Relationship between activities of daily living and cognitive ability in a sample of older adults with heterogeneous educational level

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Abstract

Introduction: A number of studies have shown the impact of cognitive abilities on instrumental activities of daily living, in particular executive functions. Nevertheless, it is not clear to what extent these results can be generalized, given that most samples studied have not included people with a low educational level. **Objectives:** The current study aims to investigate the association between cognitive abilities and activities of daily living in older adults — with and without dementia — from a middle-income country. **Sample:** The sample consisted of 48 healthy older adults and 29 people with dementia, who were evaluated in an Outpatient Care Unit in a University Reference Center in Rio de Janeiro. **Results:** Regression analyses indicated that the best predictors for activities of daily living were performance in immediate verbal memory in the case of controls and in a categorical fluency task in the patient group. The educational level itself was not a significant predictor of functional ability in either sample, but showed moderate correlation with the predictors. **Conclusions:** These results suggest that educational level may be a mediating factor in the association of cognitive variables and activities of daily living, and indicate a potential dissociation in terms of predictors according to the diagnostic status, pointing to relevant treatment directions.

Key Words

Activities of daily living, aging, dementia, executive functions, memory

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Introduction

Cognitive loss and conditions such as dementia have an important impact on the capacity to conduct activities of daily living (ADL) in older people, resulting in dependency, distress, and reduced quality of life.[1,2] However, it is not yet clear which cognitive domains,[1,3-5] demographic characteristics[6-8] or clinical conditions,[2,9,10] are particularly important to predict the ADL capacity. Identification of the factors that best predict future dependence on ADL has important clinical implications, especially in differentiating between normal aging, mild cognitive impairment, and dementia.

Activities of daily living can be divided into two main categories: Basic and instrumental.[11] Basic ADLs involve activities such as grooming, feeding and toileting. Instrumental ADLs include complex voluntary behavior directed to a goal, such as managing finances, problem-solving, handling medication, and housekeeping.[12] Basic ADLs are associated with motor function,[13,14] whereas instrumental ADLs are typically correlated to cognitive functions.[3,6] Recent studies point out that people in the preclinical stage of dementia and mild cognitive impairment patients have instrumental ADL disabilities.[9,10] Similarly, Dodge and colleagues[15] have indicated, in a community-based study, that poorer scores in cognitive domains predict functional decline. Some studies have addressed the association between specific cognitive abilities and ADL disability.[3,4,5,16] For example, associations between memory or executive functions and instrumental ADL during normal aging,[1,3,15,17] mild cognitive

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impairment,[9,10] and early stage of dementia[2] have been indicated.

Executive functions may be particularly relevant to ADL capacity, given their role in the organization and regulation of mental processes and voluntary behavior, including the formulation of plans, monitoring of their implementation, and changing to new plans.[18,19] In this regard, some studies show that executive functions are important to perform simple tasks in everyday life (i.e., functional capacity), such as preparing meals, taking medication, paying bills or organizing and planning the daily routine and appointments. Bell-McGinty and colleagues[5] conducted a study with 50 older adults, examining the association between tests of executive function and functional performance. All tests of executive functions employed in the study (Trail Making Test (TMT) Part B, Wisconsin Card Sorting Test (WCST), Manual Postures Test, Oral Digit Span Forward and Backward, and Dementia Rating Scale (DRS) Initiation/Perseveration) were significant predictors of performance in the instrumental activities of daily living, even after adjusting for demographic variables. Cahn-Weiner and colleagues[3] investigated episodic memory and executive functions, as well as their neural correlates, in a group of healthy controls (n = 52), and groups of people with mild cognitive impairment (MCI) (n = 35) and dementia (n = 37). The authors found that severe executive dysfunction is associated with a more rapid decline in ADLs. Similar findings were obtained by Razani and colleagues,[2] who indicated a strong association between ADLs and performance in a verbal fluency task, by using the Wisconsin card sorting test in a sample of people with dementia.

Although a majority of studies seem to indicate a relationship between cognitive impairment, in particular executive dysfunction, and dependence on ADL, the extent to which these results can be generalized is not clear. Specifically, very few studies on this topic have been conducted in low- and middle-income countries where varying levels of educational achievement are present. Complex cognitive abilities such as executive functions may be heavily influenced by educational level, with some evidence suggesting that these two factors are closely related.[20,21] In this sense, it is important to explore if the relationship between ADL and executive functions would also be present in a sample with a heterogeneous educational level. Accordingly, the aim of the current study is to investigate the relationship between executive functions and ADL in a sample of older adults and people with dementia from a developing country, with varying levels of educational achievement.

Materials and Methods

Participants and setting

The study took place in a public Geriatric Outpatient Clinic in Rio de Janeiro, Brazil. The source population was composed of 1,200 older adults who attended the clinic over a period of eight months. A research team examined the records of the subjects who would be treated and selected those who fulfilled the eligibility criteria. On the day of their clinical appointment, the selected subjects were approached and invited to take part in the study.

For both groups, the inclusion criteria were to be over 60 years of age and to be able to understand the study's objectives. The exclusion criteria were: Delirium, sight or hearing impairment, motor deficiency or tremor in the dominant hand, which impaired tasks such as writing and copying, or any severe illness (e.g., cancer).

All subjects (including controls) underwent a comprehensive geriatric assessment consisting of a functional and cognitive evaluation (instruments described below), in addition to an informant interview (Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE)[22]. Considering the cognitive performance in the tests, as well as in the Mini Mental State Examination,[23] functional ability status, and informant report, a diagnosis of dementia based on the DSM-IV criteria was given by the geriatrician. A total of 29 people with dementia were included in the study.

The control group included 48 healthy older adults, free of neurological/psychiatric disorders — including dementia — and who were not using psychoactive drugs.

Instruments

All tests were used in versions adapted for Brazilian Portuguese, having been extensively employed in previous research in Brazil.

Oral digit span forward and backward (Working memory)

This test assesses verbal span (storage capacity in short-term memory) and verbal information processing in working memory. It is also a measure of selective and divided attention. This test consists of two steps: (1) Forward: First a sequence of three digits is spoken to the person who must repeat it once in the same order. One digit is read per second. After two sequences, a digit is added. (2) Backward: The examinee must repeat each sequence backward. Each correct sequence gets a point.[24,25] For the purpose of the analysis, the value used was the sum of forward and backward scores.

Fluency tasks (Executive functions)

Two fluency tasks, evaluating verbal information processing, inhibition of inappropriate responses, behavioral initiative, and language, were used. In the phonemic verbal fluency test (FAS), the subject is asked to produce orally, over one minute, as many words as possible beginning with the letters 'F', 'A,' and 'S'. Proper nouns and derivations of gender, number, and degree are not considered.[26,27] As a categorical fluency task, subjects were asked to name as many animals as possible over a one minute period.[20]

Rey auditory verbal learning test (Verbal episodic memory)

The Rey Auditory Verbal Learning Test (RAVLT) assesses verbal learning and verbal episodic memory. The examiner reads a list of 15 words and the participant is asked to recall as many words as possible. This procedure is repeated five times, with the total number of remembered words calculated (verbal immediate recall). After 30 minutes, the participant is asked to recall the words again (verbal delayed recall).[26,28]

Figures memory (Visual episodic memory)

This test assesses visual learning and visual episodic memory. The examiner shows ten simple and concrete

figures to the participant, with the procedure being repeated thrice. Each time, the participant is asked to name the remembered figures (visual immediate recall), and after five minutes the participant is asked to recall the figures again (visual delayed recall).[29] For the purpose of the analysis only visual delayed recall was included in the regression models (see below).

Mattis Dementia Rating Scale subscales (Executive functions and visuoconstruction)

The Mattis Dementia Rating Scale (DRS) is a neuropsychological battery widely used in older adults. The battery is divided into subscales, and within each subscale, items are organized in a hierarchical manner, such that correct answers to more difficult items allow the scoring of all items.[30] In the current study, the following subscales were used: Construction, consisting of copying designs and name writing; and initiation and perseveration, which in the current study included repeating a series of rhymes, performing double-alternating hand movements, and copying rows of alternating symbols (fluency items were removed from the subscale, as they were already measured by other tasks, as described above).

Instrumental activities of daily living Lawton Scale

The Instrumental activities of daily living (IADL) Lawton Scale is a self-report scale, which investigates the level of independence in daily living tasks through a series of questions. It has a total of 8 items divided into the following factors: Telephone use, shopping, food preparation, household repairs, care of clothing, transportation, medication administration, and management of finances.[31]

Ethics

The study was approved by the Ethics Committee from the Institute of Social Medicine - Universidade do Estado do Rio de Janeiro (UERJ). All the participants provided written informed consent.

Statistical analysis

Data analysis was carried out using SPSS software (version 18.0). Descriptive statistics were used to illustrate the sample characteristics. Independent sample t-tests were used to test differences in demographic and clinical variables, with the exception of gender, for which a chi-square test was used.

Stepwise regression models were calculated to explore the relationship between instrumental ADL and cognitive tests (verbal immediate recall [RAVLT total A1-A5 learning], verbal delayed recall [RAVLT A7 list], visual memory delayed recall [number of recalled images in the Figures test after delay], working memory [total forward + backward digit span], non-verbal initiation/perseveration (Mattis subscale), visuoconstruction (Mattis subscale), phonemic fluency [total number of words named in the FAS], and categorical fluency [total number of animals named]) and demographic variables (educational level and age). To avoid inflation of type II error and exclusion of predictors involved in suppressor effects, we used a backward regression method. Finally, Pearson correlations were calculated between educational level and any significant predictors found in the regression models. These analyses were conducted separately for each group.

Results

The demographic characteristics and clinical profile of the sample are described in Table 1. There were no significant group differences in terms of demographic variables. Regarding clinical variables, the groups were significantly different in ADL, MMSE, IQCODE, and most memory tests (immediate and delayed, verbal and visual). There were no significant group differences for fluency or working memory.

Results of the regression for the control group can be seen in Table 2. The regression model that significantly predicted performance in instrumental ADL and had the highest explained variance (R^2) included age, non-verbal initiation/perseveration, visuoconstruction, delayed visual memory,

Table 1: Sociodemographic and clinical characteristics of participants

Variable	PwD (*n* = 29) Mean (SD), range	Controls (*n* = 48) Mean (SD), range	*P*-value
Age (mv=0)	79.4 (7.4), 66–91	78.2 (5.6), 66–90	0.424
Education (mv=0)	6.2 (4.9), 0–21	4.9 (3.9), 0–16	0.193
Gender* (mv=0)	17/12	35/13	0.194
IADL (mv=0)	15.5 (3.8), 8–21	18.5 (2.3), 12–21	>0.001
MMSE (mv=0)	21.9 (3.7), 15–28	23.6 (4.6), 15–30	0.049
IQCODE (mv=0)	3.7 (0.1), 3.0–4.8	3.3 (0.1), 1.7–4.8	0.001
Mattis initiation/perseveration (mv=0)	4.7 (2.7), 0–9	5.6 (2.1), 0–9	0.131
Mattis visuoconstruction (mv=0)	3.1 (1.8), 0–6	3.6 (1.8), 0–6	0.263
RAVLT			
Immediate recall (mv=0)	22.8 (6.7), 11–38	30.1 (9.2), 16–52	>0.001
Delayed recall (mv=3)	1.3 (2.1), 0–8	3.9 (3.4) 0–12	>0.001
Visual delayed recall (mv=1)	4.0 (2.8), 0–9	6.5 (2.1), 0–10	>0.001
Digit Span			
Forward (mv=0)	4.6 (1.9)	4.7 (1.7)	0.854
Backward (mv=0)	3.5 (1.4)	3.1 (1.5)	0.352
Verbal fluency			

*female/male = Analysis of differences in the gender variable using chi-square test, other analyses using t-tests, mv = Missing values

immediate verbal memory, and working memory. However, upon inspection of the predictors, none of them gave a significant contribution to the model. In addition, the adjusted R^2 values were similar in the first significant model and a model including only immediate verbal memory. There was no evidence of collinearity in the data with the Variance Inflation Factor (VIF) and tolerance values within the recommended range in the statistically significant models.[32]

Results of the regression in the dementia group can be seen in Table 3. The regression model that significantly predicted the performance in instrumental ADL and had the highest explained variance (R^2) included categorical fluency, non-verbal initiation/perseveration, educational level, and phonemic fluency. However, in this model only categorical fluency showed a statistically significant standardized β value. The adjusted R^2 values were similar in the first significant model and the model including only categorical fluency. There was no evidence of collinearity in the significant models.

Educational level showed moderate correlations with immediate verbal memory in the control group ($r = 0.27$) and categorical fluency in the patient group ($r = 0.36$). However, these results failed marginally to reach statistical significance (respectively, $P = 0.061$ and $P = 0.055$).

Discussion

In summary, the results suggest that the best predictors of ADL were immediate verbal recall in the healthy older adult group and categorical verbal fluency in the dementia group. Educational level was not a significant predictor in either group. However, this variable showed moderate correlations with the predictors, suggesting that although this factor may not be a primary predictor of ADL, it may mediate its relationship with cognitive abilities. The explained variance was generally low, suggesting that other variables not included in the regression models may be important influencing factors in ADL.

The specific associations observed in this study are similar to those described by other authors, showing that executive functions and verbal memory are important predictors for IADL performance.[1,3,15] In the present study, immediate verbal recall predicted ADL capacity in healthy older adults. Memory is essential for the execution of complex abilities such as handling money, using technology, and housework. It is also possible that older adults with memory impairment are more at risk of developing dementia, with memory potentially being a more evident sign of an insidious neurodegenerative process already in course.

By contrast, in the patient group memory was not found as a predictor, but this is probably due to the fact that memory impairment is a diagnostic criterion for dementia and there was not enough variability in the patient sample in this variable. Categorical fluency was a predictor of ADL in the patient group, which may highlight the role of behavioral initiation on functional abilities. Similarly, categorical fluency tasks measure strategies of generation, and may tap into constructs that are relevant for instrumental ADL, such as planning. These results support previous findings that executive functions and frontal lobe integrity are crucial to execute ADL.[5,16,17]

Previous studies conducted in developing countries suggest that educational level influences cognitive performance in

Table 2: Regression models — healthy older adult groups

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Variable	**β**	***P*-value**	**β**	***P*-value**	**β**	***P*-value**	**β**	***P*-value**	**β**	***P*-value**	**β**	***P*-value**
Immediate verbal recall	0.27	0.108	0.27	0.112	0.30	0.067	0.30	0.071	0.30	0.071	0.41	0.008
Initiation/Perseveration	0.22	0.151	0.23	0.134	0.26	0.082	0.23	0.118	0.24	0.111		
Delayed visual recall	0.21	0.215	0.21	0.191	0.19	0.242	0.17	0.293				
Working memory	−0.20	0.194	−0.18	0.238	−0.17	0.252						
Visuoconstruction	0.11	0.478	0.13	0.383								
Age	−0.11	0.481										
Model *P*-value	0.047		0.030		0.019		0.014		0.008		0.008	
R^2	0.30		0.29		0.27		0.25		0.22		0.17	
Adjusted R	0.18		0.19		0.19		0.18		0.18		0.15	

Table 3: Regression models — people with dementia

	Model 1		Model 2		Model 3		Model 4	
Variable	**β**	***P*-value**	**β**	***P*-value**	**β**	***P*-value**	**β**	***P*-value**
Categorical fluency	0.55	0.022	0.64	0.004	0.56	0.004	0.52	0.006
Initiation/Perseveration	0.33	0.129	0.34	0.120	0.24	0.170		
Educational level	−0.29	0.257	−0.18	0.428				
Phonemic fluency	0.24	0.340						
Model *P*-value	0.032		0.021		0.009		0.006	
R^2	0.38		0.35		0.33		0.28	
Adjusted R^2	0.26		0.26		0.28		0.24	

different neuropsychological tests, especially executive and working memory tasks.[22,33] These findings support the idea of a potential mediation of educational level in the execution of instrumental ADL, found in our sample. In this regard, Castro and Guerra[6] and Rosa and colleagues[7] found a similar result in cross-sectional studies, suggesting that educational level is associated with global cognitive performance, but not directly to functional disability.

A potential limitation of the current study is the fact that the samples were generally small, which may have led to reduced power to detect the predictors. Nevertheless, according to general guidelines (e.g., error degrees of freedom of at least 10[34]), the sample was large enough to include the chosen number of predictors, and inspection of the regression tables suggest that the standardized β values were not very high in any case. Another limitation was the possible inclusion of people with mild cognitive impairment in the healthy older adults group. This may have driven the results of the regression analysis, with participants more at risk of developing dementia already showing signs of functional disability. However, given the thorough clinical examination that the participants underwent, this seems unlikely. In any case, given that the sample is restricted to very mild patients, the results may not be generalized to people with more severe dementia.

In summary, executive functions (fluency) and episodic verbal memory were found to be significant predictors of instrumental activities of daily living, depending on the diagnostic status and with a possible mediation by educational level. Results are in line with previous findings[2,6,7,9] and support the notion that simple and brief neuropsychological tests can predict information about the ability to conduct complex voluntary behaviors. Understanding which factors lead to functional disability in older people has important clinical implications, pointing to relevant treatment directions (e.g., cognitive rehabilitation) and helping in the differential diagnosis between age-related cognitive loss and dementia.

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