

Research Paper



Comparing the Diagnostic Value of Four Dementia Tests in the Amnesic and Healthy Elderly

Fatemah Khamseh¹, Gholamreza Hadjati^{1*}, Hossein Nahvinejad², Zahra Nouparsat¹, Masomeh Salehi¹, Maryam Noroozian³, Mahshid Foroughan⁴, Farshid Alaedini⁵, Afrooz Saffarifard², Faraneh Farin¹, Mehrdad Khansari¹, Maryam Pourseid Mohammad², Zahra Ahmadi²

1. Iranian Association of Alzheimer's Disease, Tehran, Iran.

2. Iranian State Welfare Organization, Tehran, Iran.

3. Department of Neurology, Tehran University of Medical Sciences, Tehran, Iran.

4. Iranian Research Center on Aging, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.

5. Shafa Health Research Center, Tehran, Iran.



Citation Khamseh, F., Hadjati, G., Nahvinejad, H., Nouparsat, Z., Salehi, M., & Noroozian, M., et al. (2023). Comparing the Diagnostic Value of Four Dementia Tests in the Amnesic and Healthy Elderly. *Basic and Clinical Neuroscience*, 14(1), 137-142. <http://dx.doi.org/10.32598/bcn.2022.1745.1>

doi <http://dx.doi.org/10.32598/bcn.2022.1745.1>

**Article info:**

Received: 16 Mar 2019

First Revision: 28 Jun 2020

Accepted: 07 Nov 2020

Available Online: 01 Jan 2023

Keywords:

Alzheimer's disease, Diagnosis, Mini-mental state examination, Abbreviated mental test score, Functional assessment staging tool

ABSTRACT

Introduction: This study aimed to compare the diagnostic value of four questionnaires for the diagnosis of neurocognitive disorders (NCDs) in the elderly.

Methods: In this project, people older than 60 years who lived in Tehran were investigated. A total of 99 literate cases were enrolled in the study, and four questionnaires, including functional assessment staging tool (FAST), abbreviated mental test score (AMTS), mini-mental state examination (MMSE), and modified Persian test of elderly for assessment of cognition and executive function (PEACE) were completed for them. They were then referred to a neuropsychiatrist, and the status of their cognition and neurobehavior was determined. The specialists were blinded to the results of the tests.

Results: Of the 99 participants studied, 39 cases were healthy, eight cases had mild Alzheimer's disease, 38 had amnesic MCI, five cases had secondary dementia, and nine cases had mixed vascular dementia and Alzheimer's disease. The area under the ROC curve for distinguishing the healthy group from the rest of the population was 0.692, 0.629, 0.734, and 0.751 for the FAST, AMTS, MMSE, and NBCSS questionnaires, respectively.

Conclusion: MMSE and NBCSS tests had better diagnostic power than the other two tests to distinguish the healthy group from the rest of the population.

*** Corresponding Author:**

Gholamreza Hadjati, PhD.

Address: Iranian Association of Alzheimer's Disease, Tehran, Iran.

E-mail: rhadjati47@yahoo.com

Highlights

- The global prevalence of Alzheimer's disease is on the rise, thereby necessitating active medical and social interventions and this demands more research on the elderly
- There are several questionnaires for the diagnosis of neurocognitive disorders (NCDs) in the elderly
- NBCSS and MMSE could be applied for distinguishing healthy people from patients

Plain Language Summary

Due to rising in elderly with Alzheimer's disease among people over sixty, in worldwide, finding a non invasive method, rapid and simple cognitive screening required. So using questionnaires are mentioned as a usefull method. So here we applied four questionnaires for determine in the first sytep of distinguishing healthy people from patients.

1. Introduction

Alzheimer's disease (AD) has multiple etiologies, which affect memory, cognitive abilities, and behavior, posing problems to the patients. Some of these problems are connected to driving ability, financial management ability, self-care ability, and independence (Blazer et al., 2015). AD can deeply affect patients and their job, as well as their families, community, and society (Alzheimer's Association, 2016).

The global prevalence of AD is on the rise, thereby necessitating active medical and social interventions and this demands more research on the elderly (Prince et al., 2016; Shafiee & van Bodegom, 2012). Approximately, 47 million people worldwide were living with AD in 2015, which is estimated to reach 75 million by 2030 and 132 million by 2050 (Alzheimer's disease international, dementia statistics, 2017, <http://www.alz.co.uk/research/statistics>). A recent study estimated that there will be nearly 9.9 million new cases of dementia each year worldwide.

The timely diagnosis of AD contributes to the provision of appropriate counseling, healthcare, and caregiving services (Baruch et al., 2017; Cordell et al., 2013; Khanassov & Vedel, 2016). Clinicians use various instruments to screen cognitive impairments. Despite their limitations, such as limited sensitivity to initial stages of cognitive impairment, these tests have been widely used in scientific areas and clinical studies (Folstein et al., 1975; Pendlebury et al., 2010). The mini-mental state examination (MMSE) is the most widely used screening

test for the evaluation of cognitive impairments in the elderly (Moraes et al., 2010).

There is a substantial difference between some researchers, journals, a larger community of research physicians and physicians in screening healthy populations to predict the premature incidence of dementia and AD (Bayley et al., 2015; Dubois et al., 2014; Morley et al., 2015; Morris et al., 2014). Here, premature refers to scenarios, under which neither the patients nor their caregivers do not diagnose the symptoms, prove them, or recognize the need for clinical examination. Mild cognitive impairment refers to a transition state between the normal cognition of AD (Petersen et al., 1999; Winblad et al., 2004). Nevertheless, the majority of screening tests can make only two-fold discriminations between normal cognition and AD, or between normal cognition and cognitive dysfunction.

There is no comprehensive screening test to evaluate other risk factors of AD, such as comorbidities, brain injury, and depression. Therefore, the screening programs should first review the current instruments to select the best one for wide utilization.

This study investigated four screening tests to find the best one as the first level of the screening process for AD.

2. Materials and Methods

Participants

Ninety-nine people, including 42 men and 57 women, with a mean age of 69.8 ± 7.4 years old, participated in the present study. The participants were selected from those who volunteered in a public announcement in Tehran.

They had normal or normalized visual acuity, as well as sufficient hearing ability. There was no indication of psychiatric disorders irrelevant to their diagnosed disease. All participants completed the geriatric depression scale (GDS) (Malakouti et al., 2006). The patients with symptoms of depression, geriatric depression scale (GDS) >5, were excluded from the study. All participants signed written informed consent.

Instruments

Four different instruments were used in this study, namely the mini-mental state examination (MMSE) (Crum et al., 1993), Functional assessment staging test (FAST) (Sclan & Reisberg, 1992), Abbreviated mental test score (AMTS) (Foroughan et al., 2017), and modified persian test of elderly for assessment of cognition and executive function (PEACE) (Javadi et al., 2015).

Gold standard

All patients were examined by a neurologist and a psychiatrist. The specialists divided the participants into five groups (healthy, mild AD, amnesic mild cognitive impairment (MCI), secondary dementia (defined as a form of dementia that develops as a peripheral condition to a pre-existing mental illness or physical condition), and mixed dementia (changes representing more than one type of dementia occur simultaneously in the brain, like vascular dementia and AD) using data from magnetic resonance imaging (MRI) results, medical examination, and interview.

Statistical analysis

Data analysis was done with SPSS software, version 23 (IBM, USA). The significance level for all statistical tests was set at $P < 0.05$. The Chi-square test was used to distinguish the groups in terms of the distribution of qualitative variables and the one-way ANOVA was employed to find between-group differences in quantitative variables. The Bonferroni post hoc test was utilized to evaluate the between-group differences. The receiver operating characteristic (ROC) curves were created to illustrate specific characteristics of screening tests in terms of sensitivity in the classification of healthy people and patients with mild cognitive impairment, caused by dementia (healthy people versus patients with premature memory and cognitive impairment because of AD).

3. Results

In this study and from 99 literate participants, 39 patients were healthy, eight patients had mild AD, 38 patients were with amnesic MCI, five patients had secondary dementia, and nine patients suffered from mixed dementia. Table 1 presents a comparison between the five groups in terms of demographic variables and other characteristics. Table 2 presents a comparison between the five groups in terms of screening test scores. Table 3 presents a comparison of the area under the ROC curve between different groups and tests.

4. Discussion

Rapid and simple cognitive screening should be the first step in the assessment of the elderly susceptible to cognitive impairment. There are scant studies on the performance of these tests in diagnosing mild cognitive impairment. A systematic study reported a sensitivity of 88.3% and specificity of 86.2% for MMSE at the cutoff points of 23.24 or 25.24 for AD diagnosis (Lin et al., 2013). A meta-analytical of very heterogeneous studies reported a sensitivity of 81% (95% CI 78% to 84%) and specificity of 89% (95% CI 87% to 91%) for MMSE at the cutoff points of 23 or 24 for AD diagnosis; in addition, a sensitivity of 62% (95% CI 52% to 71%) and specificity of 87% (95% CI 80% to 92%) were reported for the diagnosis of mild cognitive impairment.

This study intended to determine a suitable screening test to distinguish between healthy people and patients with cognitive problems in a large population aged over 60 years old. As a result, the area under the ROC curve was selected for making the comparison.

In this study, the subjects were people diagnosed as healthy, or with mild AD, amnesic MCI, secondary dementia, or mixed dementia. The four tests used in the current study showed their ability to distinguish between these diagnoses. The lowest and best scores were obtained by the AMTS and modified PEACE tests, respectively. The FAST test had moderate results and MMSE showed correct results in some cases and incorrect results in some other cases.

The tests acted best in distinguishing between healthy people and individuals with amnesic MCI. Test results were more similar in amnesic MCI and healthy groups than in other groups, thereby making it difficult to distinguish between the two former groups. The MMSE and, specifically, the modified PEACE tests produced different mean scores in the healthy and amnesic MCI groups.

Table 1. Baseline characteristics of the study groups based on their cognitive status

Characteristic*	Mean±SD/%					P†
	Mild AD	Amnesic MCI	Secondary Dementia	Mixed Dementia	Healthy	
Age (y)	76.1±5.8	69.6±7.2	71.8±7.6	77.0±8.8	66.7±5.5	<0.001
Male sex	50	35.9	60	33.3	47.4	0.702
Years of education	9.3±4.7	12.1±5.2	11.2±7.7	8.1±4.9	12.4±3.9	0.089
Married individuals	42.9	74.4	60	77.8	94.7	0.011
SBP (mmHg)	131.4±12.2	133.7±18.8	122.2±16.7	143.1±16.0	134.4±18.5	0.329
DBP (mmHg)	68.4±5.0	74.4±8.3	66.8±6.9	82.4±7.5	76±9.2	0.003
FBS (mg/dl)	100.4±11.0	101.8±20.2	89.6±7.0	112.9±47.1	103.5±19.2	0.454
Family history of Alzheimer	12.5	28.2	20	11.1	31.6	0.63
Family history of Down syndrome	0	5.1	0	0	7.9	0.77
Family history of Parkinson	0	12.8	20	11.1	10.5	0.822
Family history of depression	0	7.7	40	11.1	15.8	0.202
Family history of seizure	0	10.3	40	0	5.3	0.061
GDS score	2.25±1.91	1.74±1.45	2.80±1.64	1.11±1.45	1.68±1.54	0.313

NEURSCIENCE

Abbreviations: AD: Alzheimer's disease; DBP: Diastolic blood pressure; FBS: Fasting blood sugar; GDS: Geriatric depression scale; MCI: Mild cognitive impairment; SBP: Systolic blood pressure.

*Continuous variables are shown as Mean±SD while categorical variables are shown as frequency (percentage). †P<0.05

Table 2. Comparing the cognitive test results between the study groups

Characteristic*	Mean±SD					P†
	Mild AD	Amnesic MCI	Secondary Dementia	Mixed Dementia	Healthy	
FAST score	2.37±0.94	2.72±0.97	3.63±0.52	3.40±1.67	4.33±1.12	<0.001
AMTS score	9.34±0.88	9.05±1.5	7.88±0.99	8.00±1.58	7.89±2.71	0.008
MMSE score	28.24±2.1	26.69±2.82	23.13±3.4	23.80±4.60	24.22±5.07	<0.001
NBCSS score	45.55±8.83	40.67±11.31	30.63±7.01	30.60±11.87	25.44±5.88	<0.001

NEURSCIENCE

Abbreviations: AD: Alzheimer's disease; AMTS: Abbreviated mental test score; FAST: Functional assessment staging test; MMSE: Mini-mental state examination; MCI: Mild cognitive impairment.

*Continuous variables are shown as Mean±SD. †P<0.05

Table 3. Area under the ROC curve for the cognitive tests

Test	The Healthy Group as Compared to Other People	Healthy and Amnesic Groups MCI as Compared to Other People	Healthy and Amnesic MCI Groups	MCI With Patients With Amnesic Group
FAST	0.692	0.8	0.611	0.765
AMTS	0.629	0.752	0.548	0.732
MMSE	0.734	0.779	0.676	0.721
NBCSS	0.751	0.863	0.658	0.814

NEUROSCIENCE

Abbreviations: Abbreviated mental test score: AMTS ; FAST: Functional assessment staging test; MMSE: Mini-mental state examination; MCI: Mild cognitive impairment.

Finally, the modified PEACE and MMSE performed best in distinguishing the healthy people from the patients, showing their broad screening applicability.

In a systematic review (Brodaty et al., 2006), various dementia screening tools were reviewed to find out which of them is the most suitable instrument for detecting dementia. Based on the findings of this review, the general practitioner assessment of cognition (GPCOG), mini-cog, and memory impairment screen (MIS) were chosen as the most suitable instruments for detecting dementia in the elderly in routine clinical care as they were reliable and easy to utilize. Another review showed that MMSE is the most frequently used instrument to evaluate cognitive impairment in clinical studies. Although other tests have shown acceptable results in detecting dementia, the evidence regarding their use and reproducibility in primary health care is insufficient. On the contrary, another review showed that despite a high specificity, MMSE has a low sensitivity in comparison with the memory section of the Cambridge cognitive examination (CAMCOG), cognitive capacity screening examination (CCSE), Chinese abbreviated mild cognitive impairment test (CAMCI), and the Addenbrooke's cognitive examination (ACE) or ACE-revised (ACE-R) (Lischka et al., 2012). PEACE test has also proved to be a valid screening tool for dementia, particularly in low-middle-income countries with high rates of illiteracy (Javadi et al., 2015).

Study limitations

This study was performed in a single referral center and the results may not be generalized to the public. The small sample size of the study was the other limitation of our study. Moreover, exclusion of the illiterate individuals from this study reduces its generalizability.

4. Conclusion

In the present study, we found that NBCSS and MMSE performed best in distinguishing healthy people from patients, showing their applicability in screening programs. Further studies are required to determine the applicability of every individual test in detecting dementia in the elderly.

Ethical Considerations

Compliance with ethical guidelines

All ethical principles are considered in this article.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

References

- Alzheimer's Association. (2016). 2016 Alzheimer's disease facts and figures. *Alzheimer's & Dementia*, 12(4), 459-509. [DOI:10.1016/j.jalz.2016.03.001] [PMID]
- Baruch, N., Allan, C. L., Cundell, M., Clark, S., & Murray, B. (2017). Promoting early dementia diagnosis: A video designed by patients, for patients. *International Psychogeriatrics*, 29(5), 863-867. [DOI:10.1017/S104161021600209X] [PMID]
- Bayley, P. J., Kong, J. Y., Mendiondo, M., Lazzaroni, L. C., Borsari, S., & Buschke, H., et al. (2015). Findings from the national

- memory screening day program. *Journal of The American Geriatrics Society*, 63(2), 309-314. [DOI:10.1111/jgs.13234] [PMID]
- Institute of Medicine (U.S.). Committee on the Public Health Dimensions of Cognitive Aging. (2015). *Cognitive aging: Progress in understanding and opportunities for action*. Washington, DC: National Academies Press. [Link]
- Brodaty, H., Low, L. F., Gibson, L., & Burns, K. (2006). What is the best dementia screening instrument for general practitioners to use? *The American Journal of Geriatric Psychiatry: Official Journal of The American Association for Geriatric Psychiatry*, 14(5), 391-400. [DOI:10.1097/01.JGP.0000216181.20416.b2] [PMID]
- Cordell, C. B., Borson, S., Boustani, M., Chodosh, J., Reuben, D., & Verghese, J., et al. (2013). Alzheimer's Association recommendations for operationalizing the detection of cognitive impairment during the Medicare Annual Wellness Visit in a primary care setting. *Alzheimer's & Dementia*, 9(2), 141-150. [DOI:10.1016/j.jalz.2012.09.011] [PMID]
- Crum, R. M., Anthony, J. C., Bassett, S. S., & Folstein, M. F. (1993). Population-based norms for the Mini-Mental State Examination by age and educational level. *JAMA*, 269(18), 2386-2391. [DOI:10.1001/jama.1993.03500180078038] [PMID]
- Dubois, B., Epelbaum, S., Michon, A., Funkiewiez, A., Samri, D., & Hampel, H. (2014). Screening for AD: Why and how? *Alzheimer's & Dementia: The Journal of the Alzheimer's Association*, 10(4), P200. [DOI:10.1016/j.jalz.2014.04.242]
- Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). Mini-mental state: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12(3), 189-198. [DOI:10.1016/0022-3956(75)90026-6] [PMID]
- Foroughan, M., Wahlund, L. O., Jafari, Z., Rahgozar, M., Farahani, I. G., & Rashedi, V. (2017). Validity and reliability of Abbreviated Mental Test Score (AMTS) among older Iranian. *Psychogeriatrics*, 17(6), 460-465. [DOI:10.1111/psyg.12276] [PMID]
- Javadi, P. S., Zendeabad, A., Darabi, F., Khosravifar, S., & No-roozian, M. (2015). Development and implementation of Persian test of Elderly for Assessment of Cognition and Executive function (PEACE). *Electron Physician*, 7(7), 1549-1556. [DOI:10.19082/1549] [PMID] [PMCID]
- Khanassov, V., & Vedel, I. (2016). Family physician-case manager collaboration and needs of patients with dementia and their caregivers: A systematic mixed studies review. *Annals of Family Medicine*, 14(2), 166-177. [DOI:10.1370/afm.1898] [PMID] [PMCID]
- Lin, J. S., O'Connor, E., Rossom, R. C., Perdue, L. A., & Eckstrom, E. (2013). Screening for cognitive impairment in older adults: A systematic review for the US Preventive Services Task Force. *Annals of Internal Medicine*, 159(9), 601-612. [DOI:10.7326/0003-4819-159-9-201311050-00730] [PMID]
- Lischka, A. R., Mendelsohn, M., Overend, T., & Forbes, D. (2012). A systematic review of screening tools for predicting the development of dementia. *Canadian Journal on Aging*, 31(3), 295-311. [DOI:10.1017/S0714980812000220] [PMID]
- Malakouti, S. K., Fatollahi, P., Mirabzadeh, A., Salavati, M., & Zandi, T. (2006). Reliability, validity and factor structure of the GDS-15 in Iranian elderly. *International Journal of Geriatric Psychiatry*, 21(6), 588-593. [DOI:10.1002/gps.1533] [PMID]
- Moraes, C., Pinto, J. A., Jr, Lopes, M. A., Litvoc, J., & Bottino, C. M. (2010). Impact of sociodemographic and health variables on mini-mental state examination in a community-based sample of older people. *European Archives of Psychiatry and Clinical Neuroscience*, 260(7), 535-542. [DOI:10.1007/s00406-010-0104-3] [PMID]
- Morley, J. E., Morris, J. C., Berg-Weger, M., Borson, S., Carpenter, B. D., & Del Campo, N., et al. (2015). Brain health: The importance of recognizing cognitive impairment: An IAGG consensus conference. *Journal of the American Medical Directors Association*, 16(9), 731-739. [DOI:10.1016/j.jamda.2015.06.017] [PMID] [PMCID]
- Morris, J. C., Weng, J., & Xiong, C. (2014). Screening for Alzheimer's disease in cognitively normal older adults: Subjective cognitive decline versus informant report. *Alzheimer's & Dementia: The Journal of the Alzheimer's Association*, 10(4), P200. [DOI:10.1016/j.jalz.2014.04.241]
- Pendlebury, S. T., Cuthbertson, F. C., Welch, S. J., Mehta, Z., & Rothwell, P. M. (2010). Underestimation of cognitive impairment by Mini-Mental State Examination versus the Montreal Cognitive Assessment in patients with transient ischemic attack and stroke: A population-based study. *Stroke*, 41(6), 1290-1293. [PMID]
- Petersen, R. C., Smith, G. E., Waring, S. C., Ivnik, R. J., Tangalos, E. G., & Kokmen, E. (1999). Mild cognitive impairment: Clinical characterization and outcome. *Archives of Neurology*, 56(3), 303-308. [DOI:10.1001/archneur.56.3.303] [PMID]
- Prince, M., Comas-Herrera, A., Knapp, M., Guerchet, M., & Karagiannidou, M. (2016). *World Alzheimer report 2016: Improving healthcare for people living with dementia: Coverage, quality and costs now and in the future*. London: Alzheimer's Disease International (ADI). [Link]
- Sclan, S. G., & Reisberg, B. (1992). Functional assessment staging (FAST) in Alzheimer's disease: Reliability, validity, and ordinality. *International Psychogeriatrics*, 4(Suppl 1), 55-69. [DOI:10.1017/S1041610292001157] [PMID]
- Shafiee, A., & van Bodegom, D. (2012). The necessity for research on the elderly in Iran. *The Journal of Tehran University Heart Center*, 7(1), 40-40. [Link]
- Winblad, B., Palmer, K., Kivipelto, M., Jelic, V., Fratiglioni, L., & Wahlund, L. O., et al. (2004). Mild cognitive impairment-beyond controversies, towards a consensus: Report of the International Working Group on Mild Cognitive Impairment. *Journal of Internal Medicine*, 256(3), 240-246. [DOI:10.1111/j.1365-2796.2004.01380.x] [PMID]