appear to be driving the association with total MMSE to falls.

**Table 3. Logistic regression model estimates for falls based on MMSE Domain errors in 618 subjects, 35.7% of whom experienced falls in the most recent 12 months**

| MMSE Domain | Odds Ratio | 95 % Confidence Interval (Lower–Upper) | *P* value |
|---|---|---|---|
| Orientation to place | 1.81 | 1.19–2.76 | .006 |
| Visual construction (pentagons) | 1.67 | 1.01–2.74 | .044 |

The pentagon copying item is a measure of visuospatial, motor and constructional skills. Subjects who scored lower on this item may have a problem with risk judgment due to visuospatial, motor or constructional errors. Visuospatial/constructional dysfunction has been associated with a variety of dementias which can further increase the risk of falls in subjects with these diseases.[28–30] These areas of deficit could present problems on transferring or ambulation, subsequently increasing the risk for falls.

Orientation to place was significantly associated with falls. Our results are similar to Salgado and colleagues,[31] whose results indicated a direct association between the MMSE-orientation domain and falls in a hospitalized population. It has also been found that the orientation to place domain is associated with delirium and resistance to delirium recovery in hospitalized patients.[32] The increased confusion associated with a loss of sense of place may be related to a delirium state which, in turn, contributes directly to falls. More work in this area is clearly needed.

The recall domain did not prove to be significantly associated with falls in our cohort. This finding contradicts the findings of Van Schoor et al,[15] who found that immediate memory may be the strongest risk factor for recurrent falls.

This study had several limitations. Reliance on self-reported falls may underestimate the true fall rates in this community, although the rate of falls seen in the H-EPESE was similar to that seen in other community-based falls studies.[33] Also, the nature of the analysis can not confer direct causality between domain score and falls. Finally, dichotomizing domains with multiple possible scores (attention, calculation) may lead to underestimating the impact these domains may have on falls risk.

In conclusion, the MMSE domains most predictive of older Mexican American falls were orientation to place and visual construction. Further evaluation for confusion level and visual ability in elders who present with dysfunction on these domains may lead to a reduction of falls in this ethnic group.

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