Original Article

Diagnostic Performance of Ain-Shams Cognitive Assessment tool among older adults with Mild Cognitive Impairment

Safinaz Saadeldeen Abousamra[1], Khaled Elsayed Elsorady[2], Ghazi, Hossam Arafa[1], El-Hariri, Hazem Mohamed[3], Salma M.S. El Said[2], Somaia Mohamed Ebeid[2].
[1]Department of Geriatrics and Gerontology, Faculty of Medicine, Mansoura University, Mansoura, Egypt.
[2]Department of Geriatrics and Gerontology, Faculty of Medicine, Ain Shams University, Cairo, Egypt.
[3]Department of Community Medicine, National Research Centre, Cairo, Egypt

Abstract

Background: A new neuropsychiatric battery named Ain-shams cognitive assessment tool (ASCA) targets MCI and dementia diagnosis. The current study aims to determine the diagnostic performance of ASCA among older adults with MCI.

Methods: A comparative cross-sectional study included one hundred elderly persons (aged ≥60 years) both males and females recruited from El-Mansoura university hospital outpatients' clinics, divided into 2 groups based on the Arabic version of Rowland Universal Dementia Assessment Scale (A-RUDAS) score: Group A: Fifty participants with MCI, defined as A-RUDAS score<24. Group B: Fifty participants with normal cognitive function. The data collection process included: Step 1: Comprehensive geriatric assessment. Step 2: cognitive assessment by using A-RUDAS, Step 3: Applying ASCA. Step 4: Statistical analysis was done.

RESULTS: The Mean age in the MCI group was 68.9±4.1 years. Participants who were assisted in IADL and had a higher risk of malnutrition were significantly more frequent in the MCI group, P-value 0.004 and 0.02 respectively. The total ASCA score for the current study participants at cut-off point ≤95 had perfect diagnostic characteristics in differentiating MCI from normal participants with sensitivity and specificity of 100%. The total score of Verbal learning and recall tests of ASCA of the current study participants at ≤39 had the highest MCI diagnostic performance with sensitivity and specificity 96.0% and 90.0% respectively. There was no statistically significant association between the participants` educational level and their performance in ASCA battery tests.

CONCLUSION: ASCA was a valid tool for MCI diagnosis among literate and illiterate participants.

Keywords
Mild Cognitive Impairment, RUDAS, ASCA, Older Adults

Introduction:

Mild cognitive impairment (MCI) is a heterogeneous clinical syndrome that reflects a change in cognitive function and deficits on neuropsychological testing, but relatively intact daily living activities [1]. Nowadays, the scientific community uses the term of MCI, introduced by Reisberg et al., (1982) [2], described as a transition period where cognition is no longer normal as regard age expectation, but also where daily functions are not sufficiently disrupted to correlate with the diagnosis of dementia [3].

There are several tools for cognitive assessment for older adults with MCI. The use of the Dementia Rating Scale (DRS) and the Mini-Mental Status Examination (MMSE) as screening tools for MCI is not preferred due to their drawbacks concerning detecting abnormal cognitive function [4]. Clinical dementia rating scores did not have a good association with MCI [5]. The MCI recommended cognitive screening tool is the Montreal Cognitive Assessment tool (MoCA) at a cutoff point of 24/25. The sensitivity and specificity of the test are observed to be 80.48% and 81.19%, respectively [6]. However, it gets influenced by educational level, ethnic diversities and lifestyle factors [7, 8]. Although MoCA is recommended principally in MCI screening in various studies, there are some restrictions as explained besides the need for clinical assessment including premorbid functioning such as occupational status and intellectual function as fundamental elements in diagnosing MCI [9]. The

Addenbrooke's Cognitive Examination III (ACE III) has a good distinguishable ability for the screening of MCI with verified diagnostic properties similar or superior to the MoCA and the MMSE [10].

Rowland Universal Dementia Assessment Scale (RUDAS) [11] is a multicultural, short cognitive assessment scale that was created to overcome the effect of cultural variation and education on cognitive performance. At a cut-off point of 23 it shows sensitivity and specificity 89% and 98% respectively for differentiating normal subjects and those with cognitive impairment [12]. RUDAS is a brief cognitive test developed and validated in Australia [13]. It has satisfactory psychometric properties and is not affected by sex, years of education or language [14]. It has been translated to other languages, without the necessity to alter the structure or the format of its item. It also offers an objective measure of cognitive results that do not depend on the history of an informant. RUDAS is easy to apply, takes around 10 min to administer, demands minimal training [15] and has been translated into the Arabic version of Rowland Universal Dementia Assessment Scale (A-RUDAS) [16]. Recently, a new neuropsychiatric battery has been developed in Egypt at Geriatrics and Gerontology department, Ain-shams university named as Ain-shams cognitive assessment tool (ASCA) targeting the diagnosis of MCI and dementia, the battery should be appropriate for illiterates, low educated and highly educated Egyptian elderly people [17].

The current study aims to determine the diagnostic performance of ASCA among older adults with MCI through cognitive assessment by using ASCA. The study participants were classified into normal and MCI based on their A-RUDAS score.

Patients and Methods:

Study design:
A comparative cross-sectional study

Study population:
Sample size: a total sample of one hundred (100) elderly subjects, they were divided into case and control groups according to their A-RUDAS score.
Case group: Fifty (50) participants with mild cognitive impairment.
Control group: Fifty (50) cognitively intact elderly.
The two groups were matched for age, gender, and education.
Site and timing of recruitment: they were recruited from the Geriatrics outpatients' clinics at El-Mansoura university hospital in the period of 7 months from August 2020 to March 2021,

Inclusion criteria included: individuals 60 years and above, both males and females.
Exclusion criteria included: individuals with history of dementia, visual and hearing impairment enough to interfere with the assessment, individuals with depression by using Geriatric Depression Scale (short form) (GDS) [18] and individuals who were unwilling to participate in the study.

Data collection included the following steps:

Step 1: Comprehensive Geriatric assessment to record data concerning:
a*) socio-demographic data* as name, age, sex, marital status, occupation, special habits and education.
b) *Functional assessment* by using Activities of Daily Living (ADL) [19] and Instrumental Activities of Daily Living (IADL) [20], Nutritional assessment was done through Mini-nutritional assessment tool (MNA) [21], Risk of falls by using Timed up and Go test (TUGT) [22] and depression by using Geriatric Depression Scale (short form) (GDS) [18].
c)Past medical history including: Co-morbidities as HTN and DM, history of dementia, history of visual and hearing impairment, history of urinary and fecal incontinence and medications review.

Step 2: cognitive assessment by using A-RUDAS [16]***:***
RUDAS includes six-item (totaling 30 points). These items tackle various cognitive domains, involving memory, language, visuospatial orientation, praxis, visuospatial drawing and judgment [15]. A-RUDAS score [16] was used as the gold standard tool for the diagnosis of MCI with cut-off values <24 to discriminate between MCI and normal participants and <21 to discriminate between MCI and early dementia [23]. It was applied to all participants and according to its result patients were classified into case and control groups.

Step 3: cognitive assessment by using ASCA [17]. ASCA includes the following tests: *1. Verbal paired associated test:* (a) Verbal learning (VL) (b) Distractor interval (DI) (c) Delayed recall (DR) (d) Word recognition test *2. Bender Gestalt (BG) copy and memory 3. Digit forward and digit backward span length (DS) 4. Set shifting lines and time 5. Letter/Lexical fluency 6. Verbal fluency (spherical) 7. Semantic fluency 8. Language object naming test 9. Abstraction 10. Judgment.*

Step 4: Cut-off scores for some battery tests with the highest diagnostic accuracy of MCI were calculated. ***Total ASCA scores*** for participants in MCI and non-MCI groups were calculated.

Differences between ASCA and RUDAS subdomains:

A) Recall:
ASCA uses *Verbal paired associated test* from *Wechsler memory scale* to assess the ability to form new links between two items and retrieval [24]. A list of six related and four unrelated pairs is read then the first word of each pair is presented; the participants should remember the paired word and the number of correctly recalled pairs are recorded for three learning trials. *Recall* is tested using distractor interval and delayed recall tests. While in *RUDAS recall* is tested by asking him to remember four items that he needs to buy from shop after delay, then a score is given.
ASCA also includes a special test which is word recognition test that involves a group of words nine of them are selected from the paired associate and incorporated among other 18 words from the same category to act as a new pattern and participants should identify if they are present in the paired associate or not. This reveals that ASCA doesn`t measure only items recall but also encoding for associations between new learned items.
ASCA includes *digit span forward and backward tests* that assess serial order recall. The digit span backward test is used to evaluate working memory defects in both dementia and MCI. The digit span backward test includes two types: a) total any recall and b) total serial order recall – the type used in ASCA- noted as the total percent recall of digits in the exact serial order and provide a measure of working memory and the capacity for mental manipulation [25]. RUDAS doesn't include *digit span forward and backward tests.*
B) Visual-motor function:
RUDAS involves *visuo-constructional cube drawing* in which the participants are asked to draw a cube with all its internal and external lines while ASCA involves *Bender Gestalt copy and memory* [26]. In the latter participants are asked to copy a figure to measure visual-motor skills and then to copy it from their memory 10 minutes later to assess visual memory. This figure was chosen as it is not influenced by cultural variation [27] and as it is easier to illiterates.
C) Praxis and visuospatial body orientation:
In ASCA there are no separate tests for *praxis and visuospatial body orientation* while RUDAS includes a separate test for *praxis* through Fist-palm test in addition to *visuospatial body orientation test.*
D) Judgment:
Judgment is assessed in ASCA using the question "If you find a stamped, addressed envelope lying on the sidewalk, what would you do?", answers are scored according to the well-known base in Egyptian culture, while RUDAS uses the question "You are standing on the side of a busy street. There is no pedestrian crossing and no traffic lights. Tell me what you would do to get across to the other side of the street safely". In the current study *RUDAS judgment* was statistically significant in MCI diagnosis among the studied groups while *ASCA judgment* wasn`t.
E) Abstraction:
Abstraction ability is not included in RUDAS but it is tested in ASCA using popular Egyptian metaphors.
F) Language:
ASCA battery tests also include *confrontation naming (CN) test* which was modified from the Egyptian–Arabic Addenbrooke's Cognitive Examination – III (ACE-III) [28]. Confrontation naming tasks are used in the context of clinical language assessment for aphasia to measure defects of word-finding abilities or anomia in individuals with neurologic conditions typically involving the left hemisphere of the brain [29]. Although word finding happens in the context of conversational speech, we test it clinically using picture confrontation naming through common, recognizable target words [30]. Some confrontation naming tests assess words from different semantic categories – as in ASCA- such as animals, fruits, vegetables and man-made categories such as furniture, clothing, tools, and transportation [31]. RUDAS doesn`t include a *confrontation naming test.*
In addition, ASCA involves category fluency test by asking the participant to name the animals he knows in one minute and lexical fluency test through asking the participant to name items that start with the letter (sh) and spherical fluency test for illiterates while RUDAS includes only category fluency test.
G) Executive functioning:
ASCA also uses trail making test B which is a test to evaluate the part of executive functioning concerned with the rapid ability to switch attention while inhibiting automatic responses [32]. The test consists of both numbers and letters, and participants are asked to match numbers and letters alternatively [33] in order to make the test more suitable for illiterates a new trail making test is used with changes to suit illiterates under the name of *Ain Shams Set Shifting for Illiterates (ASTI)*. RUDAS doesn't include a test to assess this part of executive functioning.

Statistical analysis:

The collected data were coded, tabulated, and statistically analyzed using IBM SPSS statistics (Statistical Package for Social Sciences) software version 22.0, IBM Corp., Chicago, USA, 2013. Quantitative normally distributed data was described as mean ± SD (standard deviation) after testing for normality using Shapiro-Wilk test, then compared using independent t-test if normally distributed, while Pearson test was used for correlations. Qualitative data was described as number and percentage and compared using Chi square test and Fisher's Exact test

for variables with small expected numbers. ROC curve was used to evaluate the performance of different tests to differentiate between certain groups. McClish test was used to compare two independent AUCs [34]. The level of significance was taken at P-value < 0.050 was significant, otherwise was non-significant.

Ethical consideration:

An oral informed consent was obtained from every subject before the enrollment in the study. Study protocol was revised and approved by the ethical Committee at the faculty of Medicine, Ain Shams University (FMASU M S 295/2020).

Results:

Demographics:

A total of one hundred Geriatric male and female participants recruited from geriatrics outpatients' clinics were matched for age, gender and education divided into two groups; MCI and non-MCI groups.

Table 1 showed the baseline characteristics of the study participants. In both MCI and non-MCI groups gender distribution was as follows 25 (50.0%) males and 25 (50.0%) females.

Mean age of participants in MCI group was 68.9±4.1 years and mean age of participants in non-MCI group was 67.7±4.8 years.

MCI group included 25 (50.0%) illiterates and 25 (50.0%) literates, 11 (22.0%) of the literates were <10 years of education and 14 (28.0%) of the literates were ≥10 years of education and non-MCI group included 32 (64.0%) illiterates and 18 (34%) literates, 10 (20.0%) of literates were < 10 years of education and 8 (16.0%) of literates were ≥10 years of education with no statistically significant differences between MCI and non-MCI groups (P-value= 0.280).

There was no statistically significant differences between MCI and non-MCI groups regarding *demographic characteristics*.

Functional assessment:

Assistance in IADL was significantly more frequent in MCI group, P-value= 0.004 while no statistically significant difference in ADL in both groups. Similarly, the higher risk of malnutrition was significantly more frequent in patients with MCI, P-value= 0.02.

Table2 shows the means and standard deviations for total score of A-RUDAs and its subdomains for MCI and non-MCI groups. The mean results of A-RUDAS total score in MCI and non-MCI groups were 21.9±0.8 and 27.0±1.7 respectively with statistically significant difference, p-value<0.001. Also, A-RUDAS subdomains scores were significantly lower (worse performance) in MCI group with statistically significant difference, p-value <0.001.

Table 3 illustrates the mean and standard deviations for total ASCA score and its subdomains for MCI and non-MCI groups. The mean results of total ASCA score in MCI and non-MCI groups were 84.9±5.9 and 116.1±12.9 respectively with statistically significant difference, P-value <0.001. The study showed that ASCA subdomains scores were significantly lower in MCI group (worse performance) with statistically significant difference as regards all subdomains except for judgment and abstraction, p-value > 0.999.

Table 4 involves the cut off points between MCI and non-MCI groups for some ASCA subdomains with higher diagnostic accuracy.

Semantic fluency at cut off point ≤ 10 showed sensitivity and specificity 88% and 72% respectively (AUC= 0.904, 95% CI= 0.847-0.960).

Total score of VL and recall at cut off point ≤ 39 showed sensitivity and specificity 96% and 90% respectively (AUC= 0.979, 95% CI= 0.958-1.000).

Total score of VL and recall easy at cut off point ≤ 28 showed sensitivity and specificity 94% and 76% respectively (AUC= 0.921, 95% CI= 0.866-0.975).

Total score of VL and recall Hard at cut off point ≤ 9 showed sensitivity and specificity 82% and 96% respectively (AUC= 0.931, 95% CI= 0.877-0.984).

VL 1st trial total at cut off point ≤ 6 showed sensitivity and specificity 86% and 88% respectively (AUC= 0.945, 95% CI= 0.905-0.985).

VL 2nd trial total at cut off point ≤ 7 showed sensitivity and specificity 90% and 90% respectively (AUC= 0.941, 95% CI= 0.893-0.990).

VL 3rd trial total at cut off point ≤ 8 showed sensitivity and specificity 88% and 78% respectively (AUC= 0.913, 95% CI= 0.857-0.969).

DI total at cut off point ≤ 8 showed sensitivity and specificity 94% and 74% respectively (AUC= 0.926, 95% CI= 0.870-0.981).

DR total at cut off point ≤ 8 showed sensitivity and specificity 98% and 72% respectively (AUC= 0.949, 95% CI= 0.911-0.988).

Set shifting lines at cut off point ≤ 5 showed sensitivity and specificity 86% and 86% respectively (AUC= 0.918, 95% CI= 0.860-0.976).

Figure 1 emphasizes that Semantic fluency, total score of VL and recall, Total score of VL and recall easy, Total score of VL and recall Hard, VL 1st trial total, VL 2nd trial total, VL 3rd total, DI total, DR total and Set shifting lines had highest significant diagnostic performance among different ASCA subdomains.

Figure 2 shows that Total score of VL and recall ≤39 had the highest diagnostic performance among all

studied subdomains. Total ASCA score ≤95 had perfect diagnostic characteristics in detecting MCI especially in illiterates.

Table 5 demonstrates that no statistically significant differences in the diagnostic accuracy of ASCA Total and subdomains scores as regards MCI diagnosis according to education.

Discussion:

The objective of this study was to evaluate the diagnostic performance of a newly developed neuropsychiatric battery named Ain Shams Cognitive Assessment tool "ASCA". ASCA was designed to overcome the defects in existing dementia screening instruments and their inability to detect early cognitive impairment by assessments of verbal learning, short- and long-term memory, cued memory, visuospatial functions, executive functions, verbal fluency, and confrontation naming and to apply tests that are less affected by education, in diagnosing MCI among literate and illiterate elderly Egyptian population [17] A-RUDAS was used as the gold standard test for MCI diagnosis [16].

The current study showed that ASCA total and subdomains scores including Semantic Fluency, Verbal learning (VL), Distractor interval, Bender Gestalt (BG) copy and recall, Digit Span forwards and backwards, set shifting lines and time, Confrontation naming (CN) total, CN phonemic cue, CN stimulus cue, spherical fluency, and lexical fluency were statistically significant in MCI diagnosis. This result was partially concordant with El-Kholy et al [17] except for digit span forward and backward, and phonemic cuing of confrontation naming that weren`t significant in diagnosing MCI among illiterate and low-educated people in El-Kholy et al [17] but were significant in the current study. This difference could be attributed to the higher level of education in El-Kholy et al [17] sample in comparison to this study.

Based on the reported importance of both category and lexical fluency [35], ASCA doesn't only assess category fluency as RUDAS but also lexical fluency. Both tests were statistically significant in MCI diagnosis in the current study. It is believed that AD patients are comparatively more impaired on category fluency, while traumatic brain injury patients exhibit the opposite pattern and perform more errors on letter fluency [35] but in MCI the pattern is less clear [36]

ASCA involved Bender Gestalt copy and memory [26] that were statistically significant in the current study in differentiating MCI and non-MCI groups using P-value (BG copy AUC = 0.792, 95%CI = 0.702-0.882, BG recall AUC = 0.804, 95% CI = 0.714-0.893, p= value <0.001). It was similar to a cross-sectional study done in Bojnord City, Iran with amnestic MCI and non-MCI participants that used Bender Gestalt test to assess their visual-motor coordination and showed that it can strongly expect amnestic MCI [37]

As regards judgment assessment, RUDAS was statistically significant in differentiating MCI and non-MCI groups while ASCA wasn't in the current study. This result was similar to ElKholy et al [17] in which ASCA judgment showed no statistically significant difference in MCI diagnosis suggesting possible limitation in this subdomin in ASCA.

Abstraction ability was tested in ASCA using popular Egyptian metaphors and showed no statistically significant association with MCI in the current study that could be attributed to relatively small sample size and needs further study. The assessment of abstract thinking necessitates the ability of establishing similarities between objects which is related to frontal lobe functions [38]. Abstraction impairment is used for differentiation between normal aging and MCI. It is also helpful in clinical assessment of elderly with vascular MCI [39].

The study showed that the mean of total ASCA score was significantly lower among participants with MCI (84.9±5.9 versus 116.1±12.9 in participants with non-MCI, P <0.001) and supported its utility for diagnosis of MCI. ASCA total score at cut off point ≤95 had perfect diagnostic characteristics in distinguishing MCI from normal subjects with sensitivity and specificity 100% (AUC=1.000, 95% CI= 1.000-1.000). As regards ASCA subdomains, semantic fluency, total score of VL and recall, Total score of VL and recall easy, Total score of VL and recall Hard, VL 1st trial total, VL 2nd trial total, VL 3rd total, DI total, DR total and Set shifting lines had the highest significant diagnostic performance among different ASCA subdomains. Total score of VL and recall at cut-off point ≤39 (AUC= 0.979, 95% CI= 0.958-1.000) had the highest significant diagnostic performance.

Association between education and ASCA diagnostic accuracy

The current study showed no statistically significant association between education and ASCA subdomains diagnostic accuracy of MCI. This result was partially similar to El-Kholy et al [17] that revealed no statistically significant association between levels of education and the following tests; VL, distractor interval (DI), delayed recall (DR), word recognition, visuospatial figure copying and recall, set shifting abilities, forward digit span, animals and spherical

fluencies, CN, stimulus and phonemic cuing, abstraction, and judgment. This denotes the ability of the battery to be applied on literates as well as illiterate subjects. However, there was highly statistically significant difference in ElKholy et al [17] regarding backward digit span and letter fluency while in the current study there was no statistically significant difference between education and backward digit span and letter fluency. This can be contributed to the higher level of education in El-Kholy et al [17] compared to the current study, as the higher educated participants in El-Kholy et al represented about 62 % of the study sample while in the current study the higher educated participants represented only 22%.

Association between MCI with functional and nutritional status

In the current study, participants who were assisted in IADL were significantly more frequent in MCI group. While, there was no statistically significant difference regarding ADL assessment in the MCI and non-MCI groups. This observation is similar to that found through a meta-analytic study done in July 2020 in which subjects with MCI had more difficulties in performing IADLs rather than basic activities of daily living (BADLs), it also revealed a significant difference between MCI and healthy controls on transportation of IADLs and on feeding of BADLs, suggesting that these activities can be used in differentiation between normal aging and MCI in clinical practice [40]. Also, Yeh et al [41] showed that MCI is characterized by a mild decrease in specific IADL tasks performance such as shopping, using the telephone, handling medication, preparing food, and finances, i.e., the IADLs depending mostly on memory and executive functioning. On the other side, the current study showed a significant association between MCI and the risk of malnutrition by using the MNA [21] and this is consistent with another cross sectional study to assess the malnutrition risk among elderly with normal cognitive function and MCI living in elderly homes in Cairo, Egypt using the MNA which found that the risk of malnutrition was more frequent among MCI elderly than those with normal cognitive function that emphasizes the importance of early nutritional assessment and intervention among elderly with MCI to demonstrate whether enhancing their nutritional status may improve the cognitive function or postpone progression to dementia or not [42].

Strengths and limitations of the study

The strengths of the study are investigating the efficacy of a newly designated tool, ASCA for diagnosis of MCI among elderly population with high prevalence of illiteracy and low education with the provision of different cut off points. However, the study has some limitations including the relatively small sample size and inclusion of a single institute.

Conclusion:

ASCA can be used as a valid tool for MCI diagnosis among literate and illiterate Egyptian elderly population. It needs further validation and studying on multi-central longitudinal studies.

Conflicts of interest: The authors declare no conflicts of interest for this article

Funding: None

References:

1. Dunne, R. A. et al. Mild Cognitive Impairment: the Manchester consensus. Age Ageing 50, 72–80 (2021).
2. Reisberg, B., Ferris, S. H., De Leon, M. J. & Crook, T. The global deterioration scale for assessment of primary degenerative dementia. Am. J. Psychiatry 139, 1136–1139 (1982).
3. Petersen, R. C. Mild cognitive impairment as a diagnostic entity. in Journal of Internal Medicine vol. 256 183–194 (J Intern Med, 2004).
4. Matallana, D. et al. The relationship between education level and mini-mental state examination domains among older Mexican Americans. J. Geriatr. Psychiatry Neurol. 24, 9–18 (2011).
5. Woolf, C. et al. Can the Clinical Dementia Rating Scale Identify Mild Cognitive Impairment and Predict Cognitive and Functional Decline? Dement. Geriatr. Cogn. Disord. 41, 292–302 (2016).
6. Espino, D. V., Lichtenstein, M. J., Palmer, R. F. & Hazuda, H. P. Ethnic differences in Mini-Mental State Examination (MMSE) scores: Where you live makes a difference. J. Am. Geriatr. Soc. 49, 538–548 (2001).
7. Gagnon, G. et al. Correcting the MoCA for education: Effect on sensitivity. Can. J. Neurol. Sci. 40, 678–683 (2013).
8. O'Driscoll, C. & Shaikh, M. Cross-Cultural Applicability of the Montreal Cognitive Assessment (MoCA): A Systematic Review. Journal of Alzheimer's Disease vol. 58 789–801 (2017).

9. Petersen, R. C. et al. Practice guideline update summary: Mild cognitive impairment report of theguideline development, dissemination, and implementation. Neurology 90, 126–135 (2018).

10. Senda, M. et al. Diagnostic utility of the Addenbrooke's Cognitive Examination – III (ACE-III), Mini-ACE, Mini-Mental State Examination, Montreal Cognitive Assessment, and Hasegawa Dementia Scale-Revised for detecting mild cognitive impairment and dementia. Psychogeriatrics 20, 156–162 (2020).

11. Storey J, Rowland J, Basic D, Conforti D & Dickson H. R R U U D D A A S S R owland U niversal D ementia A ssessment S cale A Multicultural Cognitive Assessment Scale Administration and Scoring Guide. (1996).

12. JE, S., JT, R., D, B., DA, C. & HG, D. The Rowland Universal Dementia Assessment Scale (RUDAS): a multicultural cognitive assessment scale. Int. psychogeriatrics 16, 13–31 (2004).

13. Storey, J. E., Rowland, J. T. J., Conforti, D. A. & Dickson, H. G. The Rowland Universal Dementia Assessment Scale (RUDAS): A multicultural cognitive assessment scale. Int. Psychogeriatrics 16, 13–31 (2004).

14. Rowland, J. T., Basic, D., Storey, J. E. & Conforti, D. A. The Rowland Universal Dementia Assessment Scale (RUDAS) and the Folstein MMSE in a multicultural cohort of elderly persons. Int. Psychogeriatrics 18, 111–120 (2006).

15. Jha, A. & Mukhopadhaya, K. RUDAS Cognitive Scale. 49–56 (2021) doi:10.1007/978-3-030-56739-2_4.

16. Chaaya, M. et al. Validation of the Arabic Rowland Universal Dementia Assessment Scale (A-RUDAS) in elderly with mild and moderate dementia. Aging Ment. Heal. 20, 880–887 (2016).

17. ElKholy, N., Tawfik, H. M., Ebeid, S., Madkor, O. R. E. & Hamza, S. A. A model of cognitive evaluation battery for diagnosis of mild cognitive impairment and dementia in educated and illiterate Egyptian elderly people. Egypt. J. Neurol. Psychiatry Neurosurg. 56, 1–14 (2020).

18. Yesavage, J. A., Brink, T. L., Rose, T. L., et al., (1982). Development and validation of a geriatric depression screening scale: A preliminary report. Journal of Psychiatric Research, 17(1), 37–49. https://doi.org/10.1016/0022-3956(82)90033-4

19. Katz, S., Ford, A. B., Moskowitz, R. W., Jackson, B. A. & Jaffe, M. W. Studies of Illness in the Aged: The Index of ADL: A Standardized Measure of Biological and Psychosocial Function. JAMA J. Am. Med. Assoc. 185, 914–919 (1963)

20. Lawton, M. P. & Brody, E. M. Assessment of Older People: Self-Maintaining and Instrumental Activities of Daily Living 1.

21. Guigoz Y., Vellas BJ, Garry PJ. Mini Nutritional Assessment: A practical assessment tool for grading the nutritional state of elderly patients. Facts Res Gerontol 1994;4(suppl 2): 15–59

22. Richardson, S. (1991). The Timed "Up & Go": A Test of Basic Functional Mobility for Frail Elderly Persons. Journal of the American Geriatrics Society, 39(2), 142–148. https://doi.org/10. 1111/j.1532-5415.1991.tb01616.x

23. Custodio, N., Montesinos, R., Lira, D., Herrera-Perez, E., Chavez, K., Hernandez-Córdova, G., … Metcalf, T. (2019). Validation of the RUDAS in Patients With a Middle-Level Education in Lima, Peru. American Journal of Alzheimer's Disease and Other Dementias, 34(7–8), 513–522. https://doi.org/10.1177/1533317519869709

24. Wang, H. C., Wass, M. & Castles, A. Paired-Associate Learning Ability Accounts for Unique Variance in Orthographic Learning. Sci. Stud. Read. 21, 5–16 (2017).

25. Lamar, M., Catani, M., Price, C. C., Heilman, K. M. & Libon, D. J. The impact of region-specific leukoaraiosis on working memory deficits in dementia. Neuropsychologia 46, 2597–2601 (2008).

26. Keppeke, L. de F., Cintra, I. de P. & Schoen, T. H. Bender Visual-Motor Gestalt Test in Adolescents: Relationship between Visual-Motor Development and the Tanner Stages. Percept. Mot. Skills 117, 257–275 (2013).

27. dos Santos, A. A. A., Noronha, A. P. P., Marín Rueda, F. J. & Segovia, J. L. Bender-gradual scoring system: Performance of Brazilian and peruvian children. Percept. Mot. Skills 118, 897–908 (2014).

28. Qassem, T. et al. Normative data for healthy adult performance on the Egyptian-Arabic Addenbrooke's Cognitive Examination III. doi:10.1097/01.XME.0000457267.05731.0f.

29. The Handbook of Adult Language Disorders. The Handbook of Adult Language Disorders (Psychology Press, 2015). doi:10.4324/9781315713557.

30. Raymer, A. M. & Rothi, L. J. G. The oxford handbook of aphasia and language disorders. The Oxford Handbook of Aphasia and Language Disorders (Oxford University Press, 2015). doi:10.1093/oxfordhb/9780199772391.001.0001.

31. The assessment of aphasia and related disorders (E-Book, 2001) [WorldCat.org]. https://www.worldcat.org/title/assessment-of-aphasia-and-related-disorders/oclc/764476497.

32. Kim, H. J., Baek, M. J. & Kim, S. Alternative Type of the Trail Making Test in Nonnative English-Speakers: The Trail Making Test-Black & White. PLoS One 9, e89078 (2014).

33. Of Two Minds: An Anthropologist Looks at American Psychiatry - T.M. Luhrmann - Google Books. https://books.google.com.eg/books?hl=en&lr=&id=a9rt1N0AuXoC&oi=fnd&pg=PR11&dq=Luhrmann+TM.+Of+Two+Minds:+An+anthropologist+looks+at+American+psychiatry.+2011%3B+&ots=CMDa2eui3m&sig=m46AerTBFil1_XyPGm_5wsvjvz4&redir_esc=y#v=onepage&q=Luhrmann TM. Of Two Minds.

34. DK, M. Determining a range of false-positive rates for which ROC curves differ. Med. Decis. Making 10, 283–287 (1990).

35. Capitani, E., Rosci, C., Saetti, M. C. & Laiacona, M. Mirror asymmetry of Category and Letter fluency in traumatic brain injury and Alzheimer's patients. Neuropsychologia 47, 423–429 (2009).

36. Rinehardt, E. et al. Verbal fluency patterns in mild cognitive impairment and Alzheimer's disease. Dement. Geriatr. Cogn. Disord. 38, 1–9 (2014).

37. Amani, M. The Role of Neuropsychological Function Tests in Predicting Amnestic Mild Cognitive Impairment in the Elderly. Casp. J. Neurol. Sci. 6, 139–146 (2020).

38. Matsuda, O. & Saito, M. Multiple cognitive deficits in patients during the mild cognitive impairment stage of Alzheimer's disease: How are cognitive domains other than episodic memory impaired? Int. Psychogeriatrics 21, 970–976 (2009).

39. Sudo, F. K. et al. Impaired abstract thinking may dSudo, F. K., Alves, G. S., Alves, C. E. de O., Lanna, M. E., Ericeira-Valente, L., Moreira, D. M., … Laks, J. (2010). Impaired abstract thinking may discriminate between normal aging and vascular mild cognitive impairment. . Arq. Neuropsiquiatr. 68, 179–184 (2010).

40. Altieri, M., Garramone, F. & Santangelo, G. Functional autonomy in dementia of the Alzheimer's type, mild cognitive impairment, and healthy aging: a meta-analysis. Neurological Sciences vol. 42 1773–1783 (2021).

41. Yeh, Y. C. et al. Functional disability profiles in amnestic mild cognitive impairment. Dement. Geriatr. Cogn. Disord. 31, 225–232 (2011).

42. Shawky Khater, M. & Fawzy Abouelezz, N. Nutritional status in older adults with mild cognitive impairment living in elderly homes in Cairo, Egypt. J. Nutr. Heal. aging 2011 152 15, 104–108 (2011).

Table (1): Characteristics of Participants

^Independent t-test, #Chi square test, §Fisher's Exact test

Variables		MCI (N=50)	Non-MCI (N=50)	p-value
Age (years)		68.9±4.1	67.7±4.8	^0.209
Sex	**Male/ Female**	25 (50.0%)/25 (50.0%)	25 (50.0%)/25 (50.0%)	#0.999
Marital status	**Married**	34 (68.0%)	39 (78.0%)	#0.260
	Widow	16 (32.0%)	11 (22.0%)	
Education years	**0**	25 (50.0%)	32 (64.0%)	#0.280
	1−9	11 (22.0%)	10 (20.0%)	
	≥10	14 (28.0%)	8 (16.0%)	
Current Working	**Males**	5 (10.0%)	5 (10.0%)	#0.999
	Females (housewives)	25 (50.0%)	25 (50.0%)	
Smoking	**Current**	3 (6.0%)	2 (4.0%)	§0.344
	Ex	8 (16.0%)	14 (28.0%)	
	non	39 (78.0%)	34 (68.0%)	
Nutrition	**Normal**	22 (44.0%)	35 (70.0%)	**§0.020***
	At risk of malnourishment	25 (50.0%)	12 (24.0%)	
	malnourished	3 (6.0%)	3 (6.0%)	
ADL	**Independent**	50 (100%)	50 (100%)	0.999
	Assisted	0 %	0%	
	Dependent	0%	0%	
IADL	**Independent**	24 (48.0%)	38 (76.0%)	**#0.004***
	Assisted	26 (52.0%)	12 (24.0%)	
	Dependent	0%	0%	
Co-morbidities				
HTN		32 (64.0%)	33 (66.0%)	#0.834
DM		26 (52.0%)	25 (50.0%)	#0.841
Dyslipidemia		16 (32.0%)	19 (38.0%)	#0.529
Chronic liver disease		16 (32.0%)	17 (34.0%)	#0.832
Chronic renal disease		6 (12.0%)	13 (26.0%)	#0.125
Ischemic heart disease		5 (10.0%)	10 (20.0%)	#0.161
Thyroid disease		6 (12.0%)	2 (4.0%)	§0.269
Insomnia		1 (2.0%)	0 (0.0%)	§0.999

Table (2): A-RUDAS scores among the studied groups

Subdomains	MCI (N=50)	Non-MCI (N=50)	p-value
Body orientation	4.6±0.6	5.0±0.1	**<0.001***
Praxis	1.2±0.4	1.8±0.4	**<0.001***
Drawing	1.2±0.7	2.1±0.9	**<0.001***
Judgement	2.7±0.6	3.5±0.6	**<0.001***
Memory (Recall)	4.8±1.2	6.6±1.2	**<0.001***
Language	7.5±0.8	8.0±0.1	**<0.001***
Total	21.9±0.8	27.0±1.7	**<0.001***

^Independent t-test. *Significant

Table (3): ASCA scores among participants

Subdomains	MCI (N=50)	Non-MCI (N=50)	P-value
Semantic fluency	8.2±1.6	13.0±4.4	**<0.001***
Total score of VL & recall	30.9±4.3	43.7±3.8	**<0.001***
VL 1st trial total	5.0±1.3	7.9±1.2	**<0.001***
VL 2nd trial total	6.0±1.5	8.7±0.9	**<0.001***
VL 3rd trial total	6.8±1.7	9.1±1.3	**<0.001***
DI total	6.1±1.5	8.9±1.2	**<0.001***
DR total	6.1±1.3	9.0±1.2	**<0.001***
Word recognition	7.2±1.3	8.6±0.7	**<0.001***
BG Copy	3.3±1.2	4.5±0.7	**<0.001***
BG recall	2.8±1.0	3.9±1.0	**<0.001***
Set shifting lines	3.7±2.1	8.1±1.7	**<0.001***
Set shifting time	72.4±21.4	62.2±27.9	**<0.001***

DS forward	4.7±0.7	6.1±1.1	**<0.001***
DS backward	1.9±1.2	3.3±1.3	**<0.001***
Semantic spherical	5.1±1.2	7.5±1.6	**<0.001***
Lexical fluency	3.0±1.2	6.3±3.2	**<0.001***
CN total	11.4±0.7	11.8±0.7	**<0.001***
CN stimulus cue	2.1±1.1	0.8±1.0	**<0.001**
CN phonemic cue	1.1±0.7	0.3±0.5	**<0.001**
Abstraction	50 (100%)	50 (100%)	0.999
Judgement	50 (100%)	50 (100%)	0.999
Total	84.9±5.9	116.1±12.9	**<0.001***

^Independent t-test *Significant

Table (4): Diagnostic characteristics of ASCA scores for diagnosis of MCI

Subdomains	AUC	95% CI	Cut off	Sensitivity	Specificity	p-value
Semantic fluency	**0.904**	0.847–0.960	**≤10**	88.0%	72.0%	**<0.001***
Total score of VL and recall	**0.979**	0.958–1.000	**≤39**	96.0%	90.0%	**<0.001***
Total score of VL and recall easy	**0.921**	0.866–0.975	**≤28**	94.0%	76.0%	**<0.001***
Total score of VL and recall hard	**0.931**	0.877–0.984	**≤9**	82.0%	96.0%	**<0.001***
VL 1st trial total	**0.945**	0.905–0.985	**≤6**	86.0%	88.0%	**<0.001***
VL 2nd trial total	**0.941**	0.893–0.990	**≤7**	90.0%	90.0%	**<0.001***
VL 3rd trial total	**0.913**	0.857–0.969	**≤8**	88.0%	78.0%	**<0.001***
DI total	**0.926**	0.870–0.981	**≤8**	94.0%	74.0%	**<0.001***
DR total	**0.949**	0.911–0.988	**≤8**	98.0%	72.0%	**<0.001***
Set shifting lines	**0.918**	0.860–0.976	**≤5**	86.0%	86.0%	**<0.001***
Total	**1.000**	1.000–1.000	**≤95**	100.0%	100.0%	**<0.001***

AUC: Area under curve. SE: Standard error. CI: Confidence interval. *Significant

Table (5): Comparing diagnostic accuracy of ASCA scores in diagnosing MCI according to education

Subdomains	Literate		Illiterate		P-value
	AUC	SE	AUC	SE	
Semantic fluency	0.929	0.043	0.901	0.039	0.512
Total score of VL and recall	0.992	0.009	0.986	0.011	0.503
VL 1st trial total	0.987	0.012	0.928	0.034	0.527
VL 2nd trial total	0.944	0.039	0.947	0.031	0.499
VL 3rd trial total	0.862	0.062	0.954	0.025	0.460
DI total	0.973	0.020	0.917	0.041	0.525
DR total	0.966	0.025	0.963	0.021	0.501
Word recognition	0.851	0.059	0.861	0.052	0.496
BG Copy	0.840	0.060	0.775	0.065	0.527
BG recall	0.803	0.074	0.841	0.056	0.484
Set shifting lines	0.951	0.035	0.920	0.041	0.514
set shifting time	0.714	0.087	0.565	0.076	0.561
DS forward	0.921	0.045	0.780	0.061	0.560
DS backward	0.852	0.058	0.802	0.061	0.521
Semantic spherical	0.936	0.034	0.858	0.051	0.534
Lexical fluency	0.914	0.056	0.803	0.059	0.547

AUC: Area under curve. SE: Standard error. McClish test

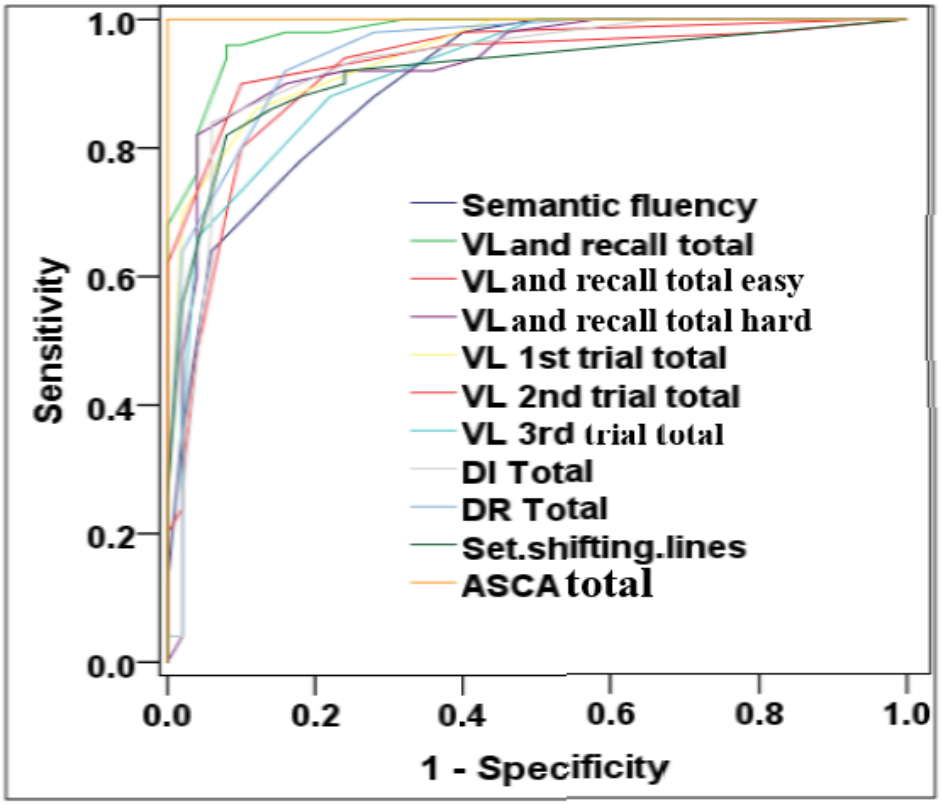

Figure 1; ROC curve for ASCA total and some subdomain scores in diagnosing MCI

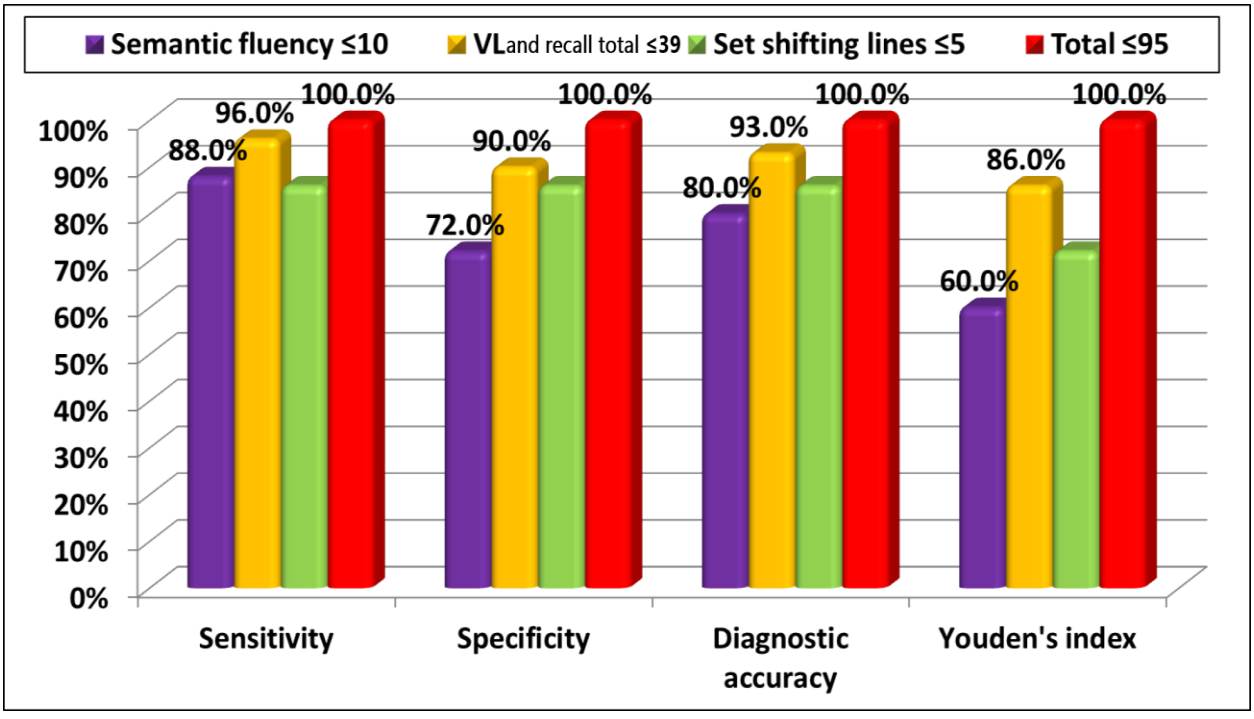

Figure 2; Diagnostic characteristics of ASCA total and some subdomain scores cut-off points in diagnosing MCI