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Executive Function [Capacity for Behavioral Self-regulation] and Decline Predicted Mortality in a Longitudinal Study in Southern Colorado

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Abstract

Objective—To assess the relationship between mortality and impairment and decline in a specific executive cognitive function, the capacity for behavioral self-regulation.

Study Design & Setting—This study examined the association between mortality and baseline and 22-month decline in the capacity for behavioral self-regulation, as measured by the Behavioral Dyscontrol Scale, among 1,293 participants of the San Luis Valley Health and Aging Study (SLVHAS), a population-based longitudinal study. The Behavioral Dyscontrol Scale and a measure of overall mental status, the Mini-Mental State Examination, were administered at baseline and follow-up interviews. Cox regression was used to examine baseline and decline in capacity for behavioral self-regulation as possible predictors of mortality.

Results—Baseline Behavioral Dyscontrol Scale score was predictive of mortality, independent of demographics and comorbidity count (HR=1.07; 95% CI:1.04–1.09). It remained a significant predictor with further adjustment for Mini-Mental State Examination score. Decline in this specific executive cognitive function was associated with mortality after adjustment for covariates and baseline cognitive scores (HR=1.09; 95% CI:1.04–1.13).

Conclusion—Thus, both baseline capacity for behavioral self-regulation and its decline over time predicted mortality in the SLVHAS cohort. These associations may partly be due to maintaining the ability for self-care. Understanding how specific forms of impairment contribute to mortality may help identify patients who could benefit from early intervention.

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Keywords

executive cognitive function; cognitive impairment; cognitive decline; mortality; Hispanic; San Luis Valley Health and Aging Study

Introduction

Previous research shows moderate associations between cognitive impairment and mortality among older individuals [1–8]. Typically [9–15], these studies have employed general (e.g. Mini-Mental State Examination) [16], rather than specific measures of cognitive function [1, 3–6]. Understanding whether and how specific forms of cognitive impairment and decline contribute to mortality, independent of known risk factors, may help identify patients who could benefit from intervention.

In this study, the relationship between baseline executive cognitive function, its decline over time, and subsequent mortality was examined in the rural, elderly, Hispanic and non-Hispanic white (NHW) cohort of the San Luis Valley Health and Aging Study (SLVHAS). The executive cognitive function of interest, the capacity for behavioral self-regulation [17], involves the initiation of purposeful behavior and the inhibition of inappropriate actions [18]. We measured this executive cognitive function using the Behavioral Dyscontrol Scale, which is dissociable from, although correlated with, both more general measures of cognitive ability or mental status, such as the Mini-Mental State Examination, and other specific cognitive abilities (e.g., declarative learning, reasoning) [18]. Focusing specifically on the capacity for behavioral self-regulation may help fill a gap in the current knowledge of the relationship between cognition and mortality.

Impairment and decline in overall mental status, as well as some more specific aspects of cognition, predict mortality in older populations [1,3,4,10,12,15]. A previous study in the SLVHAS cohort determined that approximately one-third of persons 60 years of age or older showed evidence of at least mild impairment of behavioral self-regulation [19]. Because the capacity for behavioral self-regulation is prerequisite for functional independence, the Behavioral Dyscontrol Scale may provide an early and more sensitive predictor of mortality than general mental status assessments.

The purpose of this study was to determine whether the capacity to use intentions to guide purposeful behavior, as measured by the Behavioral Dyscontrol Scale, predicted mortality in the SLVHAS cohort. Study participants were examined at two time points a mean of 22 months apart. Behavioral Dyscontrol Scale scores at the baseline interview, and decline in scores over time, were examined as independent predictors of mortality.

Methods

Study population

The SLVHAS is a population-based longitudinal study of aging-related outcomes in older Hispanic and NHW residents of Alamosa and Conejos counties in Colorado [20]. Most residents of the study counties live in small communities or on farms or ranches. The population is relatively stable, with little recent immigration from Mexico. In the 2000 census, 68% of Hispanic residents self-identified as “Other Spanish/Hispanic,” and 31% identified themselves as “Mexican/Mexican American” [21].

Study methods relevant to current analyses are summarized here; previous publications provide further detail [20,22]. All households in the study counties (n=6,482) were enumerated in 1992

and 1993, with a 97.2% response rate. This provided a complete sampling frame from which to attempt to recruit all Hispanic residents aged 60 and over, as well as a sample of NHW residents. In addition to age, eligibility criteria required Hispanic or NHW ethnicity and current residence in either Alamosa or Conejos county. Of the initially selected sample of subjects ($n=2,067$), 171 died before completing a visit; 125 moved out of the study area; and 14 were found to be ineligible after correction of sampling information on age or ethnicity. Of the remaining 1,757 eligible persons, 1,444 completed the first visit between 1993 and 1995 (82%). Refusers were more likely to be NHW, to have a history of smoking, and not to have diabetes. Of 1,444 interviewed at baseline, 1,358 participants were community-dwelling and 86 were nursing home residents. The analyses reported here included only community-dwelling individuals. The Colorado Multiple Institutional Review Board reviewed and approved the study.

Participants could choose to be interviewed either in English or Spanish [20]. Of the 1,358 participants, 188 required proxy respondents at the baseline interview; of these, 152 (80.9%) were Hispanic. Reasons for the need for proxy responses included a Mini-Mental State Examination score < 18 , illiteracy, lack of time to complete the interview for oneself, or contact made with a surrogate who refused access to the eligible elder. Proxy respondents provided data on physical functioning and medical history. In addition to the Mini-Mental State Examination, the Behavioral Dyscontrol Scale was administered to participants whenever possible; 65 respondents did not complete the Behavioral Dyscontrol Scale at baseline, leaving 1,293 (95.2%) of the original 1,358 community-dwelling eligible subjects with available baseline Behavioral Dyscontrol Scale data for use in this analysis.

Follow-up visits (between 1995 and 1998) occurred at a mean interval of 22 months [22]. Of the 1,358 community-dwelling subjects, 85.2% completed the visit; of those who did not complete the visit, 105 had died (9.2% of Hispanic subjects and 5.3% of NHW subjects), and 96 refused to be re-interviewed (7.4% of Hispanic subjects and 6.5% of NHW subjects). Furthermore, 116 individuals (14.7% of Hispanic subjects and 3.8% of NHW subjects) required proxy respondents, and of those individuals, 78 were unable to complete the Behavioral Dyscontrol Scale. Hence, data on follow-up executive cognitive function (Behavioral Dyscontrol Scale performance) were acquired for a total of 1,079 individuals (79.5% of the original community-dwelling eligible subjects). Participants with incomplete follow-up data were not excluded from baseline analyses.

Mortality outcome

Vital status was ascertained through April 2002, through Colorado death certificate searches; 443 of the original 1358 subjects died. Thirty-three deceased subjects were among the 65 individuals who could not complete the Behavioral Dyscontrol Scale at baseline.

Measure of executive cognitive function: Behavioral Dyscontrol Scale

The Behavioral Dyscontrol Scale evaluates the ability to regulate one's own behavior; that is, to initiate goal-directed action based on intentions, to monitor one's performance, and to inhibit irrelevant or inappropriate activity [18,23,24]. Possible total scores range from 0 to 19 points. Scores above 14 are considered to be within normal limits. The Behavioral Dyscontrol Scale has been extensively validated as a measure of an executive cognitive function [18,19]. Inter-rater reliability, internal consistency, and retest reliability are all above 0.85 [18,25,26].

Covariates

Covariates assessed as potential confounders included general mental status (Mini-Mental State Examination score), age, sex, years of education, ethnicity, marital status, number of comorbid medical conditions, and body mass index (BMI).

The Mini-Mental State Examination, available in both English and Spanish, measures general mental status [16]. Interviewers identified respondents who had Mini-Mental State Examination scores below 18 as needing proxy respondents unless their scores appeared to be due to illiteracy or visual impairment. Those needing proxy assistance completed a physical exam, selected performance tasks, and if possible, the Behavioral Dyscontrol Scale; a surrogate such as a caregiver or close relative, if available, then answered questions about recent functioning and medical history.

Age and years of education were treated as continuous variables. Ethnicity was assessed by the 1980 U.S. Census question, “Are you of Spanish or Hispanic descent?” [27]. The dichotomous marital status variable compared individuals who were married or living with someone in a long-term relationship to those who were never married, separated, divorced, or widowed.

The comorbidity variable was a count of diseases derived from questions asking if a physician had ever diagnosed the subject as having Parkinson’s disease, arthritis, cancer, heart attack, stroke, angina, heart failure, diabetes, hypertension, pulmonary disease, cirrhosis, kidney failure, depression, osteoporosis, seizure, migraine, or difficulty with hearing or vision, or if the subject had had an angioplasty.

Analysis

Ethnic differences in covariates, Behavioral Dyscontrol Scale and Mini-Mental State Examination scores, and 10-year vital status were examined using chi-square and t-tests. Correlations between Mini-Mental State Examination and Behavioral Dyscontrol Scale scores and other covariates were examined using Spearman’s rho. Cox proportional hazards regression models provided estimates of the association between mortality and four combinations of continuously-scaled cognitive measures, adjusted for covariates: 1) baseline Behavioral Dyscontrol Scale score alone; 2) scores on both the Behavioral Dyscontrol Scale and Mini-Mental State Examination; 3) decline in Behavioral Dyscontrol Scale scores over an average of 22 months without adjustment for Mini-Mental State Examination scores; and 4) decline in Behavioral Dyscontrol Scale scores over an average of 22 months, adjusted for baseline Mini-Mental State Examination scores. Kaplan-Meier plots graphically presented the stepwise relationship between Behavioral Dyscontrol Scale scores and survival probability over time with the scores categorized as follows: 15 – 19 indicated no impairment, 11 – 14 indicated mild impairment, 7 – 10 indicated moderate impairment, and 0 – 6 indicated severe impairment. An additional Kaplan-Meier plot examined the relationship between decline in Behavioral Dyscontrol Scale score and survival probability. For this plot, the possible decline of 15 points, the maximum amount of decline found in this cohort, was stratified into three categories of five-point declines and was plotted along with a referent category that combined individuals whose scores remained the same with those persons whose scores improved.

Possible multiplicative interactions between ethnicity and Behavioral Dyscontrol Scale status/decline and between baseline scores and decline in scores were examined.

The Behavioral Dyscontrol Scale typically is used as a continuous measure; baseline and decline models therefore incorporated the raw scores. Mini-Mental State Examination score at baseline was also scaled continuously to allow for consistency between the two cognitive assessments. Continuous declines in Behavioral Dyscontrol Scale scores over time were examined in models with and without adjustment for continuous baseline Behavioral Dyscontrol Scale and Mini-Mental State Examination scores. In the decline models, the referent group consisted of those whose Behavioral Dyscontrol Scale scores improved or remained unchanged over time.

Modeling used a stepwise method, examining both the effect of the addition of each covariate to the model on the parameter estimate of the primary explanatory variable and the statistical significance of the added covariate. If there was no (or negligible) change in the parameter estimate of the primary explanatory variable, then whether the covariate stayed in the model depended upon whether it was statistically significant or was necessary to permit comparison with analyses in previous literature. All statistical analyses used SAS version 9.1 (SAS Institute, Cary, NC).

Results

Table 1 summarizes the characteristics of the study population by ethnicity. Hispanic respondents had lower mean baseline Behavioral Dyscontrol Scale and Mini-Mental State Examination scores, fewer mean years of education, and a lower mean count of comorbid conditions. They also were less likely to be married or living with someone in a serious relationship. BMI, age, gender distribution, and mortality rates were similar between NHW and Hispanic respondents.

Both Behavioral Dyscontrol Scale and Mini-Mental State Examination scores were inversely correlated with age and positively correlated with education (Table 2). Though they measure different aspects of cognition and have been shown to be independent (dissociable) of one another in many individuals [18,23,29], the scores from the two assessments were positively correlated with each other ($r=0.71$).

Kaplan-Meier plots for approximately ten-year survival by baseline Behavioral Dyscontrol Scale score categories are shown in Figure 1. The data demonstrate that subjects with greater executive cognitive function impairment (those in the lower score categories) had lower survival probabilities over time than those who were less impaired.

Baseline Behavioral Dyscontrol Scale scores were significantly and positively associated with mortality hazard over time (HR = 1.05, 95% confidence interval: 1.01, 1.08) (Table 3) after controlling for age, sex, education, BMI, comorbidity, ethnicity, and baseline Mini-Mental State Examination score. Baseline Mini-Mental State Examination score, treated as a covariate, was of borderline statistical significance in association with mortality (HR = 1.03, 95% CI: 1.00, 1.06). Marital status did not contribute to the model or alter the relationship between Behavioral Dyscontrol Scale score and mortality hazard. Controlling for age and educational level made the greatest relative impact on the relationship of interest. An additional model without adjustment for baseline Mini-Mental State Examination score generated an almost identical hazard ratio for baseline Behavioral Dyscontrol Scale score (HR=1.06; 95% CI: 1.04, 1.09). Baseline scores on the Behavioral Dyscontrol Scale and the Mini-Mental State Examination predicted mortality hazard similarly and independently of one another.

Figure 2 shows the relationship between survival after the follow-up visit and decline in Behavioral Dyscontrol Scale scores between baseline and follow-up. Declines of 1 to 5 points resulted in a slightly decreased survival probability over time, compared to scores that improved or stayed the same. Those persons with declines of 11 to 15 points had the most significant decrease in survival probability over time. There may be a threshold for increased mortality risk in the vicinity of a 6 to 10 point decline.

The unadjusted hazard ratio for continuous decline in Behavioral Dyscontrol Scale scores between baseline and follow-up visits was 1.13 (95% CI: 1.08, 1.17) (Table 4). Controlling for age, sex, education, BMI, comorbidity, and ethnicity decreased the ratio to 1.06 (95% CI: 1.01, 1.11), mostly due to adjustment for age. Further adjustment for baseline Behavioral Dyscontrol Scale score increased the hazard ratio to 1.08 (95% CI: 1.04, 1.14). Finally, the hazard ratio for decline in Behavioral Dyscontrol Scale scores remained significantly

associated with mortality over time (HR=1.09; 95% CI: 1.04, 1.15), despite adjustment for baseline performance on the Mini-Mental State Examination. The relationship between these covariates and mortality remained relatively stable between the baseline and decline models (data not shown).

Analysis of interaction terms permitted assessment of the relationship between performance on the Behavioral Dyscontrol Scale and mortality in subgroups of interest. There were no significant differences in the effect of decline in executive cognitive function on mortality in Hispanic versus NHW subjects, or for different levels of baseline Behavioral Dyscontrol Scale scores.

Discussion

Impaired capacity for behavioral self-regulation and decline in this executive cognitive function over time, as measured by Behavioral Dyscontrol Scale baseline and change in scores, were both significant predictors of mortality in the SLVHAS cohort. Specifically, every one-point lower baseline Behavioral Dyscontrol Scale score (i.e., $\sim 1/4$ standard deviation for the total sample) was associated with a five-percent increase in mortality hazard. (In other words, a four-point lower baseline score was associated with an increase in mortality hazard of over 21 percent.) Impairment of general mental status, and deficits in certain specific cognitive abilities, have been shown to predict mortality across different populations [1–4,6,9–12,28]. However, to our knowledge, no studies have demonstrated an effect on mortality of both baseline status and decline in an executive cognitive function.

Previous studies finding that cognitive deficits predict mortality have focused primarily on impairment of general mental status, and not on this specific executive function (e.g., [1,2,4–6,28]). Those studies that have examined the relationship between survival and specific cognitive abilities—fluid abilities, crystallized intelligence, verbal memory, episodic memory, visuospatial ability, perceptual speed—have generally found these aspects of cognition to be significant predictors of mortality in older populations, but which of these factors is a stronger predictor remains unresolved [8,12,14,15].

Of major importance to our finding is the fact that the executive cognitive function of interest involves the capacity to engage in goal-directed behavior. While there are many different types of cognitive impairment (e.g., visual-spatial functioning), the Behavioral Dyscontrol Scale specifically measures the capacity to initiate and complete purposeful behavior autonomously. This ability is of obvious importance for independent daily functioning [19,24,32–34], and is independent of most of the cognitive skills assessed by such measures as the Mini-Mental State Examination [18]. The independence of behavioral self-regulation from other aspects of cognition reflects the occurrence of *double dissociations* between abilities [17,29,30]. That is, an individual may appear cognitively intact, yet upon closer examination, not be able to regulate his or her behavior appropriately, or vice versa. Hence, it is not uncommon for individuals with seemingly normal mental status to be unable to regulate their behavior [18,23,29,31]. This condition could potentially affect one's health negatively by preventing one from obtaining health care services actively when it is appropriate to do so, or engaging in healthy behaviors and daily self-care [19,32–34].

In the SLVHAS cohort, Behavioral Dyscontrol Scale score was previously shown to be a significant predictor of both self-reported instrumental activities of daily living ability and observed performance on the abbreviated Structured Assessment of Independent Living Skills [19,44,45]. These associations indicate that the Behavioral Dyscontrol Scale gauges the ability not only to regulate one's behavior, but also to live independently. The link between Behavioral Dyscontrol Scale performance and mortality may be bi-directional; that is, due both to

maintaining the capacity to care for oneself, and to the underlying health-related etiology of executive cognitive function impairment and/or decline.

For these reasons, it should not be surprising that performance on the Behavioral Dyscontrol Scale remains significantly predictive of mortality despite adjustment for Mini- Mental State Examination score, even though the two measures are strongly correlated. Discrete impairment of executive cognitive function is relatively common in association with a variety of primarily chronic health conditions (e.g., diabetes, congestive heart failure, chronic low-level inflammation), compared to disturbances of language, reasoning, primary memory, or general mental status [35–43]. By contrast, *general* cognitive impairment in older persons is not always as strongly associated with specific chronic health conditions. Impaired general mental status can be due to causes such as primary neurologic insults, progressive dementing disorders, general systemic decline with secondary effects on the central nervous system, or age-related factors [12].

For example, one hypothesis suggested by previous evidence is that certain chronic illnesses (e.g., diabetes) may adversely affect cognition, perhaps especially executive cognitive function [36]. If poorly managed, cognitive decline could be accelerated, and yet impaired executive cognitive function itself is likely to make self-management more problematic [19]. The result could be a positive feedback loop that increases the likelihood of mortality. Although this hypothesis has not been tested, irrespective of the specific causes, the evidence to date supports the idea that cognitive impairment can provide a relatively reliable predictor of mortality among the elderly. The exact mechanism that explains why the Behavioral Dyscontrol Scale predicts mortality warrants further investigation.

Decline in Behavioral Dyscontrol Scale scores also had a significant association with mortality (Figure 2). The relationship between decline in scores and mortality remained significant after adjustment for demographic factors, BMI, comorbidity, and baseline performance on both the Behavioral Dyscontrol Scale and the Mini-Mental State Examination (Table 4). There was no evidence of multiplicative interaction between baseline Behavioral Dyscontrol Scale scores and declines in scores. Furthermore, the examination of declines in scores by baseline scores yielded no evidence for the presence of a “floor effect;” that is, the potential that scores could not decline further because they were already low at baseline.

Although an association between decline in a specific executive cognitive function, as assessed by the Behavioral Dyscontrol Scale, and mortality has not, to our knowledge, been investigated before, the association between mortality and decline in mental status has been examined [1, 4,28]. It remains unclear whether cognitive impairment itself or decline in cognitive functioning is a better independent predictor of mortality, since baseline and decline in functional status are somewhat dependent on each other despite adjustment [1,4,12,28].

The Hispanic Established Population for the Epidemiological Study of the Elderly (HEPESE) was the first study to observe that a decline in mental status, as defined by decreases in Mini-Mental State Examination scores over time, predicted subsequent mortality in Hispanics [4]. The HEPESE study also investigated a potential interaction between baseline Mini-Mental State Examination performance and decline in performance on mortality, but as in the present study, they did not find evidence for the presence of an interaction between baseline and decline in scores.

The ability to examine the relationship between mortality and decline in an executive cognitive function over time constitutes a major strength of our study. Unlike baseline Behavioral Dyscontrol Scale performance, the decline in scores over time may signal a new or worsened medical condition. Thus, it may be more informative to examine decline over time rather than

current impairment status in order to assess temporal trends. Baseline measures do not indicate whether the impairment has occurred recently, or has been stable over time.

This study may have underestimated the true association between impairment in executive cognitive function and mortality because 65 subjects who had Mini-Mental State Examination scores below 18 were unable to complete the Behavioral Dyscontrol Scale. These individuals would likely have had lower Behavioral Dyscontrol Scale scores, and about 51% of these individuals died before April 2002, thus, potentially underestimating the relationship between impairment in executive cognitive function and mortality. Despite this bias towards the null, the relationship between Behavioral Dyscontrol Scale scores and mortality hazard remained strong.

In this study, all-cause mortality was utilized as the outcome. The associations reported here indicate the need for future research on whether the association between mortality and impairment in the capacity for behavioral self-regulation can be explained by, or differs by specific causes of mortality. Additionally, this study only examined one executive cognitive function (capacity for behavioral self-regulation) and general mental status as predictors. Further research is necessary to clarify whether this specific executive cognitive function is more strongly predictive of mortality relative to other specific aspects of cognition.

In conclusion, both the baseline capacity for behavioral self-regulation and its decline over time predicted mortality in the SLVHAS cohort, adjusted for general mental status and other important clinical and demographic covariates. This study also provided evidence that though scores on the Behavioral Dyscontrol Scale and the Mini-Mental State Examination are correlated, these assessments measure different cognitive domains that may predict mortality independently. Furthermore, the Behavioral Dyscontrol Scale may have an advantage over the Mini-Mental State Examination as a predictor of mortality because it depends less on the literacy level of the respondent, allowing its use across more educationally diverse populations [26].

What is New?

This study may help fill a gap in the current knowledge of the relationship between cognition and mortality by focusing specifically on the capacity for behavioral self-regulation.

Due to the possibility of double dissociations, under which a person with seemingly normal general mental status may be unable to regulate his behavior, the effects of behavioral dyscontrol should be specifically evaluated.

Both baseline capacity for behavioral self-regulation and its decline over time significantly predicted mortality in the San Luis Valley Health and Aging Study cohort.

The Behavioral Dyscontrol Scale may have an advantage over other cognitive scales as a predictor of mortality because it specifically targets the capacity for behavioral self-regulation and depends less on the literacy level of the respondent.

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Figure 1. Survival by Baseline Level of Executive Cognitive Functional Impairment: Unadjusted Kaplan-Meier Survival Curves

Behavioral Dyscontrol Scale Categories: No impairment 15 to 19 points, mild impairment 11 to 14 points, moderate impairment 7 to 10 points, severe impairment 0 to 6 points.

Figure 2. Survival by Decline in Executive Cognitive Functioning: Unadjusted Kaplan-Meier Survival Curves
 Point declines represent continuous decreases between baseline and follow-up Behavioral Dyscontrol Scale scores.

Table 1
 Characteristics of Study Population, by Ethnicity and Overall San Luis Valley Health and Aging Study

Characteristic	By Ethnicity			Overall
	Hispanic Mean (SD) or n (%) (n=793)	Non-Hispanic White Mean (SD) or n (%) (n=565)	p-value	Total Mean (SD) or n (%) (n=1358)
Age (yrs)	74.1 (8.1)	74.9 (9.2)	0.10	74.4 (8.6)
Sex (Male)	346 (43.6%)	240 (42.5%)	0.67	586 (43.2%)
Education (yrs)	8.4 (3.9)	12.2 (2.9)	0.00	10.0 (4.0)
Body Mass Index ^a	27.7 (5.0)	27.6 (4.9)	0.63	27.7 (5.0)
Marital Status (Married) ^b	483 (55.4%)	355 (62.8%)	0.01	793 (58.5%)
Comorbidity Count ^c	1.9 (1.6)	2.2 (1.8)	0.01	2.0 (1.7)
MMSE baseline score ^d	22.9 (5.8)	26.8 (4.0)	0.00	24.6 (5.5)
BDS baseline score ^e	13.7 (4.5)	16.5 (3.1)	0.00	14.9 (4.2)
Median (Interquartile Range)	15 (11–17)	18 (16–19)		16 (13–18)
Mortality by 2002	249 (31.4%)	194 (34.3%)	0.26	443 (32.6%)

Note. SD= Standard Deviation

^aIn kilograms per meters squared.

^bOr living together in a long-term relationship

^cBecause this variable is skewed, median (interquartile range) in the overall study population are provided: 2 (1–3).

^dMini-Mental State Examination

^eBehavioral Dyscontrol Scale

Table 2

Correlation Between Baseline Behavioral Dyscontrol Scale, Mini-Mental State Examination, and Population Characteristics

	BDS^a	MMSE^b
Age (yrs)	−0.33 (p<0.0001)	−0.37 (p<0.0001)
Sex	0.02 (p=0.37)	0.06 (p=0.02)
Education (yrs)	0.57 (p<0.0001)	0.61 (p<0.0001)
Body Mass Index	0.10 (p=0.0002)	0.11 (p<.00001)
Comorbidity Count	−0.02 (p=0.43)	0.01 (p=0.79)
MMSE ^b	0.71 (p<0.0001)	1.00

Note. Spearman *rho* correlation coefficients

^a Behavioral Dyscontrol Scale

^b Mini-Mental State Examination

Table 3

Baseline Executive Function as a Predictor of Ten-Year Mortality Hazard San Luis Valley Health and Aging Study

Variables	Adjusted Hazard Ratio ^a (95% CI)
Baseline BDS Score ^b	1.05 (1.01–1.08)
Age (yrs)	1.07 (1.06–1.08)
Sex ^c	0.52 (0.42–0.64)
Education (yrs)	1.03 (0.99–1.06)
Body Mass Index (kg/m ²)	0.98 (0.95–1.00)
Comorbidity Count	1.22 (1.15–1.29)
Ethnicity ^d	0.86 (0.67–1.11)
Baseline MMSE Score ^e	1.03 (1.00–1.06)

Note. 95% CI= 95% Confidence Interval

^a Hazard ratio for each variable is adjusted for all other variables in the table. Number of deaths included in mortality hazard calculation=410.

^b Behavioral Dyscontrol Scale; per point decrease.

^c Females

^d Hispanic versus non-Hispanic white

^e Mini-Mental State Examination; per point decrease.

Table 4

Decline in Executive Functioning as a Predictor of Ten-Year Mortality Hazard San Luis Valley Health and Aging Study

Models	Hazard Ratio for BDS Decline ^c (95% CI)
Unadjusted BDS Decline ^a	1.13 (1.08–1.17)
BDS Decline Adjusted for Covariates ^b	1.06 (1.01–1.11)
BDS Decline Adjusted for Covariates ^b and Baseline BDS	1.08 (1.04–1.14)
BDS Decline Adjusted for Covariates ^b , Baseline BDS, and Baseline MMSE ^d	1.09 (1.04–1.15)

Note. 95% CI= 95% Confidence Interval

^aContinuous decline in Behavioral Dyscontrol Scale (BDS) scores over average of 22 months.

^bCovariates are age, sex, years of education, body mass index, and comorbidity count.

^cNumber of deaths included in mortality hazard calculations=272.

^dMini-Mental State Examination score.