The Utility of the Timed Up-and-Go Test in Predicting Cognitive Performance: A Cross-Sectional Study of Independent Living Adults in a Retirement Community

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Abstract

Physical, emotional, and cognitive changes are well documented in aging populations. We administered a comprehensive battery of mental and physical health measures and the Montreal Cognitive Assessment (MoCA; a cognitive screening tool) to 93 independently living older adults (OAs) residing in a Continuing Care Senior Housing Community. Performance on the Timed Up-and-Go (TUG) test (a measure of functional mobility) correlated more strongly with the MoCA total score than did measures of aging, psychiatric symptoms, sleep, and both self-report and objective physical health. Furthermore, it was associated with MoCA Attention, Language, Memory, and Visuospatial/Executive subscales. The MoCA-TUG relationship remained significant after controlling for demographic and physical/mental health measures. Given that the TUG explained significantly more variance in broad cognitive performance than a comprehensive battery of additional physical and mental health tests, it may function as a multimodal measure of health in OAs, capturing physical changes and correlating with cognitive measures.

Introduction

Aging is associated with changes in physical, socioemotional, and cognitive functioning. Successful aging hinges on high levels of functioning in a variety of interrelated domains, including mental/physical health, sleep, and cognition (Rowe & Kahn, 1997), with

interpersonal engagement and a positive outlook on life being particularly impactful (Jeste & Depp, 2006). The goal of the current investigation was to better elucidate associations between ambulation and cognitive functioning, while accounting for additional aspects of physical functioning, as well as emotional/psychiatric status and sleep.

Cognition is related to everyday functioning in older adults (OAs; Jekel et al., 2015); consequently, cognitive outcomes are frequently used as endpoints in aging research. Relatedly, aspects of physical functioning such as ambulation predict later cognitive decline (Verghese, Wang, Lipton, Holtzer, & Xue, 2007). Both ambulation and cognition are best captured via comprehensive assessments, but practical clinical constraints lead to the frequent use of screening instruments instead. The Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005) and the Timed Up-and-Go (TUG; Podsiadlo & Richardson, 1991) task are leading screening indicators of cognition and ambulation, respectively. However, no study of OAs to date has examined TUG performance as a predictor of MoCA scores. Additionally, past investigations of TUG and cognitive performance have not comprehensively accounted for relevant physical and mental health factors (e.g., Donoghue et al., 2012). Given significant interrelationships among physical, mental, and cognitive health variables (Jeste & Depp, 2006; Rowe & Kahn, 1997), it is important to account for all three dimensions in order to thoroughly assess global functioning.

The MoCA is a 10-minute cognitive screening instrument designed to detect cognitive impairment in a variety of clinical disorders (Nasreddine et al., 2005). It has repeatedly shown sensitivity to dementia (Davis, Creavin, Yip, Noel-Storr, Brayne, & Cullum, 2015), and it can be broken down into subscales reflecting relevant domains (Moafmashhadi & Koski, 2013). The TUG measures time to completion for a sit-to-stand maneuver, followed by a 3-meter walk at a comfortable speed, a 180-degree turn, a walk back to the original chair, and a stand-to-sit movement. It was designed to assess fall risk (Herman, Giladi, & Hausdorff, 2011), but it also correlates with poor executive functioning (Ansai et al., 2017) and global health (Viccaro, Perera, & Studenski, 2011). Relatedly, in an ongoing study (Jeste et al., 2019), we examined a sample of 86 independent living residents of a Continuing Care Senior Housing Community (CCSHC) and found that the TUG score was the best predictor of a cognitive composite score derived, in part, from the MoCA total score. By contrast, in the current study, we tested direct relationships between the TUG and MoCA total and subscale scores, including a) analyses controlling for relevant confounders (in order to account for the influence of other aspects of health, as outlined above), and b) clinically-relevant group-based analyses (see Data Analysis).

In order to thoroughly investigate relationships between ambulation and cognitive performance in non-demented, independently living OAs, we analyzed data from the MoCA, TUG, and additional physical and mental health measures in a sample of 93 participants, including the 86 individuals from the original paper. We hypothesized that the TUG would negatively correlate with the MoCA scores and that it would explain more variance in MoCA scores than measures of successful aging, psychiatric symptoms, sleep, and both self-reported and objective physical health.

Methods

Participants and Procedure

Participants were 93 individuals, aged 66–94 (n=63 with MoCA>25; n=30 with MoCA 25; Table 1), who were part of a larger longitudinal study on biopsychosocial functioning in independent living OAs (Jeste et al., 2019). The current study was approved by the affiliate university's Institutional Review Board (#170466) and all participants provided written informed consent.

Measures

We examined 25 measures of cognitive, emotional, and physical functioning (Table 1). Participants completed the MoCA as a cognitive screening tool and we created four MoCA composite scores (Moafmashhadi and Koski, 2013) – Attention (sum of attention items), Language (naming and language items), Memory (delayed recall and orientation items), and Visuospatial/Executive (visuospatial/executive and abstraction items). We also investigated aging, psychiatric symptoms, sleep, and physical health (Table 1).

Data Analysis

First, we examined distributional characteristics through a visual inspection of histograms. For measures with non-normal distributions, we utilized appropriate non-parametric tests. Second, we examined bivariate correlations between the MoCA and the 24 physical and mental health measures. We identified those indices that exhibited statistically significant relationships with the MoCA total score and then analyzed correlations between these measures and the four MoCA composites. Third, we conducted linear regression models to predict variance in the MoCA total and composite scores with the bivariate-significant mental and physical health correlates. Fourth, we included partial correlations, controlling for the potential confounding impacts of age, gender, years of education, body mass index, systolic blood pressure, waist-to-hip ratio, and illness burden. Fifth, we examined a hierarchical regression model, predicting MoCA total scores from significant bivariate correlates in step 1 and TUG in step 2. Finally, we dichotomized TUG scores based upon a published cutoff (Bischoff, 2003; 12 seconds = intact, >12 seconds = impaired) and examined MoCA performance by TUG group using independent t-tests.

Results

MoCA total scores ranged from 11–29 in the overall sample and 63/93 participants earned scores of 25/30 or lower, suggesting a broad range of cognitive functioning (including some participants with cognitive impairment) in our sample. When we excluded participants earning the three lowest MoCA total scores (11, 14, and 15/30) from the primary analyses, the results were equivalent. To maximize statistical variability, we retained these individuals in all reported results.

The following variables correlated significantly with the MoCA total score and were investigated further: the TUG, the Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983), the Cognitive Failures Questionnaire 25-item (Broadbent, Cooper, Fitzgerald, &

Parkes, 1982), the Cognitively Stimulating Activities (Krueger et al., 2009), the Short Physical Performance Battery (SPPB; Guralnik et al., 1994): Summary Ordinal Score, and diastolic blood pressure (Table 2). Next, these six variables were entered as predictors into multiple regression models. The overall models for the total score and the Attention composite were statistically significant, while the models for the Language, Memory, and Visuospatial/Executive regressions were nonsignificant (Table 3). For the total score model, the TUG was the only significant predictor among the six variables; for the Attention composite, the TUG and the Cognitively Stimulating Activities measure were the only significant predictors.

In partial correlations, relationships between the TUG and MoCA remained significant after controlling for those demographic and physical health variables that may have functioned as confounders. We also split our sample by MoCA total score (intact>25/30; impaired 25/30), and reran the partial correlations. The results mirrored those from the entire sample, although the coefficient from the intact group was nonsignificant ($r=-.21$), possibly due to a small sample size (n=30). When we analyzed the MoCA total score regression model hierarchically, with the five additional correlates in step 1 and the TUG in step 2, the R^2 was .15, $F(6, 57)=3.91$, $p=.002$, indicating that the TUG explained 15% of the variance in MoCA performance above and beyond all other significant zero-order correlates (the other five variables explained only 14% of MoCA total score variance combined).

In our final analysis, 62 participants exhibited intact TUG performance (12 seconds completion time) and 25 participants were impaired (>12 seconds completion time). Intact performers scored higher on the MoCA total score (M=24.48; SD=2.87) than did participants who were impaired (M=21.64; SD=3.76, $t(85)$=3.81, $p<.001$, Cohen's d=0.85). Intact performers also scored higher on the Attention (d=0.43), Language (d=0.54), Memory (d=0.52), and Visuospatial/Executive composites (d=0.71; all t's>2.00; all ps<.025).

Discussion

In the current study of independent living OAs in a CCSHC with a broad range of cognitive functioning, we evaluated relationships between cognitive status as measured by the MoCA and a large battery of physical and mental health variables. The TUG was more strongly associated with the MoCA than were all other measures of mental/physical health. Indeed, the TUG explained an additional 15% of variance in the MoCA total score above and beyond the five other significant correlates. Moreover, the TUG was significantly related to the MoCA Attention, Language, Memory, and Visuospatial/Executive composites, suggesting contributions to a broad range of cognitive abilities.

Several investigators have reported relationships between the TUG and neuropsychological tests (e.g., Donoghue et al., 2012). One potential explanation is contributions from attention and executive functions to stable and consistent walking performance (Verghese et al., 2007). That is, ambulating is not an entirely automatic behavior in OAs, and it requires attentional resources and top-down regulatory functions for accurate and consistent performance. Additionally, some evidence indicates that a slowing of gait is a harbinger of

future cognitive decline (Mielke et al., 2013), suggesting that TUG performance may deteriorate prior to observable changes in cognition.

The strong, consistent relationship between the TUG and MoCA has clinical implications in OAs. Specifically, the TUG is a simple, rapid assessment that is associated with relevant outcomes in OAs, including executive functioning (Ansai et al., 2017) and overall health (Viccaro et al., 2011). Our data add to this literature by suggesting that TUG performance explains more variance in cognition than do many other tests of physical and mental health status. While the TUG is not a direct measure of cognitive performance and cannot replace the MoCA, our findings support the use of the TUG in the assessment of overall health and functioning in OAs.

The current study has several limitations. All analyses were cross-sectional, which limited the ability to draw casual inferences. Additionally, our participants were primarily White (94.6%) and well-educated (M=15.65 years), which constrains generalizability. Specifically, Jeste and colleagues (2019) compared the current CCSHC sample to a group of matched OAs who were randomly sampled from the community; the current sample included fewer racial/ethnic minority individuals and had higher body mass indexes than the comparison group. However, our participants ranged in age (66–94 years) and cognitive status (MoCA total score=11–29), thereby enhancing external validity across these dimensions.

Prior investigators have reported relationships between the TUG and neuropsychological tests; however, the current study is the first to our knowledge to a) provide evidence for a relationship between the TUG and MoCA above and beyond a comprehensive assessment of physical and mental health measures, and to b) examine MoCA subscales in this context. Past empirical work also suggests that the TUG is a valid measure of overall physical health and our findings contribute to this literature by revealing that the TUG also shares a moderate degree of variance with cognitive status in OAs with a broad range of cognitive functioning. While future longitudinal investigations are necessary to determine whether the TUG has significant predictive power, our cross-sectional results indicate that the TUG may capture multiple important aspects of health in aging populations. Impaired TUG performance may indicate a need for an in-depth neuropsychological, physical, and functional assessment for identifying early decline and disability in independent living OAs.

Acknowledgements

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Table 1.

Sample characteristics and assessment battery

Sociodemographics	*Cognitively Intact (n = 30)	*Possible Cognitive Impairment (n = 63)	t or χ^2	p
Age (years)	80.62 (6.83)	84.39 (5.91)	2.73	.008
Years of education	16.13 (2.47)	15.41 (2.31)	1.37	.17
Gender (% female)	73.3	66.7	0.42	.52
Race (% nonwhite)	3.3	9.5	1.12	.29
Relationship status (% un-partnered)	63.3	60.3	0.78	.78
MoCA and Significant Correlates	**Total Sample**	**Mean (SD)**	**Construct Measured**	
Montreal Cognitive Assessment Total Score	93	23.56 (3.47)	Cognitive status	
Timed Up-and-Go test (time to completion)	87	11.02 (3.64)	Ambulation and balance	
Perceived Stress Scale	84	12.30 (5.00)	Psychosocial stress	
Cognitive Failures Questionnaire 25-item Total Score	79	32.61 (12.72)	Errors in cognitive performance	
Cognitively Stimulating Activities Component Score	79	3.35 (0.66)	Experiences that challenge thinking skills	
Short Physical Performance Battery Summary Ordinal Score	92	8.18 (2.56)	Ambulation and balance	
Diastolic blood pressure	91	76.33 (12.83)	**Cardiovascular risk marker**	
Emotional Function and Perception of Aging				
Self-Rated Successful Aging (1–10 scale)	86	8.11 (1.47)	Subjective perception of health in older adulthood	
I am aging well (1–5 scale)	86	2.02 (0.91)	Satisfaction with the aging process	
Short Form 36 Mental Component Scale-	85	54.64 (9.29)	Composite score of overall mental health	
Brief Symptom Inventory Anxiety Scale	86	1.91 (3.23)	Anxious arousal	
Patient Health Questionnaire-9 item	84	3.18 (3.98)	Depressive symptoms	
Center for Epidemiologic Studies Depression Scale	83	9.45 (2.73)	Depressive symptoms	
Life Events Scale	81	4.11 (5.14)	Stressful experiences	
UCLA Loneliness Scale	79	38.32 (10.94)	The discrepancy between desired and achieved social contact	
Coping Self-Efficacy Scale	84	89.67 (24.49)	Psychological resources available to handle stress	
PROMIS Social Isolation scale	84	8.39 (3.17)	The degree of contact and interaction with other people	
Short Form 36 General Health	86	67.27 (19.71)	Composite score of overall health	
Physical Function				
Short Form 36 Physical Component Scale	85	40.89 (10.74)	Composite score of physical health	
Cumulative Illness Rating Scale Total Categories Endorsed	93	5.81 (1.93)	Burden of chronic medial diseases	

Sociodemographics	*Cognitively Intact (n = 30)	*Possible Cognitive Impairment (n = 63)	t or χ^2	p
Nutrition Screening Checklist	84	3.13 (2.53)	Diet and nutritional intake	
Hours of self-reported sleep per night	79	7.39 (1.25)		
Systolic blood pressure	91	135.27 (15.10)		
Body mass index	93	28.43 (6.21)		
Waist-to-hip ratio score	92	0.88 (0.08)		

*
Cognitively Intact = MoCA Total Score > 25; Possible Cognitive Impairment = MoCA Total Score   25

Tabel 2.

Relationships between MoCA subscales and physical/mental health correlates.

	MoCA Total Score	Attention	Language	Memory	Visuospatial/Executive
Perceived Stress Scale (n = 84)	r = −.21	r = −.27	r = −.11	r = −.15	r = −.05
	(p = .027)	(p = .006)	(p = .167)	(p = .092)	(p = .323)
Cognitive Failures Questionnaire 25-item (n = 79)	r = −.21	r = −.20	r = −.002	r = −.17	r = −.17
	(p = .033)	(p = .036)	(p = .494)	(p = .068)	(p = .071)
Cognitively Stimulating Activities (n = 79)	r = .21	r = .27	r = .01	r = .11	r = .20
	(p = .031)	(p = .009)	(p = .477)	(p = .171)	(p = .039)
Short Physical Performance Battery (n = 92)	r = .27	r = .18	r = .04	r = .06	r = .37
	(p = .004)	(p = .046)	(p = .362)	(p = .281)	(p = .001)
Timed Up and Go (n = 87)	r = −.42	r = −.22	r = −.27	r = −.26	r = −.36
	(p < .001)	(p = .022)	(p = .007)	(p = .008)	(p = .001)
Diastolic blood pressure (n = 91)	r = .26	r = .02	r = .06	r = .26	r = .20
	(p = .006)	(p = .442)	(p = .302)	(p = .007)	(p = .028)

Note. Only variables with a statistically significant ($p < .05$) correlation with the MoCA total score are shown.

MoCA = Montreal Cognitive Assessment

Table 3.

Selected multiple regression analyses predicting variance in MoCA total score and attention composite score.

	(df), F	B	SE B	β
MoCA Total Score	$(6, 57)\ 3.91^{**}$			
Constant		30.80	5.45	
Timed Up and Go		–.78	.23	$-.61^{**}$
Perceived Stress		–.06	.10	–.08
Cognitive Failures Questionnaire 25-item		.003	.04	.01
Cognitively Stimulating Activities		.90	.61	.17
Short Physical Performance Battery		–.42	.32	–.24
Diastolic blood pressure		.03	.03	.12
MoCA Attention Composite	$(6, 57)\ 5.73^{**}$			
Constant		8.64	1.42	
limed Up and Go		–.25	.06	$-.69^{**}$
Perceived Stress		–.04	.03	–.18
Cognitive Failures Questionnaire 25-item		.004	.01	.05
Cognitively Stimulating Activities		.38	.16	$.26^{*}$
Short Physical Performance Battery		–.14	.08	–.30

Note:

*
$p < .05$

**
$p < .01$.

Regression models predicting variance in the MoCA language, memory, and visuospatial/executive composite scores were not statistically significant (p > .05).

MoCA = Montreal Cognitive Assessment