The Value of Collateral History in Screening for Mild Cognitive Impairment in Elderly with Diabetes Mellitus in Outpatient Clinics

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Abstract

Background: Cognitive decline is a common consequence of type 2 Diabetes Mellitus (T2DM) in elderly patients. It often remains an overlooked diabetic complication, especially in its preclinical stage -the mild cognitive impairment (MCI) - that is the transitional state for both Alzheimer’s and vascular dementias. MCI has been addressed as the target stage for risk reduction and therapeutic trials. The main barrier for accurate and early detection of early cognitive impairment is the time consuming neuropsychological testing that requires qualified skilled training which the primary health care providers often lack. Therefore, there is a strong need for an accurate and less time consuming screening tools that can be administered with minimal training compared to the current available neuropsychological tests.

Objective: to assess the usability of standardized collateral history as a simple screening tool for MCI in elderly patients with T2DM.

Methods: A case–control study included 90 elderly diabetic participants (≥ 60 years), divided into 45 cases with MCI (40 amnestic and 5 non- amnestic) and 45 controls. Patients with depression, dementia, delirium, previous head trauma, any central nervous system pathology, users of the anticholinergic drugs, or those refused to participate in the study were excluded. Each patient underwent neuropsychological assessment using the Arabic Mini-mental state examination and a structured objective neuropsychological battery composed of (the logical memory test, forward and backward digit span tests, category fluency test, go/no go test, stick design test, and second-order belief (John and Mary story)). Each patient had a reliable informant to complete the collateral history form which included 11 questions that cover all neurocognitive domains. The learning/ memory, and attention were the most presented domains with 4 and 3 items, respectively.

Results: The collateral history scores were higher in MCI diabetics versus controls (P = <0.0001), it had excellent accuracy to discriminate MCI (area under curve = 0.935, P = <0.0001). At cut-off ≥ 3, sensitivity and specificity values were 88.89% and 95.56%, respectively. The collateral history scores had moderate to strong inverse correlation to other used neuropsychological tests (rho=-0.659 to -0.806). The internal consistency of the collateral history scored 0.969.

Conclusion: The collateral history is a simple, reliable, and accurate screening tool for detecting MCI among aged diabetics.

Key words: Mild cognitive impairment, collateral history, cognitive screening

Background

Cognitive dysfunction is a common and debilitating complication associated with type 2 diabetes mellitus (T2 DM). Therefore, most of the clinical guidelines for diabetes management in elderly paid a great attention to cognitive screening for elderly diabetics.[1–6] However, the recommended screening tools have not
been standardized across different guidelines. Moreover, the development of cognitive screening and management strategies failed to keep the pace with those developed for other diabetic complications.[7] MCI is the preclinical transitional state of Alzheimer’s and vascular dementia. Thus, it became the target for prevention[8], early treatment[9], and cognitive training trials.[10,11] Thus detection of subtle cognitive impairment in its earliest stages remains a corner stone for these clinical interventions.

Many different brief screening tests for cognitive impairment are available,[12–16] yet; various barriers facing their dissemination in primary care and diabetes clinics. Most of these widely used tools are time consuming and require qualified skilled training for their administration and interpretation.[12–15]. Moreover, they are literacy dependent [17,18]and mostly affected by the pre-morbid cognitive reserve. [19]

Using collateral history to describe cognitive change is an important alternative for cognitive screening mainly in primary settings because the informant view is not affected by patients’ educational level and it acknowledges the decline from premorbid state. The Informant Questionnaire for Cognitive Decline in the Elderly (IQCODE) is one of the most commonly used tools. [20] it was validated for MCI screening.[21] however, the IQCODE uses a Likert scale survey, the intervals between points do not translate equal changes for all respondents, for example, the differences between a bit improved, not much change, and a bit worse.

Therefore, in this study we evaluated the accuracy of an informant based screening tool that uses closed questions including all cognitive domains presented in the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) criteria for the diagnosis of MCI among elderly diabetics.[22]

**Methods**

A case control study was conducted to assess the accuracy of collateral history taking in diagnosing mild cognitive impairment among elderly diabetic patients compared to structured objective neuropsychological battery.

The study sample comprised 90 participants with diabetes aged 60 years and above, attending the Geriatric and the Neurology outpatient clinics in Ain Shams University Hospital, Cairo, Egypt. We excluded those with any CNS pathology, or trauma, those with dementia, depression, delirium, using anticholinergic drugs, or refused to participate in the study. Each patient had a reliable informant to complete the collateral history form.

The participants were allocated into three groups according to their cognitive performance into amnestic MCI, Non- amnestic MCI, and those with normal cognition (Controls). MCI was diagnosed based on the criteria of the DSM-5.[22]

Each patient underwent neuropsychological assessment using Arabic Mini-mental state examination[23] and structured objective neuropsychological battery.

**Arabic Mini-mental state examination A-MMSE[23]:** it has a total score of 30. It assesses orientation, attention, calculation, registration, recall, language, and figure copying.

**The neuropsychological battery consisted of the following tests:** logical memory (LM) subtest of Wechsler Memory Scale Fourth Edition (WMS–IV) [24], forward and backward digit span [25], Verbal fluency test (semantic animal category)[26], go/no go test[27], stick design test [28], and second-order belief (John and Mary story)[29]. Cut off scores for MCI diagnosis is $\geq 1.5$ standard deviation (SD) below the normative data corrected for age, gender, and educational level [30].

**Description of the neuropsychological battery items:**

**Logical memory (LM) subtest of Wechsler Memory Scale Fourth Edition (WMS–IV):**[24] verbal recall of auditory presented story passage and then immediately recall all details they could remember. Then, a second story was presented followed by immediate recall. 30-minutes later the subject performed a delayed recall test. (Subjects were forewarned of a delayed recall test).

**Forward and backward digit span:**[25] For each part, the administrator presented a series of numbers at the rate of about one per second. For digits forward, the test starts with a sequence of three numbers and continues to a maximum of eight numbers, while in digits backward, the test begins with series of two numbers and continues to a maximum of seven numbers. Patients are allowed for two trials at each series length, and the test continues until both trials of a series length are failed. Each successful series is awarded by one point. The total score is the sum of all the trials answered correctly for both digits forward and digits backward.

**Verbal fluency test (semantic animal category):[26]** Each participant was asked to tell all the animals that he knew as fast as possible in one minute. The number of correct, non-repeated responses represented the total score. The animal category was chosen for this test, because it could be used in those with low formal education normative data for Egyptian elderly was adapted from Abdel Aziz et al., 2016.[26]

**Go no Go test:**[27] it is a measure of executive function, it assess frontal lobe function specifically the inhibitory control. The examiner asked the patient to place a hand on the table. Then the examiner tapped under the table, asked the patient to tap when the examiner tap once and not to tap when examiner tap twice. He showed the patient how it’s done and then the test was performed. He made sure that the patient has understood the instruction, by tapping a series of three trials is run: 1-1-1 followed by 2-2-2. Then the examiner performed the following sequence: 1-1-2-1-2-2-1-1-1-2. The score ranges between 0 when the patient
tap as the examiner for at least 4 consecutive times and 3 when there was no errors.

**Stick design test (visuospatial)**[28] it is a non graphomotor assessment of visuo-constructional ability. The patients are allowed to reproduce geometric figures using match sticks. A representation of an arrangement of four wooden matches was printed on a page. The designs included a square, a triangle with stem, a chevron, and a rake-like figure. For each item the examiner constructed the figure and then asked the patient to copy.

**Second-order belief (John and Mary story):**[29]
False – belief tasks, the subject was asked to identify the false belief of one person based on the thoughts of another. The story involved two characters (John and Mary), who were informed (independently) about placing an object in a new place. Now both John and Mary knew where the object was but John’s second-order belief is wrong about Mary’s belief: “John thinks Mary thinks the van is still at the old place” testing was by asking “Where does John think Mary will go for ice cream?” the correct response should account for John’s wrong belief.

**Collateral history form:**
The authors selected 11 questions that represented the most commonly reported cognitive symptoms of patients with MCI attending the clinic. During the selection of these questions, all neurocognitive domains were included (attention, memory, perceptual motor, executive, social cognition, and language). It ask about situations that relate to everyday life. The form aims to assess cognitive decline independent of pre-morbid ability or educational level. A closed question (yes/no) format was preferred for ease of administration and simplicity of scoring. Each yes item scored one, with a total score of 11. The learning/memory, and attention were the most presented domains with 4 and 3 items, respectively (Table 1).

**Statistical analysis**
Data were analyzed using SPSS package version number 20. Quantitative data were described as median and inter quartile range (IQR) values. Kruskal-Wallis rank sum test was used for comparing quantitative variables between groups. Qualitative data were expressed as frequencies (n) and percentage (%). Fisher’s exact test and the chi-square test were used to test association between qualitative variables. The correlation between two quantitative variables was carried out using Spearman’s correlation coefficient. The internal consistency of the scales was measured by the Cronbach’s alpha P-value ≤ 0.05 was considered significant. For the receiver operating characteristic curves, we used MedCalc Statistical Software version 18.9.1 (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org; 2018).

**Ethical consideration**
Informed consent was obtained from every elder participated in this study. The study methodology was reviewed and approved by the Research Review Board of the Geriatrics and Gerontology Department, Faculty of medicine, Ain Shams University as a part of thesis protocol approval for master degree fulfillment.

| Table 1: the collateral history items and their related cognitive domains |
|-------------------------------------------------|
| **item** | **Cognitive domain** |
| Q1: Is he/she able to track someone or follow instructions successfully to a certain place? | Learning and visuo-spatial |
| Q2: Does he/she understand facial expressions and express emotions as sympathy, joy or sad suitable for current situation? | Social cognition |
| Q3: Does he/she forget taking medications? | Memory |
| Q4: Can he/she keep track of movie or a TV series events and characters? | Complex attention, Learning and memory |
| Q5: Does he/she tell the same story to the same people repeatedly? | Learning and memory |
| Q6: Does he/she prefer to use to do lists and reminders than usual? | Learning and memory |
| Q7: Does he/she find it difficult to find a specific word or expression, for example, does he prefer to say (my daughter) instead of telling (her name)? | Language |
| Q8: Is it difficult for him/her to make decisions? | Executive function |
| Q9: Did he/she become less fond of family or friends gatherings than usual? | Social cognition |
| Q10: Does he/she need repeated instructions to perform a task? | Complex attention, executive function |
| Q11: Does he/she take longer duration to accomplish usual tasks? | Complex attention |
Results:

The sociodemographic data of the participants was previously published.[31] The mean age of the participants was 65.7 ± 3.9 years old. Females accounted for 37.8% of the subjects. There was no significant difference between cases and controls regarding gender ($P = 0.38$).

Most of the study participants were illiterate. They accounted for 32 (71.1%) and 28 (62.2%) among cases with MCI and those with normal cognition, respectively. ($P = 0.670$)

Table 2 showed that the collateral history scores were higher in MCI diabetics versus controls ($P < 0.0001$), moreover; all other neuropsychological tools were significantly affected in MCI groups compared to controls. The median A-MMSE scores were 27(26-28), 23(22-25), and 26(24-27) among controls, amnestic, and non-amnestic MCI, respectively.

The median collateral history scores were 9, 2, and 0 for amnestic, non-amnestic MCI, and controls, respectively (figure 1).

Table 3 showed that the collateral history scores had moderate to strong inverse correlation to other used neuropsychological tests ($r = -0.659$ to -0.806).

The strength of the correlation was interpreted according to values used by (Bland and Altman, 2011) [32]

The strongest correlation was between collateral history score and verbal recall ($r = 0.806$).

Table 4 showed that the internal consistency of the collateral history was excellent (Cronbach's Alpha=0.969). The corrected item total correlations were moderate to strong (ranged between 0.673 and 0.918).

Table 5 and figure 2 showed that, the collateral history had excellent accuracy to discriminate MCI (area under curve $= 0.935$, $P < 0.0001$). At cut-off $\geq 3$, sensitivity and specificity values were 88.89% and 95.56%, respectively.

It was more accurate than A-MMSE (AUC=0.875, Cut off $\leq 24$ had sensitivity and specificity values of 60.00% and 95.56%, respectively. The collateral history had a comparable accuracy to all items of the objective neuropsychological battery.

Figure 1: median collateral history score among the three groups:

![Figure 1: median collateral history score among the three groups](image)

The median collateral history scores were 9, 2, and 0 for amnestic, non-amnestic MCI, and controls, respectively.

Figure 2: ROC curve analysis for the accuracy of different tools for detecting MCI

![Figure 2: ROC curve analysis for the accuracy of different tools for detecting MCI](image)

The collateral history had excellent accuracy to discriminate MCI (area under curve $= 0.935$, $P < 0.0001$). At cut-off $\geq 3$, sensitivity and specificity values were 88.89% and 95.56%, respectively. While, A-MMSE had AUC=0.875, Cut off $\leq 24$ had sensitivity and specificity values of 60.00% and 95.56%, respectively.
Table (2): The neuropsychological assessment tools among different groups

|                      | MCI               | Control N=45 | P value |
|----------------------|-------------------|--------------|---------|
|                      | Amnestic N=40     | Non amnestic N=5 |       |
| A-MMSE median (IQR)  | 23(22-25)         | 26(24-27)     | <0.0001a |
| Collateral history score median (IQR) | 9(7-11)         | 2(1-5)        | <0.0001a |
| Digit span score median (IQR) | 6(5-8)            | 8(6-9)        | <0.0001a |
| Verbal recall score median (IQR) | 14(12-19)     | 15(15-30)     | <0.0001a |
| Animal fluency score median (IQR) | 8(6-10)          | 11(9-11)      | <0.0001a |
| Stick design score median (IQR) | 8(4-9)          | 9(6-10)       | <0.0001a |
| Go no Go score median (IQR) | 2(1-2)           | 2(2-2)        | <0.0001a |
| Abnormal John Mary story test n(%) | 7(17.5%)        | 1 (20%)       | 0.03b   |

a Kruskal-Wallis rank sum test, b Fisher's exact test

Table (3): The correlation between collateral history score and other neuropsychological tools:

| variable                | Rho   | P value |
|-------------------------|-------|---------|
| A-MMSE                  | -0.695| <0.0001 |
| Digit span              | -0.680| <0.0001 |
| Animal fluency          | -0.709| <0.0001 |
| Verbal recall           | -0.806| <0.0001 |
| Stick design            | -0.659| <0.0001 |

Spearman’s correlation

Table (4): The internal consistency of collateral history taking and its affection in different groups:

| Items                                                                 | Corrected Item-Total Correlation | Cronbach’s Alpha if Item Deleted | The studied sample | P value |
|-----------------------------------------------------------------------|----------------------------------|----------------------------------|--------------------|---------|
| Q1: Is he/she able to track someone or follow instructions successfully to a certain place? | 0.690 | 0.971 | 19(47.5%) 0 | 2(4.44%) | <0.0001 |
| Q2: Does he/she understand facial expressions and express emotions as sympathy, joy or sad suitable for current situation? | 0.673 | 0.971 | 17(42.5%) 0 | 2(4.44%) | <0.0001 |
| Q3: Does he/she forget taking medications?                            | 0.890 | 0.965 | 34(85%) 1(20%) | 2(4.44%) | <0.0001 |
| Q4: Can he/she keep track of movie or a TV series events and characters? | 0.918 | 0.964 | 37(92.5%) 2(40%) | 3(6.66%) | <0.0001 |
| Q5: Does he/she tell the same story to the same people repeatedly?    | 0.841 | 0.966 | 38(95%) 1(20%) | 2(4.44%) | <0.0001 |
| Q6: Does he/she prefer to use to do lists and reminders than usual?   | 0.915 | 0.964 | 39(97.5%) 2(40%) | 6(13.33%) | <0.0001 |
| Q7: Does he/she find it difficult to find a specific word or expression, for example, does he prefer to say (my daughter) instead of telling (her name)? | 0.876 | 0.965 | 37(92.5%) 0 | 3(6.66%) | <0.0001 |
| Q8: Is it difficult for him/her to make decisions?                    | 0.889 | 0.965 | 31(77.5%) 0 | 3(6.66%) | <0.0001 |
| Q9: Did he/she become less fond of family or friends gatherings than usual? | 0.879 | 0.965 | 30(75%) 0 | 2(4.44%) | <0.0001 |
| Q10: Does he/she need repeated instructions to perform a task?        | 0.880 | 0.965 | 38(95%) 4(80%) | 0 | <0.0001 |
| Q11: Does he/she take longer duration to accomplish usual tasks?      | 0.843 | 0.966 | 36(90%) 4(80%) | 3(6.66%) | <0.0001 |
Table (5): The accuracy of different tools for detecting MCI

|                        | Cut off point | AUC      | P value    | Sensitivity | Specificity |
|------------------------|---------------|----------|------------|-------------|-------------|
| Collateral history score | >3            | 0.935    | <0.0001    | 88.89       | 95.56       |
| MMSE score             | ≤24           | 0.875    | <0.001     | 60.00       | 95.56       |
| Immediate memory story a | ≤7            | 0.958    | <0.001     | 91.1        | 95.56       |
| Delayed memory story a  | ≤3            | 0.962    | <0.001     | 86.7        | 97.8        |
| Immediate memory story b | ≤8            | 0.966    | <0.001     | 84.44       | 95.56       |
| Delayed memory story b2 | ≤4            | 0.969    | <0.001     | 91.1        | 95.56       |
| Total verbal recall     | ≤22           | 0.974    | <0.001     | 91.1        | 95.56       |
| Animal fluency          | ≤11           | 0.944    | <0.0001    | 88.89       | 88.89       |
| Go no Go test           | ≤2            | 0.862    | <0.0001    | 82.2        | 86.67       |
| Total stick design      | ≤9            | 0.877    | <0.0001    | 80.00       | 86.4        |
| Digit forward           | ≤5            | 0.838    | <0.0001    | 75.56       | 80          |
| Digit backward          | ≤3            | 0.948    | <0.0001    | 100         | 84.44       |
| Total digit span        | ≤8            | 0.934    | <0.0001    | 91.1        | 86.4        |

Discussion:

The present study confirmed that the designed collateral history questions score discriminated well between the MCI and normal cognition among a sample of elderly diabetics attending outpatient clinics. It had excellent accuracy to discriminate MCI (area under curve = 0.935, P < 0.0001). At cut-off ≥ 3, sensitivity and specificity values were 88.89% and 95.56%, respectively. The score has high internal reliability with Cronbach’s alpha =0.969.

In our study, the collateral history score was better than the A-MMSE as a screening instrument for MCI. This may be due to the low educational level in our participants, as illiterate accounted for 32 (71.1%) of cases and 28 (62.2%) among controls. It has been previously reported that MMSE is literacy dependent tool. It has a high misclassification error for older adults who are illiterate.[33] The MMSE diagnostic cut offs are based on education-specific norms equations.[34,35]

The informant based questionnaires have the advantage of being literacy independent, informant’s view has been used to construct the widely used IQCODE which was initially applied to the Australian population and has been reported as a reliable screening tool for dementia.[36] This was followed by its validation among those with low education in many populations with like Thai[37], Chinese[38], Brazilian[39], etc.

The IQCODE was also validated for screening MCI[21] and early Alzheimer’s disease. [40]. However, the IQCODE uses a Likert scale survey, where the intervals between points do not translate equal changes for all respondents, for example, the differences between a bit improved, not much change, and a bit worse. Therefore, this study aimed to evaluate the accuracy of a brief informant questionnaire involving all cognitive domains that does not require qualified trained practitioner to administer. This is an attempt to disseminate cognitive screening in diabetic patients beyond skilled memory clinics to allow for better diabetes clinical management. The development of a standardized yet a simple way of including informant data into cognitive assessment allows for more primary physicians adherence to the clinical guidelines for diabetes management in the elderly and perform a comprehensive assessment for their diabetic patients. The tool is simple and can be administered in paper form, on the telephone, or in electronic format.

The simplicity of the collateral history score didn’t come at the expense of its accuracy. Table 5 showed that it was more accurate than MMSE, it had a comparable accuracy to all the objective neuropsychological tests used for cognitive assessment in the current study.

However, the informant’s view can be biased by the cognitive function and the mood of the informant and the subjective complaints of the patient. Therefore, prescreening of informants may be recommended. The age, degree of contact, mood, and cognitive ability of the informant, and the nature of the informant-patients relationship should be evaluated.[41].

This study has some limitations. First, CT/MRI brain was not performed so the score neuroimaging correlates was not available. Second, the prescreening of the informant was not performed, only the primary caregiver was allowed to complete the form. Thirdly, whether collateral history score alone would be sufficient for use in research setting needs further evaluation.
Moreover, further research is needed to determine the collateral history accuracy to identify older diabetic with dementia and to include the symptoms of severe neurocognitive decline.

**Conclusion:** collateral history is an accurate, reliable, and brief tool of MCI screening in the elderly with diabetes in clinical settings.

**Conflict of interest:** The authors declare no conflicts of interest with respect to the authorship and publication of this article.

**Data availability:** data and the Arabic form of collateral history will be provided upon request

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**References**

1. International Diabetes Federation, Sinclair A, Dunning T, Colagiuri S. Managing older people with type 2 diabetes: global guideline. 2013.
2. American Geriatrics Society Expert Panel on the Care of Older Adults with Diabetes Mellitus. Guidelines Abstracted from the American Geriatrics Society Guidelines for Improving the Care of Older Adults with Diabetes Mellitus: 2013 Update. J Am Geriatr Soc [Internet]. 2013 Nov [cited 2021 Mar 20];61(11):2020–6. Available from: http://doi.wiley.com/10.1111/jgs.12514
3. LeRoith D, Biessels GJ, Braithwaite SS, Canauveva FF, Draznin B, Halter JB, Hirsch IB, McDonell ME, Molitch ME, Murad MH, Sinclair AJ. Treatment of Diabetes in Older Adults: An Endocrine Society* Clinical Practice Guideline. J Clin Endocrinol Metab [Internet]. 2019 May 1 [cited 2021 Mar 20];104(5):1520–74. Available from: https://academic.oup.com/jcem/article/104/5/1520/5413486
4. Committee Report: Glycemic targets for elderly patients with diabetes: Japan Diabetes Society (JDS)/Japan Geriatrics Society (JGS) Joint Committee on Improving Care for Elderly Patients with Diabetes. J Diabetes Investig [Internet]. 2017 Jan [cited 2021 Mar 20];8(1):126–8. Available from: http://doi.wiley.com/10.1111/jdi.12599
5. California Healthcare Foundation. Am C. Guidelines for Improving the Care of the Older Person with Diabetes Mellitus. J Am Geriatr Soc [Internet]. 2003 May [cited 2021 Mar 20];51(5s):265–80. Available from: http://doi.wiley.com/10.1046/j.1532-5415.2003.51s.s.1.x
6. American Diabetes Association. 12. Older Adults: Standards of Medical Care in Diabetes—2021. Diabetes Care [Internet]. 2021 Jan [cited 2021 Mar 20];44(Supplement 1):S168–79. Available from: http://care.diabetesjournals.org/lookup/doi/10.2337/dc21-S012
7. Biessels GJ, Whitmer RA. Cognitive dysfunction in diabetes: how to implement emerging guidelines. Diabetologia [Internet]. 2020 Jan [cited 2021 Mar 20];63(1):3–9. Available from: http://link.springer.com/10.1007/s00125-019-04977-9
8. Cooper C, Sommerlad A, Lyketsos CG, Livingston G. Modifiable Predictors of Dementia in Mild Cognitive Impairment: A Systematic Review and Meta-Analysis. Am J Psychiatry [Internet]. 2015 Apr [cited 2021 Mar 20];172(4):323–34. Available from: http://ajp.psychiatryonline.org/doi/10.1176/appi.ajp.2014.14070 878
9. Kasprzak B, Bancher C, Eckert A, Förstl H, Fröhlich L, Hort J, Korczyn AD, Kressig RW, Levin O, Palomo MSM. Management of mild cognitive impairment (MCI): The need for national and international guidelines. World J Biol Psychiatry [Internet]. 2020 Sep 13 [cited 2021 Mar 20];21(9):579–94. Available from: https://www.tandfonline.com/doi/full/10.1080/15604403.2019.16 96473
10. Zhang H, Wang J, Sun T, Wang Z, Liu X, Yu X, Wang H. A randomized controlled trial of combined executive function and memory training on the cognitive and noncognitive function of individuals with mild cognitive impairment: Study rationale and protocol design. Alzheimers Dement Transl Res Clin Interv [Internet]. 2018 Jan [cited 2021 Mar 20];4(1):556–64. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1016/j.trci.2018.09.00 4
11. Train the Brain Randomized. Toward a randomized trial on the effects of a combined physical/cognitive training in aged MCI subjects: the Train the Brain study. Sci Rep [Internet]. 2017 Apr [cited 2021 Mar 20];7(1):39471. Available from: http://www.nature.com/articles/srep39471
12. Folstein MF, Folstein SE, McHugh PR. “Mini-mental state.” J Psychiatr Res [Internet]. 1975 Nov [cited 2021 Mar 20];12(3):189–98. Available from: https://linkinghub.elsevier.com/retrieve/pii/0022395675900266
13. Mathuranath PS, Nestor PJ, Berrios GE, Rakowicz W, Hodges JR. A brief cognitive test battery to differentiate Alzheimer’s disease and frontotemporal dementia. Neurology [Internet]. 2000 Dec 12 [cited 2021 Mar 20];55(11):1613–20. Available from: http://www.neurology.org/cgi/doi/10.1212/wnl.0000434309.85 312.19
14. Tariq SH, Tumosa N, Chibnall JT, Perry MH, Morley JE. Comparison of the Saint Louis University Mental Status Examination and the Mini-Mental State Examination for Detecting Dementia and Mild Neurocognitive Disorder—A Pilot Study. Am J Geriatr Psychiatry [Internet]. 2006 Nov [cited 2021 Mar 20];14(11):900–10. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1064748112608690
15. Nasreddine ZS, Phillips NA,alletirian V, Charbonneau S, Whitehead V, Collin I, Cummings JL, Chertkow H. The Montreal Cognitive Assessment, MoCA: A Brief Screening Tool For Mild Cognitive Impairment: MOCA: A BRIEF SCREENING TOOL FOR MCI. J Am Geriatr Soc [Internet]. 2005 Apr [cited 2021 Mar 20];53(4):656–9. Available from: http://doi.wiley.com/10.1111/j.1532-5415.2005.53221.x
16. Brodaty H, Kemp NM, Low L-F. Characteristics of the GPCOG, a screening tool for cognitive impairment. Int J Geriatr Psychiatry [Internet]. 2004 Sep [cited 2021 Mar 20];19(9):870–2. Available from: http://doi.wiley.com/10.1002/gps.1167
17. Yancar Demir E, Özcan T. Evaluating the relationship between education level and cognitive impairment with the Montreal Cognitive Assessment Test: Education, cognition, MoCA. Psychogeriatrics [Internet]. 2015 Sep [cited 2021 Mar 20];5(3):186–90. Available from: http://doi.wiley.com/10.1111/psgy.12093
18. Inzelberg R, Schechtman E, Abulf A, Masarwa M, Mazarib A, Strugatsky R, Farrer LA, Green RC, Friedland RP. Education effects on cognitive function in a healthy aged Arab population. Int Psychogeriatr [Internet]. 2007 Jun [cited 2021 Mar 20];19(2):1903–603. Available from: https://www.cambridge.org/core/product/identifier/S1041667307000078/type/journal_article
19. Alves L, Simoes MR, Martins C, Freitas S, Santana I. Premorbidity IQ Influence on Screening Tests’ Scores in Healthy Patients and Patients With Cognitive Impairment. J Geriatr Psychiatry Neurol [Internet]. 2013 Jun [cited 2021 Mar 20];26(2):117–26. Available from: http://journals.sagepub.com/doi/10.1177/0891987713484196
20. Quinn TJ, Fearon P, Young C, Noel-Storr AH, McShane R, Stott DJ. IQCODE for the diagnosis of Alzheimer’s disease dementia and other dementias within a secondary care setting. In: The Cochrane Collaboration, editor. Cochrane Database of Systematic Reviews [Internet]. Chichester, UK: John Wiley & Sons, Ltd; 2013 [cited 2021 Mar 20]. p. CD010772. Available from: http://doi.wiley.com/10.1002/14659899.CD010772
21. Li F, Jia X-F, Jia J. The Informant Questionnaire on Cognitive Decline in the Elderly Individuals in Screening Mild Cognitive Impairment With or Without Functional Impairment. J Geriatr Psychiatry Neurol [Internet]. 2012 Dec [cited 2021 Mar 20];25(4):227–32. Available from: http://journals.sagepub.com/doi/10.1177/0891987712464822
22. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders [Internet]. Fifth Edition. American Psychiatric Association; 2013 [cited 2021 Mar 20]. Available from: https://psychiatryonline.org/doi/book/10.1176/appi.books.978 0890425396
23. El Oki M, El banouby MH, Mortagy AK. Prevalence of AD and other types of dementia in Egypt. In: International Psychogeriatrics. 2001. p. 114.
24. Wechsler D. Wechsler Memory Scale—(WMS—II) technical and interpretive manual. 4th ed. San Antonio: Pearson; 2009.
25. Grégoire J, Van Der Linden M. Effect of age on forward and backward digit spans. Aging Neuropsychol Cogn [Internet]. 1997 Jun [cited 2021 Mar 20];4(2):140–9. Available from: http://www.tandfonline.com/doi/abs/10.1080/13825589708356642
26. Abdel Aziz K, Khatier MS, Emara T, Tawfik HM, Rasheed Y, Mohammedin AS, Tolba MF, El-Gaby DA, Qassem T. Effects of age, education, and gender on verbal fluency in healthy adult Arabic-speakers in Egypt. Appl Neuropsychol Adult [Internet]. 2017 Jul 4 [cited 2021 Mar 20];24(4):331–41. Available from: https://www.tandfonline.com/doi/full/10.1080/23279095.2016.1185424
27. Dubois B, Slachokovsky A, Litvan I, Pillon B. The FAB: A frontal assessment battery at bedside. Neurology [Internet]. 2000 Dec 12 [cited 2021 Mar 20];55(1):1621–6. Available from: http://www.neurology.org/cgi/doi/10.1212/WNL.55.11.1621
28. Baiyewu O, Unverzagt FW, Lane KA, Gureje O, Ogunniyi A, Musick B, Gao S, Hall KS, Hendrie HC. The Stick Design test: A new measure of visuoconstructual ability. J Int Neuropsychol Soc [Internet]. 2005 Sep [cited 2021 Mar 20];11(05). Available from: http://www.journals.cambridge.org/abstract_S1355617705050507X
29. Perner J, Wimmer H. “John thinks that Mary thinks that...” attribution of second-order beliefs by 5- to 10-year-old children. J Exp Child Psychol [Internet]. 1985 Jun [cited 2021 Mar 20];39(3):437–71. Available from: https://linkinghub.elsevier.com/retrieve/pii/0022096585900517
30. Petersen RC. Mild cognitive impairment as a diagnostic entity. J Intern Med [Internet]. 2004 Sep [cited 2021 Mar 20];256(3):183–94. Available from: http://doi.wiley.com/10.1111/j.1365-2769.2004.01388.x
31. Rasheed Y, Adly NN, Ahmed RM, Amer MS. Salivary amyloid β42 levels in mild cognitive impairment among aged diabetics. Eur Geriatr Med [Internet]. 2019 Aug [cited 2021 Mar 20];10(4):631–6. Available from: http://link.springer.com/10.1007/s41999-019-00190-4
32. Bland JM, Altman DG. Correlation in restricted ranges of data. BMJ [Internet]. 2011 Mar 11 [cited 2021 Mar 21];342(mar11 1):d556–d556. Available from: https://www.bmj.com/lookup/doi/10.1136/bmj.d556
33. Scauzofca M, Almeida OP, Vallada HP, Tasse WA, Menezes PR. Limitations of the Mini-Mental State Examination for screening dementia in a community with low socioeconomic status: Results from the Sao Paulo Ageing & Health Study. Eur Arch Psychiatry Clin Neurosci [Internet]. 2009 Feb [cited 2021 Mar 22];259(1):6–15. Available from: http://link.springer.com/10.1007/s00406-008-0827-6
34. Solias A, Skapinakis P, Degleris N, Pantoleon M, Katirtzoglou E, Politis A. [Mini Mental State Examination (MMSE): determination of cutoff scores according to age and educational level]. Psychiatr Psychiatr. 2014 Dec;25(4):245–56. Available from: http://link.springer.com/10.1007/s00190-014-0279-6
35. Kochhann R, Varela JS, Lisboa CS de M, Chaves MLF. The Mini Mental State Examination for screening of dementia in elderly people with low education. Int Psychogeriatr [Internet]. 2009 Jun [cited 2021 Mar 22];21(03):531. Available from: http://www.journals.cambridge.org/abstract_S1041610209008849
36. Ehrenesperger MM, Berres M, Taylor KI, Monsch AU. Screening properties of the German IQCODE with a two-year time frame in MCI and early Alzheimer’s disease. Int Psychogeriatr [Internet]. 2010 Feb [cited 2021 Mar 22];22(1):91–100. Available from: https://www.cambridge.org/core/product/identifier/S1041610209008849/type/journal_article
37. Jorm AF. Assessment of cognitive impairment and dementia using informant reports. Clin Psychol Rev [Internet]. 1996 Jan [cited 2021 Mar 22];16(1):51–73. Available from: https://linkinghub.elsevier.com/retrieve/pii/027273595000055X