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Preliminary Findings of The Brief Everyday Activities Measurement (BEAM) in Older Adults

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Abstract

Objectives—Functional losses are common in healthy and cognitively impaired older adults. However, subtle declines in instrumental activities of daily living (IADLs) are not always detected in self-reports. Performance IADL measurements are financially and time burdensome, restricting their use in varied settings. To address these limitations, we developed the Brief Everyday Activities Measure (BEAM), a short (< 5 minutes) objective IADL measure that assesses medication and finance management.

Design & Participants—The BEAM was administered to 209 cognitively non-demented community-dwellers (ages 65–95 years).

Measurements—Participants completed standardized motor, neuropsychological, psychological, and self-report functional assessments.

Results—BEAM completion time ranged from 54.16 to 259.31 seconds. Interclass correlations (ICC) for total BEAM completion time was moderate (0.65, 95% CI [.43 –.78]). Accuracy for total BEAM performance was in the low-moderate range (Kappa = 0.38, $p < .001$, 95% CI [.18 –.54]). As predicted, lower accuracy and longer time to complete the BEAM were both associated with worse executive functions, attention, and processing speed.

Conclusions—Medication and finance management can be efficiently assessed within five minutes. The BEAM may be a valuable screening tool to evaluate these functional abilities.

Keywords

Instrumental activities of daily living; performance-based functional assessments; cognitive performance; independent living; functional impairment

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Ethical Standards: The current study complies with the current laws of U.S.A in which the study was conducted. The participants were provided written informed consent according to study protocols that were approved by the institutional review board.

Introduction

Decline in independent living ability is predictive of nursing home placement [1], mortality [2] and mobility limitations [3] in older adults. Functional abilities include instrumental activities of daily living (IADLs) [4]. Decline in IADLs, specifically medication and finance management, is an essential feature for the diagnosis of dementia [5] and could be detrimental to older adults' independent living status [6,7]. Poor performance on measures of attention, speed of processing, and executive functions is associated with worse IADL in high functioning older adults [8,9] and in individuals with mild cognitive impairment or dementia [10–13].

Successful medication management is critical for independent living; over 55% of independent older adults use at least five different medications per week [14]. Moreover, impaired cognition is linked to medication non-adherence, leading to 23% of nursing home admissions and 10% of hospital admissions [6,15]. Poor financial management has been associated with impaired cognition, notably to limitations in executive functions [9,16]. Financial management declines early among individuals with dementia [16,17]. Compromised financial management may result in financial abuse, debt, bankruptcy, or eviction in older adults [16–18].

Functional abilities have been measured via self and informant-reports [19–21], which are susceptible to subjective bias, social desirability, and can be less sensitive to change compared to objective measures [7,12,21]. Comparatively, objective IADL measures have stronger associations with neuropsychological performance than IADL questionnaires [12,21,25–26], particularly, processing speed and executive function abilities [7,8,21,24]. Lack of awareness and overestimation of IADL deficits have been associated with poor outcomes in older adults with and without dementia [7,11,12,21,25,26].

Current objective IADL measures have been criticized for being expensive, time-consuming, and labor-intensive [13,19–21]. Recently published objective IADL measures' administration times range from 15 to 90 minutes [13,19,20–23] and some require intensive examiner training sessions [22]. Furthermore, medication management is often not assessed. Thus, there is an impetus to develop a sensitive, yet rapid, objective IADL assessment of medication and finance management. The current study aimed to report on the development, reliability, and preliminary findings of the BEAM. In light of previous literature, we expected correlations between BEAM and self-report IADL measures to be low. Furthermore, based on previous literature [21] we hypothesized that worse performance on the BEAM would be associated with poor attention, processing speed, and executive function.

Methods

Participants

Participants were 209 community-dwelling non-demented adults 65 years and older enrolled in an ongoing cohort study titled Central Control of Mobility in Aging (CCMA)[27]. Participants were excluded if they: were unable to ambulate or climb stairs without

assistance of another person, had severe vision or hearing impairment, and were diagnosed with physical or cognitive illnesses that could impair their ability to complete study tasks [27]. Participants provided written informed consent according to study protocols that were approved by the institutional review board.

Procedures and Measures

We conducted comprehensive cognitive, psychological, physical, and neurological assessments as previously described [27].

Brief Everyday Activities Measure (BEAM)

Instructions were worded simply (Appendix A). Standardized stimuli were used and assistive devices were not allowed. Scores of zero (incorrect) and one (correct) were used for overall accuracy of each subtest. Total BEAM performance time (seconds) was calculated by adding completion times for the three subtests. A dichotomous BEAM accuracy score and total accuracy score was calculated by adding the three subtests' scores (0–3). The BEAM has a maximum administration time of five minutes.

Finance Management

Consists of two subtests: Bill Computation and Money Handling. Participants were instructed to choose breakfast options from a menu. They were asked to calculate the total of their choices (Bill Calculation); and using a wallet containing standard amount of dollar bills and coins, place the total on the desk (Money Handling). Congruity of subtest answers was noted.

Medication Management

Participants were instructed on how to manipulate a medication bottle and a one-week pillbox with AM and PM compartments. Instructions required the participants to read the label out loud and place medication in the pillbox accordingly.

Results

Participants' mean age was 76.84 ± 6.80 years, 55% were females, and the 87% were Caucasian (Table 1). Performances on tests of global cognitive abilities, processing speed, executive functioning, memory, and attention were within normal limits (Table 1). Table 2 includes performance time and accuracy per BEAM task stratified by age, gender, and education.

BEAM: Test-Retest Reliability

Test-retest reliability was measured 8–15 days apart (11.16 ± 2.39 days), to 69 participants. The subsample was comparable to the overall sample, in terms of age (77.30 ± 7.20 years), education (14.81 ± 2.89 years), and gender composition (54% female). Interclass Correlation Coefficients (ICC) revealed moderate reliability for Finance Management completion time (ICC = 0.58, 95% CI [.33 – .74]). Reliability for Medication Management completion time was low to moderate (ICC = 0.46, 95% CI [.26 – .60]). Total BEAM completion time reliability was moderate (ICC = 0.65, 95% CI [.43 – .78]). Reliability for Finance

Management accuracy was low to moderate, (Kappa = 0.38, $p < .01$, 95% CI [.12 – .61]). Medication Management accuracy was moderate (Kappa = 0.53, $p < .001$, 95% CI [.30 – .73]). Accuracy for the total BEAM was low to moderate (Kappa = 0.38, $p < .001$, 95% CI [.18 – .54]).

Logistic regressions revealed that accurate Finance Management performance at T1 significantly increased the odds of accurate performance in T2 OR= 6.46, $p < .01$, 95% CI [1.89 – 21.76]. Accurate Medication Management performance at T1 significantly increased the odds of performing accurately in T2 OR= 13.06, $p < .0001$, 95% CI [3.75 – 45.57]. Overall BEAM performance accuracy at T1 significantly increased odds of performing accurately in T2 OR= 5.27, $p < .01$, 95% CI [1.88 – 14.75].

BEAM: Associations with Functional and Neurocognitive Measures

Correlations were low to moderate between self-report IADL and BEAM performance indices (Table 3). Associations of self-reported ability to pay and select items with BEAM Finance Management was mixed. It was significant for accuracy ($X^2(1, N = 205) = 5.06$, $p < .05$), and not with completion time ($t(1,201) = -0.972$, $p = .332$). Associations of self-reported ability to take medications regularly with BEAM Medication Management was not significant with accuracy ($X^2(2, N = 207) = 1.38$, $p = .500$) and completion ($t(1,200) = 0.708$, $p = .479$).

Correlations between BEAM completion time and self-report physical functioning were significant, although low, suggesting adequate divergent validity (Table 3). Specifically, participants with higher self-reported upper extremity and general physical limitations had longer BEAM performance times. One-way ANOVAs revealed that compared to participants who performed accurately on the BEAM those who had one or more errors reported lower physical functional abilities, $F(1,203) = 9.06$, $p < .01$.

Consistent with our hypothesis, slower BEAM completion time was associated with worse attention, executive functioning, and processing speed performance (Table 3). Significant, though low, correlations were also observed between BEAM performance and measures of delayed memory (Table 3). One-way ANOVAs revealed that compared to inaccurate performers, participants who accurately completed the Finance Management task had higher scores on the Total RBANS Index ($F(1,206) = 9.22$, $p < .01$) and processing speed measure (Digit Symbol) ($F(1,203) = 5.25$, $p < .05$). Participants who were accurate on Medication Management had higher executive functioning scores (Phonemic Fluency) compared to those who were not accurate, $F(1,207) = 6.52$, $p < .05$. Lastly, participants whose total BEAM performance was accurate had higher scores on the Total RBANS ($F(1,206) = 4.05$, $p < .05$) and processing speed measure (Digit Symbol) ($F(1,204) = 4.17$, $p < .05$) compared to those whose performance was not accurate.

Discussion

Current objective IADL assessments are lengthy and expensive, limiting their use in clinical and research settings [21]. Medication and finance management are key IADL domains shown to be sensitive to dementia and critical to maintaining independent living

[6,10,12,15–17,20,28]. Herein, we reported on the development and preliminary findings of the BEAM, an objective test of medication and finance management. Foremost, the BEAM does not require sophisticated equipment and its protocol is easily standardized. These qualities, as well as the short administration, support the feasibility of the BEAM in clinical and research settings.

Test re-test reliability of the BEAM was moderate for completion time and low to moderate for accuracy; the latter was assessed by Kappa, which can be overly conservative [29]. Additional analyses revealed that accurate performance in the first administration greatly increased the odds of accurate performance in the second administration of the BEAM. Consistent with our hypothesis we found weak associations between the BEAM and subjective IADL functioning. These findings support previous research suggesting that objective IADL measures provide subtle information not assessed through self-reports [11,19,21,25]. Objective and self-report measures of IADL functioning may assess different aspects of this construct. This difference could be attributed to participants' inaccurate reporting; highlighting the discrepancy between objective performance and performance perception [21,25,26]. Low and insignificant correlations between the BEAM with physical impairments provide preliminary support for the divergent validity and are consistent with the literature [11,24].

Results on neurocognitive correlates of BEAM accuracy and completion time indicated that longer BEAM performance and worse BEAM accuracy were associated with lower performance on measures of executive function, attention, and processing speed. Specifically, the BEAM taps into the sustained attention and mental manipulation required to compute a restaurant bill and sort medications. Results are consistent with previous literature suggesting that these cognitive domains were related to medication and finance management [8–10,13,23]. Neuropsychological correlates with IADL self-reports were not found, supporting the sensitivity of the BEAM to subtle differences in cognitive functions. These findings are also consistent with previous research demonstrating a discrepancy between the relationships of cognitive functions with objective and self-report IADL measures in community-dwelling older adults [7,21].

Limitations and Future Directions

Participants were predominantly Caucasian community residing non-demented elders with relatively high levels of education, and low levels of depression [30]. Generalizability to more diverse sociocultural and clinical populations, including neurodegenerative conditions should be examined in future research. Moderate BEAM test-retest reliability may be attributed to the range in follow-up. Future research should aim to identify factors that might affect BEAM performance and its reliability. Specifically, personality differences may underlie discrepancies between self-report and performance IADLs and account for the low – moderate correlations found. Due to time limitations, we did not compare the BEAM to other performance-based measures [23]. Lastly, future research should compare BEAM performance with published IADL objective-measures [13,23].

Summary

Overall, the BEAM's short administration time and user-friendly test materials overcome the monetary and time restrictions inherent in current objective measures [7,13,21]. The IADL domains measured by the BEAM are essential competencies for independent living [6,8–10,24] and are not included in some of the current objective IADL measures [20–23]. In conclusion, the BEAM may be a beneficial objective supplementary screening tool to quickly assess finance and medication management in older adults.

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Appendix A BEAM Subtests Description

IADL Domain	Task Description	Task Materials	Instructions to Participant	Time Limit
General Instructions			I will be asking you to complete various activities that you conduct in your daily routine. Please listen to the instructions carefully and work as quickly and accurately as possible, as you will be timed for each activity.	
Finance Management	Computing and making change	5–1\$ bills, 3 quarters, 5 dimes, 5 nickels, 5 pennies	Assume that you are in a local coffee shop buying breakfast. You may choose one item from each category: Drink, Entrée, and Side. (1) Please circle three items you have chosen off the menu. (2) Now please calculate and tell me the exact total of your three choices. Please note that tax is included. (3) I am going to give you a wallet that holds dollar bills and coins. Please place the exact total of your three choices on the desk. Do you have any questions? Ready? GO	3 Mins
Medication Management	Reading directions on a medication bottle and allocating medication in the pillbox accordingly	1 pillbox, 1 medication bottle with fake pills	This is a pillbox for a one week supply of AM and PM medication. This is how you open and close the compartments of the pillbox. Let's practice. This is a bottle of medication. This is how you open and close the bottle. Let's practice. When I say go, please read out loud the information on the label of this medication container. After you have correctly read the label, please place the medication in the pillbox as indicated on the bottle. When you are finished, please close all compartments of the pillbox. Do you have any questions? Ready? GO (Stop timing when all compartments of the pillbox are closed, regardless of whether leftover medication is put back and/or bottle is closed).	3 Mins

Table 1

Demographic, Functional, and Cognitive Characteristics (n=209)

Demographic and Functional	n (%)	Mean $\pm$ SD	
Caucasian	181 (87)		
African-American	20 (10)		
Hispanic- White	3 (1)		
Asian	5 (2)		
Female	115 (55)		
Age (years)		76.84 $\pm$ 6.78	
Education (years)		15.02 $\pm$ 3.24	
Geriatric Depression Scale	207	4.45 $\pm$ 3.73	
Comorbidity Index = 0	64 (31)		
Comorbidity Index = 1	145 (69)		
Activities of Daily Living-Prevention Instrument	206	2.06 $\pm$ 2.75	
Physical Functioning ^a	206	69.50 $\pm$ 5.83	
Upper Extremity Functioning ^a	206	22.68 $\pm$ 2.81	
Cognitive	n (%)	Mean $\pm$ SD	%ile
Phonemic Fluency ^b	209	41.64 $\pm$ 12.87	54
Semantic Fluency ^c	209	42.65 $\pm$ 9.84	21
WAIS Digit Symbol ^d	208	54.70 $\pm$ 13.64	75
RBANS Immediate Memory Index ^e	207	98.45 $\pm$ 10.89	45
RBANS Delayed Memory Index ^f	208	94.44 $\pm$ 9.57	34
RBANS Visuospatial/Construction Index ^g	206	93.86 $\pm$ 13.51	32
RBANS Attention Index ^h	206	101.77 $\pm$ 15.20	53
RBANS Total Index ⁱ	206	93.80 $\pm$ 10.82	32

^aSelf-report physical limitations on the Late-Life Function and Disability Instrument – (LLFDI) Disability Subtest^bFAS Total Words – Phonemic Word Fluency; Measure of executive functioning ability^cCOWA Total Words – Category Word Fluency; Measure of language ability^dWAIS-III Measure of attention and processing speed (raw score)^eCombined scores of List Learning and Story Learning in The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) (Standard Score)^fCombined scores of List Learning Free Recall and Recognition, Story Memory Free Recall, and Figure Free Recall in RBANS (Standard Score)^gCombined scores of Digit Span and Coding in RBANS (Standard Score)^hCombined scores of Digit Span and Coding in the The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) (Standard Score)ⁱTotal score for RBANS (Standard Score)–The RBANS measures neurocognitive abilities within an adult population. The RBANS assessed immediate memory, delayed memory, visuo-spatial, language, and attention abilities (Randolph, 1998).

Table 2

Descriptive Statistics for BEAM Tasks Stratified by Age, Gender, and Education

Variable	N	Bill Comp. Acc. % ^c	Money Hndling. Acc. % ^c	Total Fin. Time ^{d,b}	Fin. Acc. % ^c	Med. Time ^d	Med. Acc. % ^c	Total Time ^d	Total Acc. % ^c
Age 65–74	88	79	76	38 ± 13	63	62 ± 30	55	99 ± 36	56
Male	44	73	71	40 ± 15	53	61 ± 31	76	101 ± 38	53
Female	44	84	82	36 ± 12	73	60 ± 29	68	97 ± 33	59
Education 12 years ^d	28	79	79	41 ± 13	75	64 ± 29	64	106 ± 30	50
Education 12 years ^d	85	79	77	38 ± 13	72	61 ± 31	72	99 ± 36	57
Accurate Performance ^e	-	-	-	32 ± 12	-	54 ± 18	-	91 ± 26	-
Age 75–84	89	83	74	42 ± 20	70	64 ± 22	40	107 ± 33	41
Male	41	83	81	39 ± 15	72	69 ± 27	68	108 ± 34	51
Female	48	84	69	43 ± 23	67	61 ± 16	53	105 ± 32	33
Education 12 years ^d	22	82	73	49 ± 29	68	63 ± 20	68	112 ± 50	46
Education 12 years ^d	87	84	76	42 ± 19	75	65 ± 23	59	107 ± 33	41
Accurate Performance ^e	-	-	-	29 ± 15	-	58 ± 15	-	95 ± 23	-
Age 85–95	30	77	70	47 ± 15	70	76 ± 35	47	124 ± 44	47
Male	8	75	75	43 ± 17	75	75 ± 31	75	118 ± 45	62
Female	22	77	68	49 ± 15	68	76 ± 37	59	126 ± 45	40
Education 12 years ^d	7	86	57	49 ± 23	50	99 ± 51	57	148 ± 70	57
Education 12 years ^d	28	75	71	48 ± 14	68	74 ± 30	68	121 ± 36	50
Accurate Performance ^e	-	-	-	34 ± 1	-	69 ± 26	-	115 ± 27	-

^aTime in seconds^bThree subjects were excluded due to unreliable time estimate for the Money Handling subtest.^cFrequency of participants who completed task accurately^dBoth Education stratifications include participants with exactly 12 years of education (Age 65–74, n = 25; Age 75–84, n = 19; Age 85–95, n = 5)^ePerformance Time based on accuracy on respective BEAM tasks

Table 3

Pearson's Correlations between BEAM Completion Times (seconds), Demographic, Functional, and Cognitive Measures

Variable	Finance Management ^j	Medication Management	Total BEAM
Demographic & Functional			
Age	.21 **	.22 **	.27 ***
Education	-.23 **	-.20 **	-.26 ***
Depression ^a	.17 *	.05	.12
Comorbidity Index ^b	.02	-.07	-.05
IADL Functioning ^c	.09	.14	.14 *
Upper Extremity Function ^d	-.22 **	-.13	-.21 **
Physical Disability ^e	-.22 **	-.14 *	-.21 **
Cognitive ^f			
Phonemic Fluency ^g	-.19 *	-.12	-.19 **
Semantic Fluency ^h	-.17 *	-.15 *	-.21 ***
WAIS-III Digit Symbol ⁱ	-.31 ***	-.20 ***	-.32 ***
RBANS Immediate Memory	-.07	-.09	-.11
RBANS Delayed Memory	-.08	-.14 *	-.16 *
RBANS Attention Index	-.24 ***	-.15 *	-.24 ***
RBANS Total Index	-.18 **	-.20 **	-.25 ***

^aScore on Geriatric Depression Scale (GDS)

^bComorbidity Index: Diabetes, Hypertension, Rheumatoid Arthritis, Depression, Stroke, Transient Ischemic Attack (TIA), Myocardio Infarction, Congestive Heart Failure, Parkinson's disease, Chronic Obstructive Pulmonary Disease (COPD), and Angina

^cADCS–Activities of Daily Living–Prevention Instrument (ADL-PI)–Self Report

^dLate-Life Function and Disability Instrument–Upper Extremity Functioning Subtest score

^eLate-Life Function and Disability Instrument–Disability score

^fPartial correlations were adjusted for Age, Sex, Education (years), Ethnicity, Depression

^gFAS total words – executive functioning measure

^hAnimal, Vegetable, Fruit total words – measure of language ability, semantic word fluency

ⁱTotal number of items correct – processing speed measure

^jThree subjects were excluded due to unreliable time estimate for the Money Handling subtest.

^{ns} = Not significant.

* p < .05 level.

** p < .01 level.

p < .001 level

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