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The S-TOFHLA as a Measure of Functional Literacy in Patients with Mild Alzheimer's Disease or Mild Cognitive Impairment

Maira Okada de Oliveira[1,2,3,*], Ricardo Nitrini[1,2], Sonia Maria Dozzi Brucki[1,2,3]

[1]*Behavioral and Cognitive Neurology Unit, Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP), São Paulo, SP, Brazil*
[2]*Cognitive Disorders Reference Center (CEREDIC), Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP), São Paulo, SP, Brazil*
[3]*Department of Neurology, Santa Marcelina Hospital, São Paulo, SP, Brazil*

*Corresponding author at: Department of Neurology, Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP), Rua Arruda Alvim, 206, Cerqueira César – São Paulo/SP – CEP 05410-020, Brazil. Tel.: +55-11-30861326; fax: +55-11-30861326.
E-mail address: maira.okada@uol.com.br (M.O. Oliveira).

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Abstract

In developing countries, education levels vary dramatically, and the number of years of schooling does not always correlate with the true level of educational competency. This study was designed to verify the accuracy of the Short-Test of Functional Health Literacy in Adults (S-TOFHLA) in individuals with mild cognitive impairment (MCI) and mild Alzheimer's disease (AD), when compared with healthy controls (HCs), in order to assess its utility as a measure of functional literacy. One hundred forty-eight subjects were divided into three groups: HC ($n = 61$), MCI patients ($n = 42$), and AD patients ($n = 45$). The S-TOFHLA does not seem to be suitable as an instrument to measure functional literacy for patients with advanced cognitive impairment, but proved to be appropriate in both the HC group and MCI patients in numeracy and prove to be useful as an adjuvant to estimate IQ, reading ability, and premorbid IQ, as an indicator of cognitive reserve.

Keywords: Alzheimer's disease; Mild cognitive impairment; S-TOFHLA; Health literacy; Intelligence

Introduction

Different levels of schooling are common among the elderly population, particularly in developing countries. Illiteracy is recognized as a world-wide issue and, according to United Nations (UN), the prevalence of illiteracy in adults around the world is around 17%; a number which increases when considering the number of functional illiterates (Unesco, 2011). Results of the National Adult Literacy Survey (NALS) showed that 21%–23% of American adults were at the lowest level of literacy, and one-third of these individuals were over the age of 65 (Kirsch, Jungeblut, Jenkins, & Kolstad, 2010). In Brazil, approximately 42.6% of the elderly population is considered functionally illiterate (defined as having less than 4 years of schooling; IBGE, 2010).

Functional literacy can be characterized as possessing a set of capabilities that allow the individual to acquire and use new information, be it through reading, writing, comprehension, or interpretation (Williams et al., 1995). Literacy can be improved through educational programs or can diminish when age and cognitive diseases become factors (Baker, 2006; Baker, Gazmararian, Sudano, & Patterson, 2000).

Reading ability is well evaluated by National Adult Reading Test (NART; Nelson, 1982) and the Wide Range Achievement Test-Revised (WRAT-R; Jastak & Wilkinson, 1993); there are some instruments developed to evaluate literacy levels in a health-care environment, the Rapid Estimate of Adult Literacy in Medicine (REALM; Davis et al., 1993) is used, but it only includes words related to health. Another test is the Short Assessment of Health Literacy of Portuguese-Speaking Adults (SAHLPA; Apolinario et al., 2012), a test reading with 50 items that assesses the ability to correctly pronounce and understand common medical terms and showed good validity and consistency for detection of health literacy when compared with the Short Test of

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Functional Health Literacy in Adults (S-TOFHLA; Baker, Williams, Parker, Gazmararian, & Nurss, 1999), a test using practical tasks, reading and reading comprehension, within the framework of environmental health.

The S-TOFHLA proved to be an adequate tool to measure levels of functional health literacy in Brazilian individuals with normal cognitive function, correlating strongly with the number of years of formal education (Carthery-Goulart et al., 2009). In this sample, 23.4% were classified as inadequate (scoring between zero and 53 points), 9% as marginal range (scoring between 54 and 66 points), and 67.6% as adequate (scoring between 67 and 100 points). This correlated with the level of schooling, but even more strongly to the Mini-Mental State Examination (MMSE), suggesting that it could be used as an adjunct in confirming accurate scores on a cognitive test (Brucki, Mansur, Carthery-Goulart, & Nitrini, 2011).

In a longitudinal study, it was observed that patients with Alzheimer's disease (AD) maintained stable NART scores during the course of the disease and which was a good predictor of intellectual function (Paque & Warrington, 1995). Other studies showed minimal decline, with relatively preserved reading skills into the advanced stages of disease (Fromm, Holland, Nebes, & Oakley, 1991; Grober et al., 2008; Patterson, Graham, & Hodges, 1994). Tests of evaluation of premorbid intelligence quotient (IQ) based on irregular word reading and lexical decision showed no difference in outcomes between patients with subjective memory complaints, mild cognitive impairment (MCI), AD, and controls (Almkvist & Tallberg, 2009). Information about health literacy along the spectrum of cognitive impairment is less frequent in the literature.

Neuropsychological tests are markedly influenced by schooling, and in almost all cognitive areas, illiterate individuals and those with little education have lower scores than those with moderate to high educational experience (Ardila, Rosselli, & Rosas, 1989; Bertolucci, Okamoto, Neto, Ramos, & Brucki, 1998; Brucki & Rocha, 2004; Manly, Schupf, Tang, & Stern, 2005; Porto, Caramelli, & Nitrini, 2010; Rosselli, 1993; Yassuda et al., 2009).

The Brazilian classification

In Brazil, education is classified into: Elementary school (1st grade to 8th grade), middle school (9th grade to 11th grade), and higher education (+12 years of education). The main problem when using the number of years of formal education as a factor is that, in countries where schools have different programs, number of hours. and efficacy of learning, we are faced with different performance among older adults of the same educational level. Thus, a measure of the degree of literacy becomes urgent, as an adjunct to the educational level in the assessment of neuropsychological tests.

Lower health literacy is associated with increased mortality and disability, generating higher costs. The low education, being part of cognitive decline even among non-demented people, has clear implications for public policy. Materials related to health should be redesigned to make them more understandable and accessible, especially for people with cognitive impairment. It is important to reduce the cognitive demands to the materials of health, peculiarly those that require high capacities of reasoning, memory, and with regard to health decisions and financial situation (Boyle et al., 2013).

There are no studies using the S-TOFHLA as a measure of literacy in dementia and it is a relatively simple test to adopt and a more useful measure of literacy than the number of years of formal schooling. This study aimed to verify the performance on Brazilian Portuguese version (Carthery-Goulart et al., 2009) of the S-TOFHLA in individuals with MCI and mild AD compared with healthy controls (HCs) in order to verify if it still can be used as a measure of functional literacy in patients.

Method

Participants

The sample consisted of 148 subjects who were divided into three groups: Health controls (HC) ($n = 61$), MCI patients ($n = 42$), and AD patients ($n = 45$; Table 1).

HC subjects were healthy volunteers, recruited from the general population in São Paulo, Brazil. They had no history of neurological or psychiatric disease and showed no evidence of cognitive impairment.

Subjects with MCI and AD were recruited from the Cognitive Neurology Outpatient Clinic from de Hospital das Clínicas of the University of São Paulo School of Medicine and the Cognitive Neurology Outpatient Clinic from Santa Marcelina Hospital in São Paulo, Brazil.

The following inclusion criteria were used for the entire cohort: More than 1 year of education (formal or informal), at least 60 years of age, presence of an informant, and absence of depressive symptoms (<6 points, according to the 15-item Geriatric Depression Scale [15-GDS; Almeida & Almeida, 1999]). AD patients were included based on diagnosis of probable AD (Mckhann et al., 1984), with stable doses of cholinesterase inhibitors, absence of moderate or severe dementia, absence of dementia caused by other etiologies, absence of psychiatric disorders, and a Cornell Scale for Depression in Dementia score lower than 7

Table 1. Demographic characteristics of HC, MCI, and AD groups

	HC ($n = 61$)			MCI ($n = 42$)			AD ($n = 45$)			p-value
	Mean (*SD*)	Mn	Mx	Mean (*SD*)	Mn	Mx	Mean (*SD*)	Mn	Mx	
Gender (F/M)	35/26			27/15			26/19			.75[a]
Age	70.66 (6.55)*	60	91	72.64 (7.71)[†]	61	89	75.80 (4.81)*[†]	65	86	<.01[b]
Education	8.72 (5.44)	1	21	7.14 (5.11)	0	20	6.96 (4.57)	1	19	.13[b]

Notes: F = Female; M = Male; *SD* = standard deviation; HC = health control; MCI = mild cognitive impairment; AD = Alzheimer's disease; Mn = Minimum; Mx = Maximum.
[a]Chi-square test.
[b]Kruskal–Wallis test.
*Significant difference between control and AD groups ($p < .005$).
[†]Significant difference between MCI and AD groups ($p < .005$).

(Carthery-Goulart et al., 2007). For MCI patients, a score lower than 5 on the Functional Activities Questionnaire (Pfeffer et al., 1982) and a diagnosis of MCI (as proposed by Petersen et al., 2001) were used as inclusion criteria.

All patients were evaluated by members of the Behavioral and Cognitive Neurology Unit of the Department of Neurology at the University of São Paulo School of Medicine, from the Center of Cognitive Disorders (CEREDIC) and Santa Marcelina Hospital. All patients performed a comprehensive neuropsychological, functional evaluation (Functional Activities Questionnaire) and Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE; Bustamante et al., 2003).

HC groups were required to fulfill these criteria: The absence of cognitive decline according to education-adjusted cutoff scores of the MMSE (Brucki, Nitrini, Caramelli, Bertolucci, & Okamoto, 2003) and a score lower than 2 on the Functional Activities Questionnaire.

Subjects completed a structured interview, lasting approximately 1.5 h. The study was approved by Ethics Committee of Hospital das Clínicas from the University of São Paulo School of Medicine and Santa Marcelina Hospital. All subjects who agreed to participate signed written informed consent.

Design

Subjects completed a structured interview with a neuropsychologist that included basic demographic information, socio-economic status, and co-morbidity. They were then given health literacy evaluations and a cognitive battery to measure global status, crystallized and fluid intelligence, memory, visuoconstructive tasks, and estimated IQ.

Material

We obtained permission from the author for use and application of the S-TOFHLA.

Health Literacy

Health literacy was assessed by the S-TOFHLA (Baker et al., 1999), which includes both reading comprehension and numeracy competency sections. The reading comprehension text is comprised of two passages, with a total of 36 items. Each passage has every fifth or sixth word deleted and, for each blank space, the respondent must select the word that best completes the sentence from four given options. The total score of the reading comprehension section is 72 points. The numeracy test evaluates qualitative literacy needed in the healthcare setting. It comprises two medicine bottles and two cards containing information about medicine intake, date of appointments, and the result of laboratorial test. The numeric items total 28 points. The total score of the test is 100 points. Individuals scoring between zero and 53 points are considered in the inadequate range, between 54 and 66 points puts them in the marginal range, and those that score between 67 and 100 are considered to be adequate in health literacy.

Cognitive Evaluation

All subjects were given the Brief Cognitive Screening Battery (BCSB; Nitrini et al., 2004, 2007) (using learning and recall of drawings), Dementia Rating Scale (DRS; Mattis, 1988; Porto, Fichman, Caramelli, Bahia, & Nitrini, 2003), Rey Auditory Verbal Learning Test (RAVLT; Malloy-Dizniz et al., 2007; Spreen, Strauss, & Sherman, 2006), Raven's Colored Matrices (Angelini, Alves, Custódio, Duarte, & Duarte, 1999), Clock Drawing (Sunderland et al., 1989), and Verbal Fluency (Spreen et al., 2006).

Estimated IQ

Estimated IQ was calculated by adding the weighted scores of subtests, block design, and vocabulary on the Wechsler Adult Intelligence Scale-III (Ringe, Saine, Lacritz, Hynan, & Cullum, 2002).

Analysis Plan

For correlations between education, age, the S-TOFHLA, and the neuropsychological test, we used Spearman's correlation. *R*-values of $>.75$ indicate strong correlation, a value between .75 and .5 indicates average correlation, and $<.5$ indicates a weak or absent correlation. The significance level used was .05.

Factors were compared using the Kruskal–Wallis test, followed by non-parametric multiple comparisons, when necessary. Nominal and ordinal qualitative measures were described in groups with absolute and relative frequencies. We utilized χ^2 to determine association between measures and nominal groups, and ordinal measures were compared with the Kruskal–Wallis test, followed by non-parametric multiple comparisons. All statistical analysis was carried out using the Statistical Package for the Social Sciences (SPSS) program, version 15.0.

Results

The sample is described in Table 1. There were no statistically significant differences in schooling ($p = .13$) or gender ($p = .75$) between groups. However, a statistical difference was observed in age ($p < .001$). Multiple comparisons showed that the difference in age between the groups is between AD and HC groups ($p < .001$) and between MCI and AD groups ($p = .010$).

In S-TOFHLA, non-parametric multiple comparisons indicated that a statistically significant difference in reading comprehension and the overall score occurred among the three groups (HC, MCI, and AD). In numeracy, the statistical difference occurred only between the AD and HC groups (Table 3).

Table 4 is showing the performance of the groups divided by education in the S-TOFHLA and demonstrates that there is an increase in the value of the S-TOFHLA with increasing of years of education.

The S-TOFHLA scores did not correlate with age in either group, showing that age does not influence the outcome. Correlations were observed between the neuropsychological tests, demographics, and scores on the S-TOFHLA as shown in Table 5.

Fig. 1 shows the performance of the groups (control, MCI, and AD) in relation to the total score of the S-TOFHLA, the reading comprehension and numeracy items, showing decreased performance with disease progression in total score and reading comprehension. The numeracy score were less affected by disease severity than the other measures. The only difference was between HC and AD subjects.

Discussion

The goal of the present study was to verify the performance on the S-TOFHLA in individuals with MCI and mild AD compared with HCs in order to verify if it still can be used as a measure of functional literacy in patients impaired and according to the results, the S-TOFHLA was not helpful as an instrument measuring literacy function in patients with AD. However, it proved to be adequated in both the control group and MCI patients in numeracy, showing the functionality of individuals with MCI.

A study that assessed healthy numeracy among older adults found that whereas scores on reading comprehension decreased with older age, age did not differentiate ability on numeracy, and it may reflect an emphasis on basic number recognition instead of using strategies and skills associated with the decline in age (Donelle, Hoffman-Goetz, & Arocha, 2007). The numeracy item correlates with schooling and does not seem to be affected by aging.

Our results showed that demographic factors, such as gender and age, did not influence the performance of the S-TOFHLA or the neuropsychological tests within groups. Even with the factor of age showing statistically significant differences between the groups, there were no significant correlations of age with the S-TOFHLA or neuropsychological tests, demonstrating that the tests are not affected by this variable.

There was a statistically significant correlation between the S-TOFHLA total and MMSE for the control group and the group diagnosed with MCI. In this study, the association between S-TOFHLA and MMSE for the control group showed a weaker correlation compared with a previous study with a sample of healthy subjects; this sample, however, was composed of young adults, adults and seniors, and the median age was 45 years with 11 years of schooling (Brucki et al., 2011).

Another more recent study by Chin and colleagues (2011) investigated measures that were associated with tools used to predict behaviors and health outcomes, such as the S-TOFHLA and REALM. The results showed that older adults who had higher levels of processing capacity or knowledge performed better on both measures (S-TOHFLA and REALM). Wolf and colleagues (2012)

Table 2. Performance of HC, MCI, and AD groups on the tests[a]

Tests	Mean (*SD*)			*p*-value
	HC	MCI	AD	
MMSE	28.36 (1.48)*‡	25.98 (2.68)*†	23.96 (2.90)†‡	<.01
DRS-Total	136.49 (8.12)*‡	127.90(10.46)*†	117.00 (11.64)†‡	<.01
BCSB-Incidental memory	5.84 (1.36)*‡	4.57 (1.67)*†	3.51 (1.77)†‡	<.01
BCSB-Immediate recall	7.84 (1.19)*‡	6.88 (1.63)*†	5.38 (1.70)†‡	<.01
BCSB-Learning	8.59 (1.20)*‡	7.81 (1.45)*†	5.76 (1.76)†‡	<.01
BCSB-Delayed recall	7.92 (1.44)*‡	6.20 (2.39)*†	3.09 (2.63)†‡	<.01
BCSB-Recognition	9.80 (0.44)*‡	9.24 (1.12)*†	7.64 (3.23)†‡	<.01
RAVLT-Total	38.34 (8.68)*‡	31.17 (9.70)*†	22.91 (6.42)†‡	<.01
RAVLT-30′	6.49 (3.54)*‡	4.14 (3.39)*†	0.82 (1.40)†‡	<.01
Verbal Fluency (animals)	16.38 (4.96)*‡	13.76 (4.33)*†	10.60 (3.39)†‡	<.01
Clock Drawing	8.33 (2.07)*‡	7.20 (2.43)*	6.49 (2.83)‡	<.01
Vocabulary	26.46 (9.81)	23.51 (9.56)	23.20 (9.16)	.20
Block Design	25.43 (8.93)*‡	18.37 (8.42)*	14.18 (6.53)‡	<.01
Raven's Colored Matrices	25.84 (6.24)*‡	20.52 (6.35)*	17.76 (5.99)‡	<.01
Estimated IQ	98.77 (10.41)*‡	91.45 (9.92)*†	87.95 (8.92)†‡	<.01

Notes: *SD* = standard deviation; MCI = mild cognitive impairment; HC = health control; AD = Alzheimer's disease; MMSE = Mini-Mental State Exam; BCSB = Brief Cognitive Screening Battery; DRS = Dementia Rating Scale; RAVLT = Rey auditory Verbal Learning Test; IQ = intelligence quotient.
[a]Kruskall–Wallis test.
*Significant difference between control and MCI groups ($p < .005$).
†Significant difference between MCI and AD groups ($p < .005$).
‡Significant difference between control and AD groups ($p < .005$).

Table 3. Performance of HC, MCI, and AD groups on the S-TOFHLA[a]

Tests	Mean (*SD*)			*p*-value
	HC	MCI	AD	
S-TOFHLA Reading	46.79 (21.66)*‡	36.62 (19.66)*†	20.58 (13.58)†‡	<.01
S-TOFHLA Numeracy	22.72 (6.47)‡	20.33 (7.22)	19.60 (7.25)‡	.04
S-TOFHLA Total	69.41 (25.88)*‡	56.95 (24.47)*†	40.18 (16.99)†‡	<.01
S-TOFHLA Time	365.85 (201.07)	451.00 (195.06)	361.02 (190.03)	.08

Notes: *SD* = standard deviation; MCI = mild cognitive impairment; HC = health control; AD = Alzheimer's disease; S-TOFHLA = Short Test of Functional Health Literacy in Adults.
[a]Kruskall–Wallis test.
*Significant difference between control and MCI groups ($p < .005$).
†Significant difference between MCI and AD groups ($p < .005$).
‡Significant difference between control and AD groups ($p < .005$).

Table 4. Performance of HC, MCI, and AD groups on the S-TOFHLA divided by years of schooling

Schooling (years)	Mean (*SD*)								
	HC			MCI			AD		
	S-TOFHLA Reading	S-TOFHLA Numeracy	S-TOFHLA Total	S-TOFHLA Reading	S-TOFHLA Numeracy	S-TOFHLA Total	S-TOFHLA Reading	S-TOFHLA Numeracy	S-TOFHLA Total
≤4	32.58 (18.43)	19.25 (7.51)	51.83 (23.56)	22.45 (11,01)	16.55 (7.43)	39 (16.51)	15.13 (11.24)	19.25 (8.57)	34.38 (16.22)
5–8	40.67 (21.68)	23.92 (3.60)	64.58 (24.36)	49.14 (15.40)	25 (3.74)	74.14 (13.06)	24.25 (14.20)	21 (5.29)	45.25 (19.02)
≥9	63.12 (10.91)	25.48 (4.90)	88.60 (12.90)	53.85 (14.46)	24.23 (4.62)	78.08 (15.36)	28.38 (13.48)	20.46 (6.04)	48.85 (13.20)

Notes: SD = standard deviation; MCI = mild cognitive impairment; HC = health control; AD = Alzheimer's disease; S-TOFHLA = Short Test of Functional Health Literacy in Adults;

studied the degree to which cognitive abilities explain the association between health education, performance on common tasks relating to health and functional health status. In this study, conducted with adults between 55 and 74 years, measures of health literacy (REALM, TOFHLA, and Newest Vital Sign [NVS]) were strongly correlated with cognitive skills, both fluid and crystallized. Low functional literacy and poor fluid and crystallized cognitive function were both associated with poorer performance on

Table 5. Spearman's correlations among S-TOFHLA scores, schooling, age, and neuropsychological tests

	Age	Schooling	S-TOFHLA R			
			Reading	Numeracy	Total	Time
MMSE HC	.065	.506*	.509*	.472*	.545*	−.278*
MMSE MCI	−.117	.419*	.543*	.358*	.506*	−.317*
MMSE AD	.165	.327*	.278	.176	.296*	−.120
RCM HC	−.026	.614*	.663*	.437*	.663*	−347*
RCM MCI	−.133	.700*	.681*	.534*	.666*	−.374*
RCM AD	−.219	.389*	.373*	.172	.416*	−.187
Block Design HC	−.122	.529*	.606*	.456*	.598*	−.553*
Block Design MCI	−.153	.667*	**.707***	.453*	.672*	−.249
Block Design AD	−.200	.401*	.561*	.367*	.630*	−.156
Vocabulary HC	.044	.616*	**.706***	.618*	**.732***	−.578*
Vocabulary MCI	.222	.615*	.588*	.607*	.640*	−.381*
Vocabulary AD	.089	.626*	.490*	.315*	.569*	−.169
Estimated IQ HC	.035	**.724***	**.741***	.638*	**.758***	−.545*
Estimated IQ MCI	.084	**.803***	**.797***	.599*	**.793***	−.389*
Estimated IQ AD	−.115	.529*	.535*	.291	.585*	.046
Age HC			−.082	−.087	−.072	.023
Age MCI			−.142	−116	−.156	.053
Age AD			−.076	−.148	−.110	.011
Schooling HC			.634*	.477*	−.401*	.612*
Schooling MCI			**.745***	.536*	**.748***	−.371
Schooling AD			−.084	.196	−.026	.341*

Notes: R = coefficient of correlation; HC = Health Control; MCI = mild cognitive impairment; AD = Alzheimer's disease; S-TOFHLA = Short Test of Functional Health Literacy in Adults; MMSE = Mini-Mental State Exam; RCM = Raven's Colored Matrices; IQ = intelligence quotient.
$^*p < .05$.

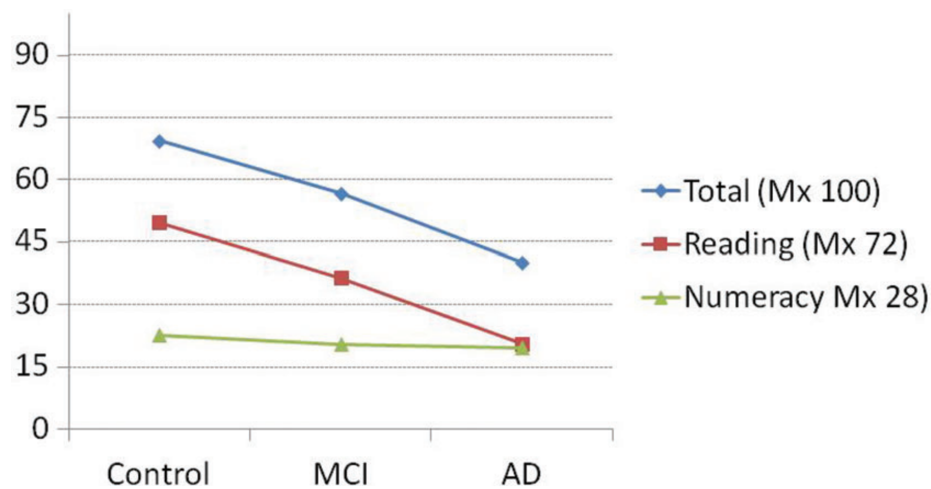

Fig. 1. Group performance (Control, MCI, and AD) in relation to the total score of the S-TOFHLA, Reading Comprehension, and Numeracy tests.

health tasks. Associations between health literacy and performance of common tasks were explained by lack of background knowledge and the need to be able to apply new information to build a sound foundation of understanding, linking fluid and crystalized processes (Weiss et al., 2005).

In our study, the S-TOFHLA showed correlation with tests that assess both skills (fluid and crystallized). The S-TOFHLA was also shown to be correlated with estimated IQ, which is a sum of the measure of both types of intelligence, for both the control group and patients diagnosed with MCI.

Intellectual decline is the hallmark of dementia and AD, and a good measure of premorbid intelligence in relation to current abilities, which can be useful in assessing the magnitude of the decline (Dierckx et al., 2008; Powell, Brossart, & Reynolds, 2003).

In our study, the S-TOFHLA showed strong and significant correlation with estimated IQ. The estimated IQ is obtained through two measures: Vocabulary as a measure of crystallized intelligence and cubes as measures of fluid intelligence. S-TOFHLA could be used as a measure of premorbid level in health and MCI individuals.

Premorbid IQ is an index of cognitive reserve. Starr and Lonie (2008) worked with the hypothesis that cognitive reserve continues to influence cognition after AD diagnosis, having an indirect impact on activities of daily living.

The S-TOFHLA does not seem to be suitable as an instrument to measure functional literacy for patients with more advanced cognitive impairment (mild dementia), but proved to be useful as an adjuvant to estimated IQ, reading ability, and premorbid IQ, when used as an indicator of cognitive reserve.

Our findings suggested that S-TOFHLA could be used as a measure of relative independency for MCI controlling their own medications. There was no difference in performance between controls and MCI patients in the numeracy items that are related to schedule and control of medications. Individuals with low numeracy are less able to understand the health risks and how to use the prescribed medication, and the numerical ability seems to matter at judgments and decisions in important ways (Peters et al., 2006). According to this study, MCI patients seem to be preserved in this item and may be considered independent for these activities.

General limitations of our findings are that S-TOFHLA has not been validated in the Brazilian population; therefore, we have no parameters to affirm the level of functional health literacy, using the labels of adequate, borderline, and inadequate. We also included more fluid than crystallized intelligence tests. However, we do not have instruments to measure crystallized intelligence that have been adapted for the Brazilian population.

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Conflict of Interest

None declared.

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