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Picture-Based Memory Impairment Screen: Effective Cognitive Screen in Ethnically Diverse Populations

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Abstract

OBJECTIVES: To describe the psychometric properties of the Picture-based Memory Impairment Screen (PMIS) in a multidisciplinary memory disorder center serving an ethnically and educationally diverse community.

DESIGN: Cross-sectional cohort study.

SETTING: Montefiore Center for Aging Brain (CAB)

PARTICIPANTS: Individuals with cognitive complaints (N=405; average age 76 ± 10 , 66% female).

MEASUREMENTS: A geriatrician or neurologist administered the PMIS, and a neuropsychologist administered the Blessed Information, Memory, and Concentration (BIMC) test and determined whether participants had dementia, mild cognitive impairment (MCI), or subjective cognitive complaints (SCC).

RESULTS: Mean PMIS scores were 4.0 ± 62.6 in participants with dementia (n=194), 6.8 ± 1.5 in those with MCI (n= 155), and 7.061.8 in those with SCC (n= 56) ($p < .001$). PMIS scores showed similar significant linear trends when analyzed according to ethnicity, education, sex, and language. The PMIS was negatively correlated with BIMC score ($p < .001$). The PMIS had positive predictive value of 77%, negative predictive value of 73%, sensitivity of 68%, and specificity of 81% to detect all-cause dementia in this population of individuals with cognitive complaints.

CONCLUSION: The PMIS is a quick, valid screening tool to identify cognitive impairment in individuals with cognitive complaints that accounts for cultural and educational differences.

Keywords

cognitive screen; dementia; epidemiology

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Given the high prevalence of cognitive impairment in older adults in clinical settings, there is a need for accurate, brief cognitive screening tests to maximize the benefits of early identification, including documentation and treatment of potentially reversible conditions, starting specific treatments and instituting support services, and healthcare planning,¹ but cognitive impairment is frequently underrecognized and underdiagnosed in primary care and other clinical settings.² Major barriers to cognitive screening in clinical settings include limited time, lack of resources, expense, training requirements, need for specialists, lack of disease-modifying agents, and lack of knowledge of suitable screening tools.³ Furthermore, many current screening instruments are educationally or culturally biased, limiting their use in clinical settings with diverse populations.

The Picture-based Memory Impairment Screen (PMIS) is a brief, 4-item free and cued recall test of memory that uses pictures to overcome many of the educational, cultural, and logistical barriers to cognitive screening in clinical settings.⁴ The PMIS is based on the free and cued memory test literature⁵ and the original and telephone Memory Impairment Screen (MIS), both of which have been well validated for assessment of memory impairment and are frequently used in assessing and diagnosing dementia.^{6,7} In addition to being brief like the MIS, the PMIS has the benefit of being nondiscriminatory with regard to culture and literacy. The PMIS was developed and validated in Kerala, India, where it was reported to be effective at discriminating individuals with dementia from those without. The internal consistency and interrater reliability of the PMIS in that sample was strong,⁴ but PMIS performance has not been reported in other populations and settings.

We examined PMIS performance in an ethnically diverse population attending the Center for Aging Brain (CAB), a multidisciplinary dementia assessment center in Yonkers, New York.⁸ The goal of this study was to report the psychometric properties of the PMIS in individuals presenting with cognitive complaints in clinical settings.

METHODS

Participants and Clinical Setting

Individuals referred with cognitive complaints were seen at the CAB between June 2014 and June 2016. The CAB is a clinical assessment center for cognitive complaints staffed by the departments of geriatrics, neurology, and neuropsychology, as well as support services, reflecting a transdisciplinary approach to cognitive assessment. The CAB protocols have been previously described.⁸ In brief, all individuals with cognitive complaints referred to the CAB have clinical evaluations performed by a geriatrician, a neuropsychologist, and a neurologist. All evaluations and interviews were conducted in English or the individual's native language through interpreters (cognitive evaluations were completed with face-to-face interpreters). The geriatrician obtains a medical and social history and medication and allergy lists, performs a physical examination, and administers a brief cognitive assessment including the PMIS. A licensed neuropsychologist conducts a 1-hour neurobehavioral interview and administers a battery of cognitive tests (described previously⁸) including the Blessed Information-Memory-Concentration (BIMC) test.⁹ The neuropsychologist's evaluation and diagnosis is independent of PMIS performance (see procedure below). Finally, the neurologist obtains additional history and does a focused neurological

examination to finalize the diagnosis, incorporating the geriatrician's and neuropsychologist's assessments. Individuals with active delirium, psychoactive drug abuse, or active or inadequately treated psychiatric illness (e.g., active psychosis) were excluded from these analyses. Individuals with severe visual impairments and aphasia who were unable to perform the PMIS were also excluded.

PMIS procedure

The PMIS was performed on all individuals at the earliest visit with geriatrics or neurology using procedures described previously.⁸ The clinician tested participants individually and randomly administered 1 of 2 alternate sets of PMIS. The examiner asked participants to identify 4 pictures shown on a laminated piece of paper. Once a participant correctly identified all pictures, he or she was provided category cues (e.g., fruit) to help encode the items. Participants had to name the correct item (e.g., banana) for the corresponding cue. After an interference task lasting approximately 2 minutes (clock drawing test or activity of daily living questionnaire), participants were asked to freely recall the pictures in any order for approximately 20 seconds. Category cues were then presented for items not retrieved during free recall. Participants were not given credit for recalling the category cue if they could not recall the item. No other cues or hints were provided during the free or cued recall phases. Two points were given for each freely recalled picture and 1 point for pictures recalled with cues (range 0–8). A score of 5 or less was indicative of dementia in the validation study conducted in India.⁴

Neuropsychological battery

A licensed neuropsychologist conducted a 1-hour neurobehavioral interview and battery of cognitive tests. The neurocognitive battery includes measures of mental status (BIMC), premorbid function (Wechsler Test of Adult Reading for English speakers), memory (Hopkins Verbal Learning Test-R / Neuropsi Atención y Memoria word list), category fluency (animals), phonemic fluency (FAS), timed transcription (Symbol Digit Modalities Test), clock drawing, and psychological function (Geriatric Depression Scale, Beck Anxiety Inventory). Batteries were adjusted as necessary for clinical utility, and additional tasks were added to aid with more complex diagnoses. The BIMC is an established omnibus test of general mental status, measuring orientation, memory, and concentration; it is educationally and culturally dependent.^{9,11–13}

Cognitive outcomes

The CAB clinicians administering the PMIS and categorizing the final dementia diagnosis were not blinded to PMIS performance. Hence, the neuropsychologist diagnosis, made independently of PMIS score, was used as the criterion standard. Participants were determined to have dementia, mild cognitive impairment (MCI), or subjective cognitive complaints with normal neuropsychological test performance (SCC) using *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*, criteria for major (dementia) and minor (MCI) neurocognitive disorders.¹⁰ There were no individuals without cognitive complaints in this dementia clinic-based referral sample.

Statistical Methods

Summative data were provided for each cognitive state: dementia, MCI, SCC. Analysis of variance for continuous variables and chi-square tests for categorical variables were used to test differences in baseline characteristics according to cognitive state. The PMIS was analyzed according to cognitive state for differences in ethnicity, sex, education, and language. Reliability was analyzed using the kappa statistic to determine consistency of PMIS administration between different raters and interclass correlation between the two sets of PMIS. The discriminative validity of the PMIS in this dementia clinic sample was assessed by calculating the sensitivity and specificity of the PMIS for detecting dementia using the previously established cut score of 5.⁴ The scores and discriminative validity of PMIS and BIMC at the established dementia cut scores were compared. Data were analyzed of the participants in the study across three cognitive states—dementia, SCC, and MCI—except in sensitivity analyses, for which the data were dichotomized into participants with and without dementia (inclusive of SCC and MCI). All statistical analyses were performed using SPSS version 20 (IBM Corp., Armonk, NY).

RESULTS

Demographic Characteristics

Over a 2-year study period, 405 participants were administered the PMIS and the BIMC, completed 2 or more clinical evaluations, and were eligible for analysis. The average age of the entire cohort was 76 ± 10 (range 46–97, 87% ≥ 65), and 66% were female. This cohort reflected a racially and ethnically diverse population in the New York City and Westchester area: 27% black, 25% Hispanic, 33% white, and 14% other races. Of the study sample, 378 had information available about years of education completed: 26% ($n=99$) of participants had an eighth-grade level of education or less, 41% ($n=155$) had a ninth- to twelfth-grade level of education, and 33% ($n=124$) had some college or higher level of education. Hispanic participants had less education (average 9 years) than non-Hispanic participants (average 13 years for whites, 11.5 years for blacks). Most participants were English speakers (75%), with the remainder having testing administered in Spanish (20%) or other languages (5%). The neuropsychologist assigned diagnoses of dementia to 194 participants, MCI to 155, and SCC to 56 independent of PMIS performance. Final dementia diagnoses assigned at the CAB based on all evaluations included Alzheimer's disease (16%), mixed dementia (16%), vascular dementia (8%), frontotemporal dementia (3.2%), and dementia with Lewy bodies (4.7%). Participants with dementia diagnoses were significantly older than those with SCC (80 vs 67) and had fewer years of education (10 vs 13 years) (Table 1).

PMIS Reliability

Two clinicians independently administered Sets 1 and 2 of the PMIS on the same day in 22 consecutive CAB attendees who were not included in the main analysis. The interrater reliability of the PMIS was very good ($\kappa = 0.72$, 95% confidence interval (CI)=0.57–0.87). The interclass correlation between the 2 sets was excellent (0.93, 95% CI 0.84–0.97).

PMIS Performance and Validity

The average PMIS score was 5.5 ± 2.6 , and the average BIMC score was 12 ± 7 for the entire cohort. Participants with SCC had a higher mean PMIS score (7 ± 2) than those with dementia (4 ± 2.6) ($p < .001$). Mean BIMC scores were 6 ± 5 for those with SCC and 1766 for those with dementia. The PMIS (higher better) and BIMC (higher worse) scores were negatively correlated (Pearson correlation coefficient = -0.661 , $p < .001$).

Mean PMIS scores declined from SCC to dementia when compared among different ethnic groups, educational levels, and sexes. (Table 2). There were no significant differences in mean PMIS scores between English and non-English speakers across different cognitive states. Inclusion of age as a covariate did not change the significance of our findings.

Using the diagnoses that the neuropsychologist assigned as the criterion standard, the previously established dementia score of 5 or below on the PMIS had a positive predictive value (PPV) of 77%, a negative predictive value (NPV) of 73%, sensitivity of 68%, and specificity of 81% (Table 3). In comparison, a score of 8 or greater on the BIMC had a PPV of 63%, a NPV of 89%, sensitivity of 93%, and specificity of 50 %.

The sensitivity of the PMIS was best in non-English speakers (71%) and those with low education (72%). The specificity of the PMIS was overall greater than 78%, in comparison with the BIMC, which was generally less than 66% across all groups. The PPV of the PMIS was good in blacks, those with less than a twelfth-grade education, and non-English speakers.

Average PMIS scores were 2.6 ± 2.2 for participants with Alzheimer's disease ($n=64$) was, 5.0 ± 2.5 for those with vascular dementia ($n=32$), 4.0 ± 2.4 for those with mixed dementia ($n=64$), 5.6 ± 2.7 for those with frontotemporal dementia ($n=13$) was, and 5.7 ± 2.5 for those with Lewy body dementia ($n=19$) ($p < .001$, analysis of variance).

DISCUSSION

Cognitive impairment, including dementia, is frequently underdiagnosed in primary care settings despite the availability of numerous assessment tools.^{2,14,15} This delays the initiation of treatment of early and reversible conditions, medical and support services, and critical planning.¹⁶ The PMIS is an easy-to-use clinical screening tool to identify individuals with cognitive impairment as a prelude to further detailed testing for making definitive cognitive diagnoses. The PMIS had good sensitivity and specificity for identifying dementia in this ethnically diverse referral population of individuals with cognitive complaints. It takes approximately 4 minutes to administer, including the 2-minute interference period,⁴ providing good utility in busy clinical settings. We also noted excellent reliability and internal consistency for the PMIS in this clinic sample.

The prevalence of dementia at the CAB was 49%, consistent with it being a referral clinic population, with a predominance of Alzheimer's disease and mixed and vascular dementia. PMIS is primarily a memory-based measure, and its performance (PPV and sensitivity) was very good for individuals with Alzheimer's disease (86% and 88% respectively) and mixed

dementia (84% and 73%) in comparison to individuals with vascular dementia (67% and 56%). Overall, the sensitivity of the PMIS was best in non-English speakers and individuals with less education. The PMIS minimizes cultural bias in ethnically diverse populations. Missed detection of cognitive impairment is higher in older African Americans and Hispanics than in older whites.^{2,13,14} The PMIS had higher PPV in identifying cognitive impairment than the BIMC in the overall sample, as well as when examined according to ethnicity. The sensitivity and specificity of the PMIS were comparable for whites, Hispanics, and blacks, and it was less culturally discriminatory than the BIMC in non-English speakers.

Low education can introduce bias in dementia screening procedures. The BIMC had lower specificity in participants with less education, with a higher false positive rate due to the educational demands of the test. For participants with less than a high school level of education, the PMIS had better specificity and PPV than the BIMC. Spanish speakers and Hispanics had lower education levels, which probably contributed to lower specificity with the BIMC, whereas the PMIS is less education dependent and was better able to detect cognitive impairments in these individuals.

Overall, the PMIS had greater specificity than the BIMC in multiple groups—non-English speakers, Hispanics, blacks, those with less education.

Limitations

Our focus was on real-world application of the PMIS in individuals with high prevalence of dementia referred to a dementia clinic. Hence, we did not selectively recruit older adults without cognitive complaints and normal neuropsychological performance as controls. The discriminative validity of the PMIS may be different in nursing home or community samples and should be examined. The sensitivity of the PMIS was lower than in our original validation study.⁴ One possible reason is that we had a higher prevalence of individuals with non-Alzheimer's dementias with mainly nonmemory impairments in our clinic than the Indian sample.⁴ Moreover, all CAB attendees without dementia included in this study had cognitive complaints, a high-risk state for dementia,¹⁷ even if their neuropsychological performance was in the normal or MCI range, which also contributes to lower sensitivity but increases generalizability to clinical settings.

In summary, the PMIS is a simple, reliable, valid screen for cognitive impairment in busy clinical settings that accounts for cultural, language, and educational differences.

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Table 1.

Baseline Characteristics According to Cognitive Status

	Subjective Cognitive Complaints (SCC)		MCI	Dementia	P value*
N	56	155	194		
Age (years), mean±SD	67±8	75±9	80±9		<0.001
Women, % (N)	69% (40)	62% (96)	69% (134)		0.27
Education, years±SD	13±4	12±4	10±4		<0.001
Ethnicity					
White % (N)	32% (18)	42% (65)	26% (50)		0.06
Black % (N)	25% (14)	22% (34)	32% (63)		
Hispanic % (N)	27% (15)	23% (36)	27% (52)		
Other % (N)	16% (9)	13% (20)	15% (29)		
PMIS, mean±SD	7.0±1.8	6.8±1.5	4.0±2.6		<0.001
Blessed, mean±SD	6.1±5.3	8.6±4.8	16.8±6.0		<0.001

* Analysis of variance for continuous variables and chi-square tests for categorical variables were used to test differences in baseline characteristics according to cognitive state.

Table 2. Picture-Based Memory Impairment Screen (PMIS) Performance According to Participant Characteristics

	SCC Mean±SD(N=56)	MCI Mean±SD (N=155)	Dementia Mean±SD (N=194)	Significance ANOVA
Ethnicity				
White (N = 133)	7.6±1.1 (18)	6.7±1.7 (65)	4.3±2.5 (55)	P<0.001
Black (N = 111)	7.1±1.8 (14)	6.8±1.4 (34)	3.9±2.6 (63)	P<0.001
Hispanic (N = 103)	6.5±2.4 (15)	6.9±1.4 (36)	4.1±2.7 (52)	P<0.001
Other (N = 58)	6.7±1.7 (9)	6.9±1.5 (20)	3.5±2.6 (29)	P<0.001
Sex				
Male (N = 135)	7.8±0.4 (16) *	6.9±1.4 (59)	4.7±2.8 (60) **	P<0.001
Female (N = 270)	6.7±2 (40) *	6.7±1.7 (96)	3.7±2.5 (134) **	P<0.001
Education				
8 th grade or less (N = 99)	6.9±1.3 (7)	6.3±1.7 (23)	3.9±2.7 (69)	P<0.001
9–12 th grade (N = 155)	7.8±0.6 (17)	6.9±1.4 (66)	3.8±2.5 (72)	P<0.001
>12 th grade (N = 124)	6.9±1.9 (28)	6.8±1.7 (56)	4.5±2.6 (40)	P<0.001
Language				
English speakers (N = 305)	7.2±1.5 (46)	6.8±1.6 (124)	4.0±2.7 (135)	P<0.001
Non-English speakers (N = 100)	6.2±2.7 (10)	6.9±1.5 (31)	4.0±2.6 (59)	P<0.001

* PMIS performance within SCC was statistically different between men and women, $p = 0.04$.

** PMIS performance within dementia was statistically different between men and women, ($p = .01$).

Table 3.

Comparison of Discriminative Validity of Picture-Based Memory Impairment Screen (PMIS) and Blessed Information, Memory and Concentration Test (BIMC) at Established Cut-Scores for Detecting Dementia in Individuals Referred for Cognitive Complaints

Subgroup	PMIS performance (5)				BIMC performance (8)			
	Sensitivity	Specificity	PPV	NPV	Sensitivity	Specificity	PPV	NPV
English speaking	66% %	82%	74%	76%	93%	56%	63%	91%
Non-English speaking	71%	78%	82%	65%	95%	24%	64%	77%
White	68%	81%	69%	81%	88%	66%	61%	90%
Hispanic	65%	78%	76%	69%	94%	33%	59%	85%
Black	67%	83%	84%	66%	95%	44%	69%	88%
12 grade	72%	81%	83%	70%	96%	37%	66%	88%

PPV = positive predictive value; NPV = negative predictive value.