



Evaluation of the psychometric properties of the Brazilian version of the Short Portable Mental Status Questionnaire (SPMSQ) by Pfeiffer

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Abstract

Objective: To evaluate the psychometric properties, including validity, reliability, sensitivity, and specificity of the SPMSQ-BR. **Method:** The analysis was conducted on 93 older adults, assessed with the Brazilian version of the SPMSQ, Mini-Mental State Examination (MMSE), Clock Drawing Test (CDT), and Verbal Fluency Test (VFT). Internal consistency was estimated using Cronbach's alpha coefficient. In order to assess intra-rater stability and inter-rater reproducibility, the intraclass correlation coefficient (ICC) with a 95% confidence interval was employed. For concurrent and convergent validity, Spearman's correlation coefficient was utilized. Accuracy in establishing the cutoff point for the SPMSQ-BR to screen sensitivity and specificity was assessed through ROC curve analysis. **Result:** The SPMSQ-BR demonstrated excellent internal consistency ($\alpha=0.803$), high intra-rater and inter-rater reliability (ICC=0.977 and ICC=0.973), respectively. In terms of concurrent validity, it showed a strong negative linear correlation with the MMSE (-0.799, $p<0.001$), while moderate correlations were found with the CDT (-0.584, $p<0.01$) and VFT (-0.569, $p<0.01$). The SPMSQ-BR proved capable of discriminating cognitive impairment with a cutoff point of 3 errors, following the original scale. The area under the curve (AUC) considering education level was 0.905 (sensitivity=81.3%, specificity=76.9%), and without considering education level, the AUC was 0.927 (sensitivity=87.5%, specificity=80.8%), indicating good sensitivity and specificity in both cases. **Conclusion:** The study demonstrated that the Brazilian version of the SPMSQ, established as a Brief Cognitive Capacity Scale, proved to be stable, reproducible, valid, and reliable for assessing the cognitive capacity of older adults. Furthermore, it showed sensitivity in identifying cognitive impairment.

Keywords: Validation Study. Elderly Health. Mental Status and Dementia Tests. Cognitive Aging. Sensitivity and Specificity.

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INTRODUCTION

The extension of life expectancy is a process that implies changes in the organization of societies. Amid discussions about the most appropriate measures to adapt to new population configurations, the projection of a longer lifespan has effects, particularly on the health of this population¹. The aging process is characterized by impairment in the functioning of the body's systems. These progressive limitations can be exacerbated by non-communicable chronic diseases, leading to changes in functional capacity^{1,2}.

Functional capacity refers to the ability to perform activities of daily living (ADLs) and instrumental activities of daily living (IADLs), which encompass, in one of their aspects, cognitive impairment. In aging, the central nervous system is one of the most affected with the development of alterations in the neurotransmitter system and cerebral hypotrophy^{2,3}. These modifications typically occur in regions responsible for cognitive functions, and it is common to observe both minor and significant impairments in this function among older individuals³. Early diagnosis is crucial for implementing measures that preserve the autonomy and independence of older adults^{3,4}.

Dementia conditions are indicated as major contributors to the development of functional dependence and are related to this decline. Dementia syndromes, although not inherent characteristics of aging, are more prevalent in this age group. It is estimated that between 2% and 10% of all dementia cases begin before the age of 65. After this age, the prevalence of cases tends to double every five years of life^{4,5}.

Studies show that the prevalence of dementia in the Brazilian population is very similar to that of foreign studies⁶, demonstrating significant impairments in functionality and consequently in the quality of life of older adults and those around them^{4,6}. This necessitates specific intervention programs to adapt routine activities, to equip caregiving, and to manage behavioral changes⁵.

In this sense, it becomes imperative to conduct an assessment that takes into account these aspects inherent in the aging process. Identifying risk factors and screening individuals who may have dementia is

essential for early treatment, as well as for delaying the effects of the disease^{3,6,7}. Therefore, it is essential to have practical, accessible, and reliable tools that allow for the detection of cognitive impairment. It is emphasized the importance of verifying whether the instrument has been validated⁷.

The Short Portable Mental Status Questionnaire (SPMSQ) by Eric Pfeiffer⁸ is a cognitive screening and diagnostic support instrument for dementia, specifically designed for older adults. A readily administered test comprising only 10 questions, it can be applied by any healthcare professional and exhibits good sensitivity (S=86%) and specificity (E=99%) in its original English version⁸. It is utilized to monitor therapeutic measures and the progression of cognitive deficits, evaluating memory, temporal orientation, spatial orientation, mathematical ability, and information regarding daily facts and skills. This instrument allows for the classification of the older adult into preserved cognitive capacity, mild cognitive impairment, moderate, or severe impairment, taking into account the individual's level of education^{8,9}. It has already been translated and culturally adapted for Brazil by Teigão et al¹⁰.

Following the process of cross-cultural adaptation of the instrument, it is necessary to analyze its psychometric properties to ensure that the characteristics of the original instrument have been maintained. The most considered measurement properties are validity, reliability, and accuracy, which are fundamental aspects for assessing the quality of an instrument^{11,12}.

Validity refers to the quality of an instrument, whether it assesses exactly what it aims to measure¹³, while reliability concerns the degree to which an instrument allows for the reproduction and consistency of results when applied on different occasions¹⁴, referring to the stability and reproducibility of assessment results to verify if the results are accurate and consistent^{15,16}. The accuracy, which addresses sensitivity and specificity, lies in the instrument's ability to discriminate between diseased and non-diseased individuals and to detect the highest possible number of correct classifications (true positives) while minimizing errors (false positives)^{13,16}.

Given this need, the aim of the present study was to evaluate the psychometric properties, including validity, reliability, stability, reproducibility, sensitivity, and specificity, of the Brazilian version of the Short Portable Mental Status Questionnaire (SPMSQ-BR) by Pfeiffer.

METHOD

A methodological validation study was conducted in the city of Curitiba (PR), Brazil. The investigation involved a non-probabilistic or convenience sample. Following international recommendations for investigating the psychometric properties of health questionnaires, the sample consisted of 93 individuals aged ≤ 60 years. Efforts were made to standardize the groups according to level of education, sex, and place of residence (institutionalized and non-institutionalized), enabling the SPMSQ-BR to be tested in groups with distinct realities and across different aspects, following its original version.

The approach and recruitment process of the older adults were conducted in two stages. Firstly, there was a presentation of the project to the board of directors of the Homes for the Aged (ILPI) to obtain access to the institutionalized older adults. After obtaining authorization and providing clarifications regarding the project, the older adults were invited to sign the Informed Consent Form (ICF). Data collection took place in the location within the institution where they felt most comfortable, respecting their privacy. The same procedure was carried out for participants from Day Centers (non-institutionalized modality, where older adults spend the day with medical and multiprofessional assistance) and for older adults residents who were registered and attended a Community Center in a metropolitan area of Curitiba.

The research participants selected were aged >60 years and had Portuguese as their native language. Individuals with severe uncorrected hearing impairment and severe psychiatric impairment were excluded.

Sociodemographic information was collected using a structured questionnaire to characterize the sample prior to the questionnaire application.

Concurrent and convergent validity were tested using the Spearman-Rank correlation coefficient, which occurs when there is a correlation between the translated instrument compared to the scale of another similar, already constructed and validated measure, considered the gold standard^{11,15}.

To test concurrent and convergent validity, the scores obtained with the SPMSQ-BR were correlated with tests considered gold standards. For concurrent validity, the scores from the Brazilian version of the Mini-Mental State Examination (MMSE) were used¹⁷. For convergent validity, it was correlated with the scores of the Clock Drawing Test (CDT)¹⁸ and the Verbal Fluency Test (VFT)¹⁹, whose validity and reliability have already been demonstrated^{17,18,19}.

The SPMSQ-BR⁹ comprises ten questions that assess memory, temporal orientation, mathematical ability, and everyday information. Its score ranges from 0 to 10, considering the sum of the errors made by the evaluated individual; the lower the score, the better the cognitive capacity. It allows the classification of the individual into preserved cognitive capacity (0-2 errors), mild cognitive impairment (3-4 errors), moderate impairment (5-7 errors), or severe impairment (8-10 errors), taking into account the individual's level of education.

The MMSE is a cognitive screening test, considered the gold standard. Its composition consists of thirty items, and in the present study, the Brazilian version adapted by Brucki and colleagues¹⁷ was employed. The score ranges from 0 to 30, with higher scores indicating better cognitive capacity in individuals. Cut-off points are also defined based on education level.

In the CDT¹⁸, the subject was asked to draw a clock with hands indicating the time as 11:10. The score ranged from 0 (worst) to 5 (best).

In the VFT¹⁹, participants were required to name as many animals as they could remember in 1 minute without repeating any of them. The test score varies according to the participants' level of education, with a higher number of words indicating better performance on the test.

Validity was examined through the Spearman-Rank correlation coefficient (ρ). To obtain the reliability of the instrument, measures of internal consistency, test-retest reliability, and intra- and inter-rater reproducibility were utilized.

Internal consistency was assessed using Cronbach's α , while intra-rater test-retest stability was analyzed through the Intraclass Correlation Coefficient (ICC). Test-retest inter-rater reproducibility was tested using the Intraclass Correlation Coefficient with a 95% confidence interval (CI95%).

The Receiver Operating Characteristic Curve (ROC Curve) analysis was performed to evaluate the sensitivity and specificity of the Brazilian version of the SPMSQ. This analysis provides the Area Under the Curve (AUC), which establishes a cut-off point on the scale, aiding in the probability of the questionnaire correctly identifying patients with cognitive impairment (true positives) compared to those without cognitive impairment (true negatives) with the estimation of the standard error (SE).

According to the criteria established in the International Classification of Diseases, Tenth Revision (ICD-10) and the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV), geriatricians diagnosed institutionalized older adults with or without dementia based on cognitive screening tests and imaging examinations such as computed tomography and/or magnetic resonance imaging, considered as the reference standard.

The test was run with data from older adults whose access to medical records was obtained ($n=51$), and through the information, it was verified whether they presented dementia, without detailing the severity (mild, moderate, or severe) or the type (Alzheimer's disease, Lewy bodies, vascular dementia, etc.). The analysis was limited to the presence or absence of cognitive impairment.

The study was conducted after obtaining authorization for the use of the instrument from the Duke University Center for the Study of Aging

and Human Development, which holds the copyright for this questionnaire. It was reviewed and approved by the Research Ethics Committee of Pontifícia Universidade Católica do Paraná (PUC-PR) under number 17222319.9.0000.0020 and is in accordance with Resolutions number 466/2012 and number 510/2016 regarding research involving human subjects.

All participants were informed about the study's objectives and signed the Informed Consent Form.

DATA AVAILABILITY

The entire dataset supporting the results of this study has been made available on Figshare and can be accessed at [10.6084/m9.figshare.25669545](https://doi.org/10.6084/m9.figshare.25669545).

RESULTS

The sample consisted of 93 older adults, with 66.7% being women and 33.3% men, with a mean age of 75.1 years, confidence interval ranging from 73.3 to 76.9, and a standard deviation of 8.83. In terms of educational level, 11.8% were illiterate, 46.2% had completed up to 4 years of schooling, 15.1% had completed 5 to 9 years, 15.1% had completed 9 to 11 years, and 11.8% had completed higher education.

Regarding housing, 51.6% were institutionalized and 48.4% were from the community. As for marital status, singles represented 37.6% of the sample, followed by 24.7% widowed, 21.5% divorced, and 16.1% married.

The validity assessment was conducted by correlating the Brazilian version of the SPMSQ with other questionnaires assessing cognitive function. Concurrent validity was verified by correlating the SPMSQ-BR with the MMSE considered as the 'gold standard', and for convergent validity, the scale was correlated with the CDT and VFT. Table 1 demonstrates the correlations.

Table 1. Concurrent and convergent validity indices of the SPMSQ-BR. Curitiba, PR, 2020.

Translated Test	Gold Standard Tests	Spearman's r	p-value
SPMSQ-BR	MMSE	-0.799	<0.01
	CDT	-0.584	<0.01
	VFT	-0.569	<0.01

Source: Authors, 2020.

The correlations conducted with the tests (SPMSQ-BR, MMSE, CDT and VFT) revealed a strong linear relationship. This relationship is negative because the tests are inversely proportional; that is, the lower the value of SPMSQ-BR, the better the cognitive function, whereas the higher the value of the other tests, the better the individual's cognitive performance.

There was a strong linear correlation between SPMSQ-BR and the MMSE (gold standard) at 0.799. However, with the CDT and VFT, moderate linear correlations were observed at 0.584 and 0.569, respectively.

The SPMSQ-BR scale demonstrated good internal consistency, with a Cronbach's Alpha value of 0.803. This indicates that the items of the scale are well-cohesive and consistently measure the same construct.

The importance of each item was verified through the analysis of their individual significance. All items

were found to be relevant, as the exclusion of any of them would decrease the Cronbach's Alpha value, indicating that the scale would lose consistency (Table 2).

Temporal stability was assessed by comparing the scores obtained between two administrations (test-retest) conducted by the same evaluator (intra-rater), with a seven-day interval, showing excellent correlation (0.977), indicating that the scale is stable, as shown in Table 3.

Reproducibility was assessed by comparing the scores obtained from two administrations conducted on the same day by two different evaluators (inter-rater).

Performed through the intraclass correlation coefficient, with a 95% confidence interval, the scale demonstrated reproducibility, showing excellent correlation (0.973), as observed in Table 3.

Table 2. Analysis of Internal Consistency if Item is excluded Curitiba, PR, 2020.

SPMSQ-BR Question	Cronbach's Alpha if Item is excluded
Question 1	0.781
Question 2	0.785
Question 3	0.801
Question 4	0.777
Question 5	0.776
Question 6	0.781
Question 7	0.756
Question 8	0.769
Question 9	0.800
Question 10	0.789

Source: Authors, 2020.

Table 3. Stability and reproducibility analysis. Curitiba, PR, 2020.

Intraclass Correlation		95% Confidence Interval	
		Lower Limit	Upper Limit
Stability	0.977	0.954	0.988
		p<0.01	p<0.01
Reproducibility	0.973	0.947	0.986
		p<0.01	p<0.01

Source: Authors, 2020.

Accuracy, assessed through the ROC Curve analysis, followed Pfeiffer's proposal, the author of the original questionnaire, which takes into account the level of education. For illiterate older adults, an additional error was allowed, while for those with higher education, one less error was allowed. As a result, the area under the curve was $AUC=0.905$ ($SE=0.04$; $p<0.01$; $95\% CI=0.817-0.993$). In the analysis disregarding educational level, the curve exhibited an $AUC=0.927$ ($SE=0.03$; $p<0.01$; $95\% CI=0.852-1.000$). These findings demonstrate that,

if chosen randomly, 90 to 92% of clinical cases will present higher scores than non-clinical cases on the SPMSQ-BR. The results revealed statistically significant curves in both cases, which can be observed in Figure 1 and Table 4.

The curves in Figure 1 demonstrate that the closer the results are to the upper left corner of the graph, the higher the sensitivity and the lower the proportion of false positives, indicating that the test is accurate in both scenarios.

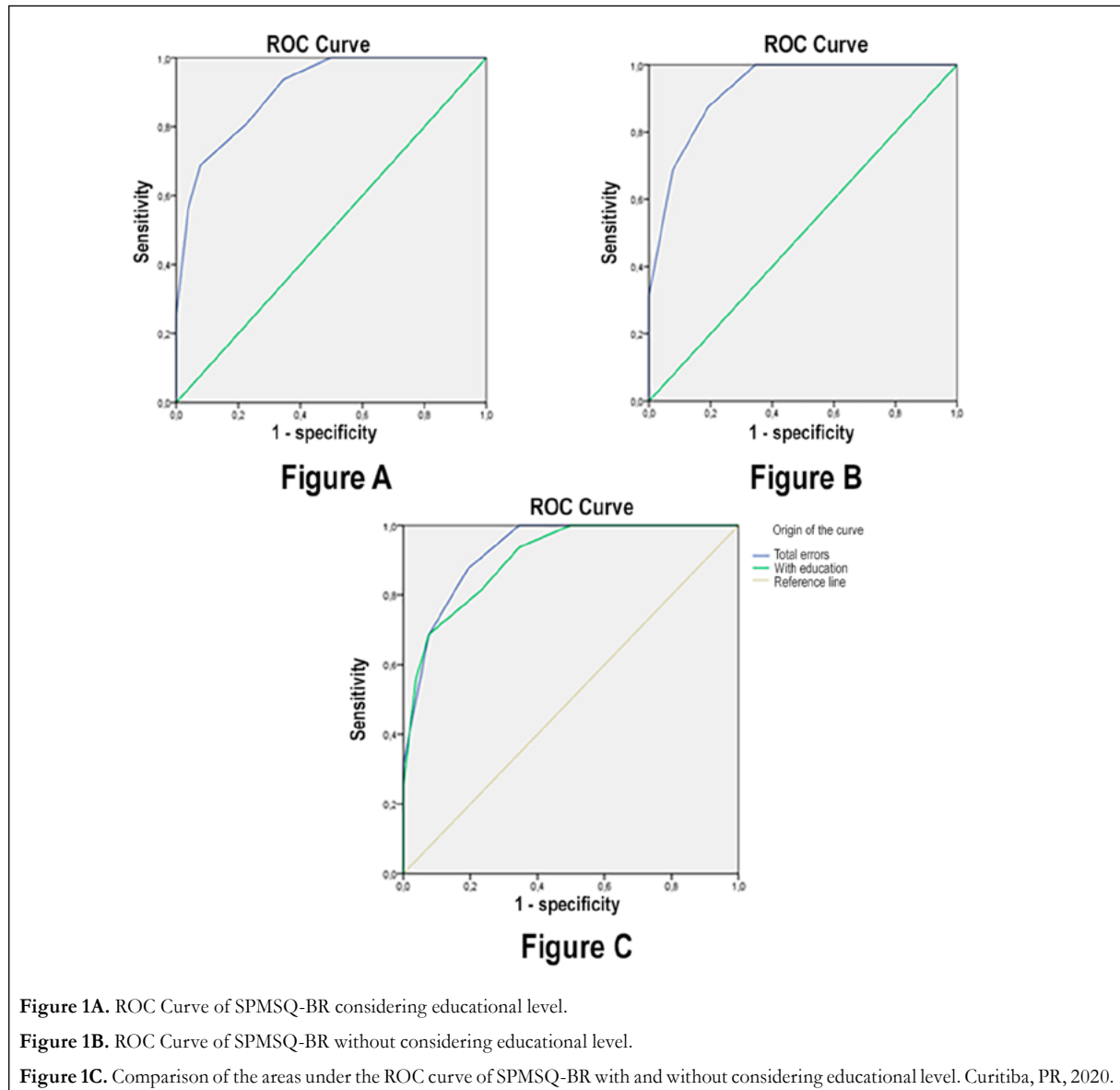


Figure 1. Areas under the ROC curve. Curitiba, PR, 2020.

Table 4. Sensitivity and specificity of the SPMSQ-BR according to the cutoff point. Curitiba, PR, 2020.

Without considering educational level		
Cutoff Point	Sensitivity	Specificity
≥3	87.5%	80.8%
≥4	68.8%	92.3%
≥5	50.0%	96.2%
Considering educational level		
Cutoff Point	Sensitivity	Specificity
≥3	81.3%	76.9%
≥4	68.8%	92.3%
≥5	56.3%	96.2%

Source: Authors, 2020.

The best parameters of sensitivity and specificity are achieved with a cutoff point of 3 or more errors, as seen in Table 4.

DISCUSSION

Recent experiences with the SPMSQ demonstrate its efficacy as a screening tool and for monitoring clinical outcomes^{19,20,21}. A study conducted in Israel analyzed the impact of sedative medications on the cognition of hospitalized older adults who were cognitively intact upon admission²², using the SPMSQ. The study concluded that sedative burden is an important risk factor for acquired cognitive decline in the hospital. This identification will also help in Brazil to monitor older adults with a potential increase in sedative burden and assist in the design of interventions to reduce the risk of cognitive decline during hospitalization.

In another study conducted in Germany by Schönstein et al.²³, the SPMSQ was used for risk stratification in older adult patients in the emergency department. The results showed that it alone is not a precise tool for stratification, however, the findings demonstrated that the SPMSQ is a significant predictor of long-term adverse outcomes. Despite its limitations, it is worth noting that the SPMSQ is used in various studies as a screening instrument for inclusion and exclusion criteria in research, such as the study by Sri-on et al.²⁴ conducted in Thailand.

Recently, the SPMSQ was validated in Iran²⁵. The SPMSQ is used in various countries; however, some do not mention whether the scale has been adapted or validated for the specific country. An example is the study by Ferruci et al.²⁶, conducted in Italy, prospectively involving 5,024 individuals who were followed for three years to assess the association between cognitive impairment (using the SPMSQ) and the risk of cerebrovascular accident (CVA), independently of other risk factors. The study concluded that the incidence of CVA was lower in those with normal scores and higher in those with severe impairment.

Despite its relevance, the authors of the mentioned study conducted in Italy relied on the original scale

and its validation for the American population. However, they made significant alterations, such as excluding question 3 and adapting the final scoring, without providing adequate justification, which may have compromised the reliability of the results.

For the aforementioned reasons, proper cross-cultural adaptation and validation are essential to demonstrate the evidence-based power of the instrument and determine whether it is suitable for use in the adapted cultural context, as well as whether it meets its proposed objectives¹³. Validation requires the demonstration of robust psychometric characteristics for the acceptance and application of a new cognitive test¹⁴.

With the scale already translated and adapted for Brazil⁹, the same criteria used in the creation of the instrument by Pfeiffer⁸ were employed for validation, following rigorous methodological standards.

In the validation sample, there was a predominance of women, a phenomenon that may be related to the phenomenon known as the feminization of aging, where there is a higher proportion of women than men in the older population, especially at older ages²⁷, and the majority had low formal education.

For the concurrent validity analysis, the correlation with the MMSE, considered the gold standard, was calculated. A strong significant and inversely proportional linear correlation was observed ($r=-0.799$, $p<0.001$), a finding that corroborated with the validation of the SPMSQ in Singapore ($r=-0.814$, $p<0.001$) and in Spain ($r=-0.738$, $p<0.001$), which also correlated it with the MMSE and showed results similar to the findings of the present study^{10,28}.

Convergent validity was analyzed through the correlation between SPMSQ-BR scores and the CDT and VFT tests, which also measure cognitive issues but in other dimensions. The obtained results showed significant moderately inversely proportional relationships (-0.584 , $p<0.001$) and (-0.569 , $p<0.001$) respectively.

In the validation study of the CDT for the Brazilian context, it was also correlated with the MMSE, obtaining a moderate relationship of 0.464

when compared¹⁸. In a study conducted in Japan on the validity and reliability of the Japanese version of the Dementia Behavior Disturbance Scale (DBD Scale), the SPMSQ was used for convergent validity, with the obtained correlation data also showing moderate correlation of 0.54 ($p < 0.001$)²⁹. A moderate correlation was also found in the SPMSQ-SV (Spanish version) when compared to the Informant Questionnaire on Cognitive Decline in the Elderly (S-IQCODE) with 0.578 ($p < 0.001$)¹⁰.

The internal consistency of the scale was highly satisfactory ($\alpha = 0.803$), such that if any item were excluded, its value would decrease. According to Streiner et al.¹⁶, alpha values above 0.90 indicate item content duplication, which points more towards redundancy rather than homogeneity. Similarly, the Iranian and Spanish versions of the SPMSQ demonstrated good internal consistency ($\alpha = 0.880$) and ($\alpha = 0.824$) respectively, a value similar to that found in the present study. This means that all items of the construct correspond to its measure.

In intra-rater stability, a coefficient of $r = 0.977$ was obtained, indicating that the rating in the first application was very close to that in the second application. Kanter and Mosquera³⁰ state that the correlation coefficient expresses the level of relationship between two events; the closer it is to a positive 1, the higher the correspondence. These values were similar to those found in the Spanish version (0.925)¹⁰.

The literature recommends that the stability of a test be verified between 7 and 14 days after its first application¹³. The original version tested stability after 4 weeks and obtained a good result (0.83)⁸, with similar results in China after 5 weeks (0.70). However, these values are lower than those found in the present study (0.97). This difference can be explained by changes in the participants' mood, which can be influenced by events occurring between the two applications, as well as the fact that participants may acquire new knowledge during this period, which can affect their results. The longer the period between applications, the higher the likelihood of these occurrences¹⁴.

Inter-rater reproducibility demonstrated excellent reproducibility ($r = 0.973$), higher than that found in the Spanish version (0.734)¹⁰.

The ROC curve analyses of the SPMSQ-BR indicated that the test has good ability to discriminate between older adults with and without cognitive impairment, revealing good sensitivity and specificity. The best parameters were obtained for a cut-off point of 3 or more errors (S=81.3%-87.5%) and (E=76.9%-80.8%), values similar to those observed in Pfeiffer's original validation⁸ (S=87.5%-92.3%) and (E=72.2%-81.9%) and in the validation conducted in Finland³¹ (S=66.7%-86.2%) and (E=99.0%-100%).

The aforementioned study conducted in Finland³¹ aimed to assess the SPMSQ's ability to differentiate between patients with dementia and delirium. The test showed good sensitivity and specificity in identifying dementia with a cut-off point of 3 errors, proving to be sensitive in both community-dwelling individuals and hospitalized older adults, consistent with the findings of the present study. In the same study, the validity of the SPMSQ for delirium was lower than for dementia, due to the variable nature of the clinical picture of delirium. The optimal cut-off point was found to be 2 errors.

In the Singapore study²⁸, the cut-off point was 5 or more errors (S=78%, E=75%). Meanwhile, in the Iranian validation²⁵, the cut-off point was determined based on educational level, with 4 errors for illiterate older adults (S=86%, E=88%) and 3 errors for literate older adults (S=83%, E=93.7%).

These studies demonstrate that education level is an important factor, and the ideal cut-off point may vary according to the population and the study's objectives. Therefore, appropriate selection is necessary to avoid errors in obtaining false positive and false negative results.

The association between low education level and dementia processes has been the focus of research since the 1970s. During this time, a study conducted at the St. Luke Medical Center in Chicago (United States of America), with 642 older adults, revealed that each year of formal education could reduce the risk of developing Alzheimer's disease by up

to 17%³², a topic that has been the subject of much current research.

A prospective cohort study with 2,458 participants from various states in the United States demonstrated that low education level is directly related to a higher incidence of dementia³³.

The MMSE itself is influenced by education level, as higher educational attainment is associated with better scores on the test¹⁸. For this reason, some authors also suggest differentiating scores for educated and illiterate older adults, establishing distinct cut-off points^{18,34}.

Within the clinical practice, it is proposed to conduct an initial assessment of the older adult. This assessment should provide a baseline measure for monitoring cognitive function and, when necessary, alert to the need for further investigation. The SPMSQ-BR emerges as a valuable tool that meets this need.

The scale can be accessed through your article on translation and cross-cultural adaptation⁹.

A limitation to be mentioned, also found in the study by Ferreira et al³⁵, is that the sample was collected in the southern region. Considering the dimensions of Brazil, it would be important to analyze the influence of different cultures on the performance of the Brief Cognitive Capacity Scale (SPMSQ-BR), compare the results from different regions, and consider variables such as education level, type of dementia, and its severity. This information could confirm the instrument's unidimensionality.

The SPMSQ-BR is not a tool for the definitive diagnosis of dementia. Its primary function is to serve

as an indicator of possible cognitive impairments, requiring further assessment to confirm a diagnosis.

CONCLUSION

The process of evaluation and analysis of the psychometric properties of the Brazilian version of the Short Portable Mental Status Questionnaire (SPMSQ-BR) demonstrated that the scale is consistent, stable, reproducible, valid, and reliable in assessing cognitive impairment in older adults.

The SPMSQ-BR will contribute to healthcare professionals and the scientific community as another valid and reliable assessment tool. It can be utilized in clinical trials, international comparisons, and support screening, planning, and monitoring of cognitive function treatment in older adults.

AUTHORSHIP

- Fernanda Cury Martins Teigão – Writing - initial drafting, design, investigation, methodology, conceptualization, writing - Revision and editing.
- Auristela Duarte de Lima Moser – Project administration, conceptualization, supervision, validation, visualization, approval of the version to be published.
- Solena Ziemer Kusma Fidalski - Formal analysis, data curation, data interpretation, approval of the version to be published.
- Javier Jerez Roig – Conception and supervision.

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