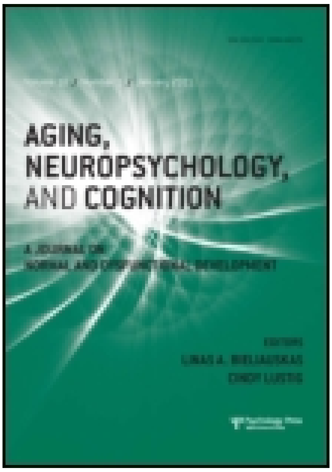

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ABSTRACT

Financial constraints, mobility issues, medical conditions, crime in local areas can make cognitive assessment difficult for elders and telephone interviews can be a good alternative. This study was carried out to evaluate the reliability, validity and clinical utility of a Brazilian telephone version of the Mini Mental State Examination (Braztel-MMSE) in a community sample of healthy elderly participants and AD patients. The MMSE and the Braztel-MMSE were applied to 66 AD patients and 67 healthy elderly participants. The test–retest reliability was strong and significant ($r = .92$, $p = .01$), and the correlation between the Braztel-MMSE and the MMSE were significant ($p = .01$) and strong ($r = .92$). The general screening ability of the Braztel-MMSE was high (AUC = 0.982; CI95% = 0.964–1.001). This telephone version can therefore be used as a screening measure for dementia in older adults that need neuropsychological screening and cannot present for an evaluation.

Keywords: Brazilian telephone MMSE; In-person MMSE; Alzheimer's disease; Validation study; Brazil.

INTRODUCTION

The Mini Mental State Examination (MMSE) is the most widely used screening tool to assess the mental or cognitive status of elderly people. This

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test measures a broad set of cognitive domains such as orientation, attention, memory, language, praxis and visuo-spatial skills (Folstein, Folstein, & McHugh, 1975). The American Academy of Neurology recommended general cognitive screening instruments, such as the MMSE, for the detection of dementia in individuals with suspected cognitive impairment (Petersen et al., 2001). However a discussion on what cognitive test should be used for those with suspected dementia still remains (Jacova, Kertesz, Blair, Fisk, & Feldman, 2007). There is some debate about the MMSE accuracy and clinical utility in diagnosing cognitive disorders (Mitchell, 2009), however the worldwide use of this instrument as a screening tool for dementia make it a good alternative when developing culturally measures.

Because aging of the population is a worldwide phenomenon, the risk is higher for cognitive impairment and dementia (Wimo, Jonsson, & Winblad, 2006). In the developing world, including Latin America, a rapid increase in life expectancy has emerged in recent decades. In Brazil, there are almost 20 million people over the age of 60 (IBGE, 2008). Of an estimated 24.3 million people with dementia worldwide in 2005, 14.6 million lived in developing countries, and these rates will increase in the next decades (Ferri et al., 2005). It is therefore important to have easy, quick and feasible instruments to evaluate cognition in the elderly population.

Financial constraints, restrained mobility, medical disorders, need for supervision or assistance, and cognitive impairment can make access to health services difficult for elders. Telephone interviews are more feasible for these adults given their possible circumstances.

In addition, database for research studies can be easily gathered by telephone interviews. This is specially valid for developing countries, such as in Brazil, where there is a higher rate of violence (IBGE, 2008) which can complicate the collection of research data. As well, telephone interviews could benefit longitudinal studies, as they allow tracking participants over time and reduces the study dropout rate. Longitudinal studies are expensive, and despite the higher proportion of old individuals in the Brazilian population, cohort studies of this age group are sparse.

Additionally, access to telephone lines is not a problem for Brazilian citizens, since 72.8% currently has access to this service (IBGE, 2008). Moreover, research in developing countries would greatly benefit from telephone interviews because of limited access to health services. Many studies have shown a favorable clinical application using telephone-based measures of cognitive status (Alexopoulos, Perneczky, Cramer, Grimmer, & Kurz, 2006; Brandt, Spencer, & Folstein, 1988; Dal Forno et al., 2006; Ferrucci et al., 1998; Graff-Radford et al., 2006; Jarvenpaa et al., 2002; Kawas, Karagiozis, Resau, Corrada, & Brookmeyer, 1995; Kempen, Meier, Bouwens, van Deursen, & Verhey, 2007; Konagaya et al., 2007; Metitieri et al., 2001; Newkirk et al., 2004; Norton et al., 1999; Roccaforte, Burke, Bayer, & Wengel, 1992; van Uffelen, Paw, Klein, van Mechelen, & Hopman-Rock, 2007). Most of them have compared different telephone measures to the in-person MMSE, showing significant positive correlations (Alexopoulos et al., 2006; Brandt et al., 1988; Dal Forno et al., 2006; Jarvenpaa et al., 2002; Kempen et al., 2007; Konagaya et al., 2007; Metitieri et al., 2001; Newkirk et al., 2004; Norton et al., 1999; van Uffelen et al., 2007; Vanacore et al., 2006).

The telephone interview based on the Adult Lifestyles and Function Interview (ALFI) (Fischbach, 1990) was developed as one of the telephone measures. The ALFI-MMSE was first used as a telephone-administered follow-up interview of subjects of 65 years or older who participated in the NIMH Epidemiologic Catchment Area (ECA) study. This is a 22-point validated telephone version of the in-person MMSE, which is very similar to but less time consuming than the original version (Roccaforte et al., 1992). This telephone version was already translated to Italian. The Italian telephone version of the MMSE (Itel-MMSE) was shown to be valid and strongly correlated to the standard original MMSE (Metitieri et al., 2001; Vanacore et al., 2006). There is an extended 26-point validated version of the ALFI-MMSE which has expanded the assessment of comprehension in the language item (Newkirk et al., 2004).

The ALFI-MMSE closely parallels the original in-person MMSE, which has already been validated and widely used in Brazil (Bertolucci, Brucki, Campacci, & Juliano, 1994; Chaves & Izquierdo, 1992). In addition, the ALFI-MMSE is a brief task which continues to incorporate the registration and recall of a short word list. This registration procedure can be advantageous for individuals with mild hearing impairment because this procedure ensures that individuals have correctly heard the words to be recalled. Then the potential confound effect of mild hearing impairment on cognitive performance can be minimized.

We therefore employed the 22-score translated ALFI-MMSE, which we have named the Brazilian telephone MMSE (Braztel-MMSE) in the current study. This is a briefer version which does not assess certain cognitive domains (e.g., verbal and written comprehension, writing, and construction) but it can be advantageous as screening measure for dementia in older adults that need neuropsychological screening and cannot present for an evaluation.

This study aimed to evaluate the test–retest reliability of the Braztel-MMSE, the correlation between the in-person MMSE and the telephone version (Braztel-MMSE) and the diagnostic validity of the Braztel-MMSE as a screening instrument to detect Alzheimer's disease (AD).

METHODS

A randomized, double-blind experiment was conducted in a community sample of AD patients and healthy participants from a southern Brazilian city to evaluate the telephone version of the MMSE in relation to the original MMSE applied in-person. We used the term in-person MMSE through the text to refer to the original MMSE. During a 6-month period, individuals of 60 years and older living in a catchment area of the Hospital de Clinicas de Porto Alegre, Brazil, were invited to participate in an evaluation at the Alzheimer's disease Center and Neurogeriatric Clinic at the hospital. Each participant underwent a standardized clinical, psychiatric, neuropsychological and neurological evaluation. A collateral informant was also used to verify the history. A whispered-voice screening test was applied to all participants to evaluate hearing impairment (Bagai, Thavendiranathan, & Detsky, 2006). All participants were also assessed with the Blessed Information-Memory-Concentration Test (Thal, Grundman, & Golden, 1986), a standardized protocol adapted from Kaye et al., 1994 (Kaye et al., 1994) and the Clinical Dementia Rating scale (CDR) (Chaves et al., 2007; Hughes, Berg, Danziger, Coben, & Martin, 1982; Maia et al., 2006). Those subjects who showed CDR score of 0.5 or greater, performed below expectations on testing and had a history consistent with AD were referred for neuroimaging and blood tests. The National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA) criteria for probable AD (McKhann et al., 1984) were applied for diagnosis. Thesecriteria include a typical insidious onset of dementia established by clinical examination and documented by the Mini-Mental Test,Blessed Dementia Scale, or some similar examination, and confirmed by neuropsychological tests; deficits in two or more areas of cognition; progressive worsening of memory and other cognitive functions; no disturbance of consciousness; onset between ages 40 and 90, most often after age 65; and absence of systemic disorders or other brain diseases that in and of themselves could account for the progressive deficits in memory and cognition. Individuals who scored zero on the CDR, presented with an average range of normative data for healthy controls on cognitive tests and had no history of clinical, neurological or psychiatric disorders were classified as healthy participants. Exclusion criteria were history of deafness, complaint of hearing impairment, positive whispered-voice screening test and MMSE scores ≤10. Severe dementia (i.e., a CDR score = 3) was also cause for exclusion. AD patients with preexisting psychiatric conditions and with severe clinical comorbidities were also excluded.

The ALFI-MMSE (called the Braztel-MMSE in the present study) was translated to Brazilian Portuguese and back translated to English before being applied to study subjects.

With the goal of controlling for task interaction or a practice or learning effect, each of the 160 initial participants in the current study was randomly assigned to one of the four following experimental conditions: (a) Group 1, Braztel-MMSE administration followed by Braztel-MMSE administration;

(b) Group 2, in-person MMSE administration followed by in-person MMSE administration; (c) Group 3, in-person MMSE administration followed by Braztel-MMSE administration; and (d) Group 4, Braztel-MMSE administration followed by in-person MMSE administration.

The groups were comparable for age, education, and gender. The final sample was composed of 66 AD patients and 67 healthy elderly participants. The time interval between the two interviews was 48 to 72 hours.

A group of four previously trained interviewers carried out the application of one of the two administrations. They were kept blind to any other MMSE result and to the diagnosis of the participants. Inter-rater reliability was established between all pairs of raters (r>.85 for both, Pearson correlation coefficient).

Similarities and differences between the in-person MMSE version (Folstein et al., 1975) and the Braztel-MMSE (phone version) are showed in Table 1. The telephone version took approximately 5 minutes to administer. Specific instruction to avoid to getting help was given.

The study was approved by the Ethics Committee for Medical Research of Hospital de Clínicas de Porto Alegre. All participants and/or their proxies signed an informed consent before entry into the study.

Statistical analysis

Each in-person and telephone MMSE pair counted as one observation. Spearman correlation coefficients were used to evaluate the Braztel-MMSE and the in-person MMSE test–retest reliability (Groups 1 and 2) and to estimate the degree to which the in-person MMSE and the Braztel-MMSE were related to each other in each experimental condition (Groups 3 and 4). In order to estimate a future score based on a previous score, regression equations were carried out for experimental condition 3 and 4.

A two-tailed paired *t*-test was used to test whether scores differed between the two administrations in each experimental condition. The 22-equivalent points from the in-person and the telephone version were used for these analyses.

The general screening ability of the Braztel-MMSE to detect AD was calculated using a receiver operating characteristic (ROC) curve. An estimate of the overall discriminative ability of a scale utilizing the area under curve (AUC) statistic is provided by ROC analysis. The AUC indicates how close a scale is to the ideal point of 100% sensitivity and 100% specificity. Sensitivity and specificity were calculated using a ROC curve that plots sensitivity and specificity across the range of possible cutoff scores. The AUC, sensitivity and specificity of the in-person MMSE to detect AD were also estimated.

An ANOVA with Tukey's *post-hoc* analysis was performed to evaluate the differences among the CDR categories in the Braztel-MMSE.

TABLE 1. Similarities and differences between the in-person MMSE version and the Braztel-MMSE (phone version)

In-person MMSE		Braztel-MMSE	
Temporal Orientation	*Points*	*Temporal Orientation*	*Points*
Year	1	Year	1
Season	1	Season	1
Date	1	Date	1
Day	1	Day	1
Month	1	Month	1
Spatial Orientation		*Spatial Orientation*	
Country	1	Country	1
State	1	State	1
City	1	City	1
Hospital	1	Street address of the house	1
Floor	1	________	_
Registration		*Registration*	
Repeat 3 objects	3	Repeat 3 objects	3
Attention and calculation		*Attention and calculation*	
Serial 7s; stop at 5 answers.	5	Serial 7s; stop at 5 answers.	5
Recall		*Recall*	
Ask for the objects above.	3	Ask for the objects above.	3
Language		*Language*	
Name pencil and watch.	2	Ask the participant: 'What is the name of the object through we are speaking?'	1
Repeat 'No ifs, ands or buts'.	1	Repeat 'No ifs, ands or buts'.	1
Read and obey the following: 'CLOSE YOUR EYES'.	1	________	_
Take paper in right hand, fold it in half and put it on the floor.	3	________	_
Write a sentence spontaneously below.	1	________	_
Copy design below	1	________	_
Total points	30	Total points	22

Statistical analyses were conducted using SPSS 13.0 for Windows (SPSS Inc., Chicago, IL). The confidence level of the sensitivity, specificity, positive predictive value and negative predictive value of the cutoffs were calculated using the epicalc package from R Project for Statistical Computing 2.8.1 (R Foundation, Auckland, New Zealand).

RESULTS

Demographic data from AD patients and healthy participants among the four experimental conditions (groups) are displayed in Table 2. Age, sex and education did not differ between AD patients and healthy participants in the groups 1 to 3, however in the group 4 (Braztel-MMSE followed by in-person MMSE) AD patients were older than healthy participants ($p = .03$) (Table 2). Age, sex and education did not differ among the four experimental conditions

TABLE 2. Demographic Data from the AD Patients and the Healthy Elderly Groups Among the Four Experimental Conditions

Experimental condition and demographic variables	AD patients	Healthy participants	*p*
Braztel-MMSE followed by Braztel-MMSE (*N*)	15	16	
Age* (mean (*SD*))	72.8(5.6)	70.5(6.5)	.30
Sex** Female (*N*(%))	7(47)	11 (69)	.21
Educational level* (mean (*SD*))	3.9(1.2)	4.8(1.6)	.07
In-person MMSE followed by in-person MMSE (*N*)	17	17	
Age* (mean (*SD*))	72.6(7.3)	71.5(7.0)	.65
Sex** Female (*N* (%))	10(59)	9(53)	.73
Educational level* (mean (*SD*))	5.4(4.8)	5.1(3.6)	.81
In-person MMSE followed by Braztel-MMSE (*N*)	17	17	
Age* (mean (*SD*))	75.8(6.4)	74.5(6.3)	.54
Sex** Female (*N*(%))	11(65)	13(77)	.45
Educational level* (mean (*SD*))	5.5(3.6)	5.3(2.8)	.86
Braztel-MMSE followed by in-person MMSE (*N*)	17	17	
Age* (mean (*SD*))	74.4(4.8)	69.2(8.1)	**.03**
Sex** Female (*N*(%))	8(47)	10(59)	.49
Educational level* (mean (*SD*))	5.1(2.6)	5.9(3.5)	.47

*Student's *t*-test. **Chi-square test.

($p = .16$, $p = .63$ and $p = .52$, respectively) and between AD and healthy participants ($p = .22$, $p = .94$ and $p = .79$, respectively). From the 66 AD patients, 39 scored a 1 on the CDR (mild dementia) and 27 scored a 2 on the CDR (moderate dementia).

The Braztel-MMSE was strongly correlated with the MMSE, independent of the order of administration, ranging from 0.70 to 0.92 (Table 3). The test–retest reliability from the two versions was also significant and strong, ranging from 0.88 to 0.97 (Table 3).

The regression equations for predicting MMSE scores from Braztel-MMSE scores and for predicting Braztel-MMSE from in-person MMSE scores were as follows: MMSE = 1.012×(Braztel-MMSE total score)+7.424 and Braztel-MMSE = 0.834×(MMSE total score)–3.224. Conversions based on regression equations are showed in Table 4.

On average, participants performed significantly better on in-person MMSE, independent of the order of administration ($p <. 036$ for experimental condition 3 and $p <. 001$ for experimental condition 4, respectively) (Table 5).

The means of the Braztel-MMSE scores were significantly different among CDR categories ($F = 166.93$, $p <. 001$, ANOVA). A multiple comparison Tukey's test showed higher scores on the Braztel-MMSE ($M = 18.60$, $SD = 2.54$) in healthy elderly subjects (CDR = 0), followed by the mild AD group (CDR = 1) ($M = 10.67$, $SD = 2.92$) and the moderate AD group (CDR = 2) ($M = 7.45$, $SD = 2.43$).

Table 3. Spearman's Correlation Coefficient Among the Four Experimental Conditions in the Whole, AD and Healthy Elderly Samples

Experimental condition	*r**
Braztel-MMSE followed by Braztel-MMSE	
Whole sample	.97
AD patients	.93
Healthy elderly participants	.88
MMSE followed by MMSE	
Whole sample	.97
AD patients	.91
Healthy elderly participants	.97
MMSE followed by Braztel-MMSE	
Whole sample	.92
AD patients	.71
Healthy elderly participants	.75
Braztel-MMSE followed by MMSE	
Whole sample	.92
AD patients	.70
Healthy elderly participants	.79

**p* <. 001 for all coefficients.

The ROC analysis indicated a high Braztel-MMSE diagnostic accuracy for identifying dementia in this sample (AUC = 0.98; CI95% = 0.96–1.00) (Figure 1). The optimal cutoffs were determined by finding the Braztel-MMSE values that allowed for the best balance between sensitivity and specificity. A range of possible cutoff values is provided in Table 6. A cutoff of 15 on the Braztel-MMSE obtained a sensitivity of 94%, a specificity of 84%, an 85% positive predictive value and a 93% negative predictive value.

The AUC of the 30 points from the MMSE was 0.95, with a 95% confidence interval of 0.90–0.99. A cutoff of 22 on the 30 score MMSE obtained a sensitivity of 91% and a specificity of 85% relative to the AD diagnosis.

DISCUSSION

The Brazilian telephone version of the Mini Mental State Examination was significantly and strongly correlated with the in-person MMSE. Both versions were considered to be interchangeable. In addition we were able to predict a future score on MMSE based on the previous score on the Braztel-MMSE and vice versa. Additionally this telephone version was shown to be a reliable and valid instrument for screening dementia. It showed high general ability to screen for AD and had favorable inter-rater and test–retest reliability.

Table 4. In-person and Telephone Conversions Based on Regression Equations

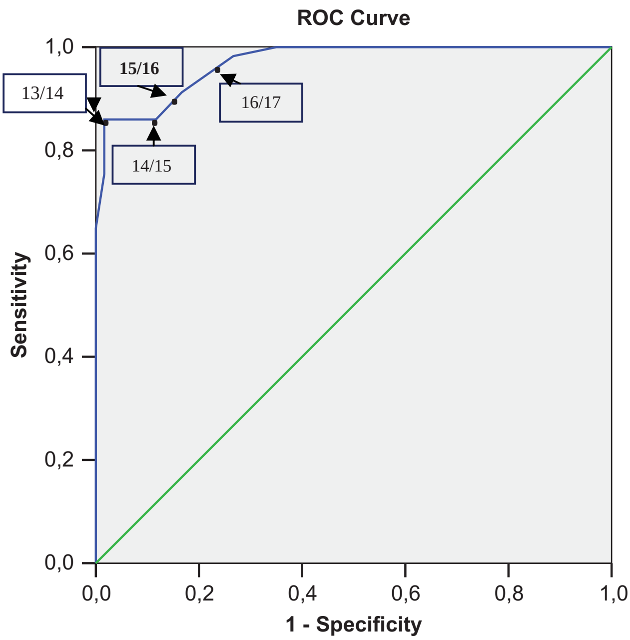
In-person MMSE score	Predicted Braztel-MMSE score	Braztel-MMSE score	Predicted In-person MMSE score
0	0	0	7
1	0	1	8
2	0	2	9
3	0	3	10
4	0	4	11
5	1	5	12
6	2	6	13
7	3	7	15
8	3	8	16
9	4	9	17
10	5	10	18
11	6	11	19
12	7	12	20
13	8	13	21
14	8	14	22
15	9	15	23
16	10	16	24
17	11	17	25
18	12	18	26
19	13	19	27
20	13	20	28
21	14	21	29
22	15	22	30
23	16		
24	17		
25	18		
26	18		
27	19		
28	20		
29	21		
30	22		

Table 5. Mean difference between first and second administration among the four experimental conditions (Student's *t*-test paired-samples)

Experimental condition	Total score	Total score	*t*	*p*
Braztel-MMSE followed by Braztel-MMSE (*N* = 31)	13.7 ± 5.9	14.0 ± 6.0	–1.034	.309
MMSE followed by MMSE (*N* = 34)	15.9 ± 3.6	16.2 ± 3.7	–1.391	.174
MMSE followed by Braztel-MMSE (*N* = 34)	15.2 ± 4.5	14.5 ± 5.0	2.186	**.036**
Braztel-MMSE followed by MMSE (*N* = 34)	13.5 ± 5.5	14.9 ± 4.7	–4.022	**<.001**

We carried out a carefully designed study in order to evaluate the correlation between the telephone and in-person MMSE versions which have included several key methodological considerations: (1) randomized order of administering in-person and telephone versions; (2) objective screening of

FIGURE 1. Receiver operating characteristic curve used to determine the accuracy of the Braztel-MMSE in diagnosing AD.



Diagonal segments are produced by ties.

TABLE 6. Cutoffs of the Brazilian telephone MMSE study obtained from coordinates of the ROC curve, and the corresponding sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV)

Cutoffs	Sensitivity (CI95%)	Specificity (CI95%)	PPV (CI95%)	NPV (CI95%)
13	90 (79–96)	100 (94–100)	100 (93–100)	90 (81–96)
14	90 (79–96)	89 (79–96)	90 (79–96)	89 (79–96)
15	94 (85–98)	84 (72–92)	85 (74–93)	93(83–98)
16	100 (94–100)	75 (62–85)	80 (69–89)	100 (92–100)

participants for hearing impairment using a whispered-voice; (3) consensus diagnosis; (4) back translation of the Braztel-MMSE instrument; and (5) interviewers were blind to each participant's other MMSE score and to diagnosis, i.e., interviewers who carried out the application of one of the two administrations were kept blind to any other MMSE result and to the diagnosis of the participants. This strategy could minimize assessment bias.

The Braztel-MMSE was strongly correlated with the results of the in-person MMSE, independent of the order of administration. We applied various conditions and changed the order of presentation of the MMSE versions to control for practice and interaction effects. This finding indicates that the Braztel-MMSE can be clinically applied to screen individuals and to identify those whose cognitive status has changed over a period of time. Braztel-MMSE was shown to be interchangeable with in-person MMSE version, and then we can use the phone version in a subject who has previously been evaluated with the in-person MMSE.

Our findings are similar to those of Roccaforte and coworkers (Roccaforte et al., 1992) when they first validated the ALFI-MMSE. The Italian version of the ALFI-telephone MMSE has also demonstrated a significant correlation with the in-person MMSE in a sample of inpatients with cognitive deficit (Metitieri et al., 2001) and in a healthy elderly population (Vanacore et al., 2006).

The sensitivity, specificity and the overall accuracy of the Braztel-MMSE to detect AD were very good. The sensitivity and specificity rates to screen for dementia were closer to those found with the original MMSE that was translated to Brazilian Portuguese (Bertolucci et al., 1994). The sensitivity and specificity of the Braztel-MMSE for the detection of AD were 94 and 84%, respectively, compared to 91 and 85% found for the in-person MMSE. We found that the cutoff for these two instruments was different. This finding was not surprising, since their total scores are different. The AUC derived from the two instruments (Braztel-MMSE and MMSE) were very similar, and both had high diagnostic accuracy for identifying AD in this sample. In a previous investigation, the sensitivity and specificity of the ALFI-MMSE were found to be 67 and 100%, respectively, and those of the MMSE were 68 and 100% in relation to an in-person brief neuropsychological screening test (BNPS) (Roccaforte et al., 1992).

Moderate AD patients (CDR = 2) did not perform as well on the Braztel-MMSE compared to the mild group (CDR = 1), and both groups presented with lower performance compared to healthy elderly participants (CDR = 0). Because it is hypothesized that Braztel-MMSE scores would change with dementia severity (i.e., CDR categories), the finding demonstrating a relation between the severity of dementia and the scores on the Braztel-MMSE can also be an indication of construct validity for Braztel-MMSE.

On average, in comparing the total scores from Braztel-MMSE and in-person MMSE, participants did slightly better on in-person MMSE.The learning effect cannot be an explanation for this better performance, as we administered the tests in a randomized order. We can hypothesize that individuals were more capable of answering in-person interviews. Brazilian individuals may be not familiar with study interviews by telephone, which may have produced the observed difference. In-person interviews could also provide some subtle clues, which could enhance the performance in the test. Another possible explanation is the controlled and appropriate environment used for the in-person interview. In the present study specific instructions to prevent or to minimize environmental distractions such as television, radio, interruptions, people in the room, etc were not provided. These environmental factors could negatively influence the individual's performance on phone version. Roccaforte and colleagues (Roccaforte et al., 1992) demonstrated that participants did slightly better on the in-person MMSE than on the ALFI-MMSE. In that study, however, the telephone version was applied before the in-person version. Participants exposed to the 26-point telephone MMSE version perform better than in the in-person interview (Newkirk et al., 2004), and elderly patients perform better on cognitive tests taken at home compared to tests administered in a clinic (Shievitz, Tudiver, Araujo, Sanghe, & Boyle, 1998; Ward et al., 1990).

The ability of telephone instruments to screen cognitive performance has been demonstrated in many developed countries (Brandt et al., 1988; Dal Forno et al., 2006; Ferrucci et al., 1998; Kempen et al., 2007; Konagaya et al., 2007; Vanacore et al., 2006), however, these types of studies have yet to be conducted in the developing regions of the world. The present findings demonstrate the first telephone cognitive screening instrument applied in a sample from a developing country. As a general expectation, one might assume that people from countries like Brazil would not respond adequately to questions on the telephone due to their lack of experience with instrumentalized tasks (e.g., the telephone, computerized tests, and so on). These findings, however, showed exactly the opposite. The Braztel-MMSE was not more difficult for the subject to complete as compared to the in-person MMSE. Another advantage of the use of a telephone screening is its ability to overcome barriers of the health services in a less expensive and expedited manner and to contact subjects in many different areas of the country, even places with higher rates of violence. The use of the telephone, a less expensive and widespread communication instrument, can improve research and clinical care in developing countries.

Performance on neuropsychological tests is under the influence of a vast array of moderating variables, including culture, ecological demands, primary language, and educational level (Ardila, 1995). One possible limitation of the study is the absence of the diagnostic validity analysis stratified by educational level and age. The education (mean±SD) of our sample was low and it was not possible to evaluate the performance on the Braztel-MMSE in individuals with a high school or a college education. Since MMSE scores repeatedly have been shown to be related to educational level (Black et al., 1999; Tombaugh & McIntyre, 1992) we can suppose the same effect on the telephone version. This is an important issue to be evaluated in further studies. In addition we could not control a translation potential confound effect which can be present in any task that require this procedure. Another possible limitation is that language impairment can be underdetected by Braztel-MMSE since comprehension (verbal and written), writing, and construction can not be assessed by telephone interviews.

One of the strengths of this study was to consider cultural factors but it can also be a limiting factor to generalize the results to other populations with diverse cultures. However one can remember that this instrument was originally developed for use in research carried out in developed country and that an Italian version was already validated. In addition, some age-related factors such as reduced mobility and clinical illness which can negatively impact access to health services seem to be independent of culture. Telephone-based instruments appear to be an option in these types of situations. As well this is a phone version of MMSE which is widely used in many cultures around the world. Other strengths of the study are the careful methodological design, the pairing of the sample among experimental groups, the control of all possible experimental conditions and a community sample of patients and healthy elderly participants.

In conclusion, the Braztel-MMSE was found to be a reliable instrument, was shown to be interchangeable with the in-person MMSE and demonstrated good diagnostic properties to screen for AD. Although this study sample included patients diagnosed with AD we can hypothesize that Braztel-MMSE could be a valid instrument to screen dementia based on the strong correlation with the in-person version and on the well established validity of MMSE as screening instrument for dementia. These characteristics make the MMSE phone version an alternative method to evaluate cognitive impairment in the population. This is especially important in situations where there is significant difficulty in accessing health facilities, such as that observed in developing countries. The telephone version of the MMSE can play a role as a reliable, feasible and economical alternative method to assess cognitive function. It also provides an additional and useful tool for epidemiological research.

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