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A Reliable Tool for Assessing MCI and Dementia: Validation Study of DemTect for Turkish Population

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Abstract

Background and Aim: Mild cognitive impairment (MCI) and dementia prevalence are expected to increase with aging. The DemTect is a very quick and easy tool to administer and recognize the early stages of dementia and MCI. In this study we aimed to evaluate the reliability and validity of a Turkish version of the DemTect and define cut off values for different age and educational levels. One of our aims is also to compare the sensitivity and specifity of the DemTect to other common screening tools. **Patients and Methods:** Fifty-four patients with MCI, 55 patients with dementia and 91 patients with subjective memory complaints (SMC) were enrolled in the study. The DemTect was translated into Turkish by forward-backward translation and compared with the Mini Mental State Examination (MMSE), the Quick Mild Cognitive Impairment Turkish version (QMCI-TR) and the Montreal Cognitive Assessment (MoCA). In order to test interrater reliability, the DemTect was administered to 11 patients, on the same day, by 2 trained raters. To establish test–retest reliability, the same rater scored the tool a second time on 11 patients within 2 weeks. **Results:** The median age of the patients was 73 (min-max: 65–90) years, 54.5% were female. We found a strong correlation between DemTect scores and the MMSE, the QMCI, and the MoCA ($r = 0.725$, $r = 0.816$, $r = 0.821$, respectively; $p < 0.001$). In ROC analysis, the cut-off point of the DemTect to differentiate MCI from SMC was 11.5 with 92.6% sensitivity, 91.2% specificity, AUC 0.973 and the cut-off point of the DemTect to differentiate dementia from SMC was 9.5 with 96.4% sensitivity, 100% specificity, AUC 0.916. Cronbach α was 0.823. Intraclass correlation coefficient was 0.873 (95% CI: 0.598–0.964) for interrater reliability and 0.966 (95% 0.777–0.982) for test-retest reliability (Cronbach $\alpha = 0.932$, 0.966 respectively). **Conclusion:** The DemTect is a very reliable tool to assess Turkish patients with MCI and dementia.

Keywords

cognitive screening, dementia, DemTect, mild cognitive impairment, older adults

Introduction

Dementia is a progressive neurodegenerative disease characterized by the deterioration of cognitive functions including learning, memory, orientation, language function, praxis, and executive functions. The most common cause of dementia is Alzheimer's disease (AD). The earliest sign of the disease is memory loss, with patients becoming dependent in basic activities of daily living in the advanced stages.[1] With an aging population and improvements in life expectancy, prevalence of dementia is expected to increase.[2] Forty-seven million people are

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estimated to be affected by dementia worldwide.[3] Mild cognitive impairment (MCI) is a transitional condition between normal cognition and dementia. Older adults with MCI are 3 times more likely to develop dementia over the next 2 to 5 years compared with age-matched controls.[4] The diagnosis is characterized by a change in cognition reported by the patient (or informant or clinician), the objective evidence of impairment in one or more cognitive domains (including memory), preservation of independence in functional abilities and the absence of dementia.[5] Many screening tools have been developed but the "ideal" cognitive screening instrument is lacking. The most widely used test is the Mini-Mental State Examination test (MMSE) but it is important to know that its sensitivity for detecting mild dementia is low and negative results do not rule out AD.[6] Additionally, the scores of the test are affected by education, age, and culture.[7] The Montreal Cognitive Assessment (MoCA) has a high sensitivity and specificity and seems to be superior to the MMSE in detecting patients with MCI.[8,9] However, in the Turkish validation study, the test has shown lower sensitivity and specificity than in the initial validation in English.[10]

The DemTect is a short screening instrument used for differentiating MCI from dementia.[11] The authors pointed out that test was highly sensitive with a short administration time including scoring as 8–10 minutes, well accepted by patients, easy to administer, and after score transformation, independent of age and education. The sensitivity of the DemTect ranges between 83% and 100% for AD patients, 67% and 86% for patients with MCI, and 90% for vascular dementia patients; the specificity ranges between 90% and 100%, in previous studies.[11-14] A cut-off score of ≤ 13 was detected for DemTect in a validation study with 18-fluoro-2-deoxyglucose positron emission tomography ($AUC = 0.780$, $p = 0.006$).[14] Retest reliability was shown to be perfect in a screening study for dementia patients.[12] The correlation between the MMSE and the total transformed score of the DemTect was found significant ($p < 0.01$ for Control group, AD and MCI patients).[11] Additionally, with the formula of $MMSE = 0.567 \times$ DemTect score plus 19.997, DemTect scores could be transformed into MMSE scores. DemTect scores only corresponded to MMSE scores higher than 20 which shows that the DemTect is preferable for detecting cognitive dysfunction in the early stages while the MMSE is more useful for severe stages of dementia.

The aim of this study was to validate the Turkish version of the DemTect in geriatric population and define cut off values for different age and educational levels. The second aim of the study is, to compare the sensitivity and specifity of the DemTect to other common screening tools for detection of cognitive impairment.

Methods

Patients

Consecutive patients aged ≥ 65 years referred to a university hospital geriatric medicine outpatient clinic between May 2017 and May 2018 were included in this study. Fifty-four patients with MCI, 55 with AD, and 91 with subjective memory complaints (SMC) were enrolled. Demographic characteristics of the patients such as age, gender, and duration of education were recorded on their first visit. Patients were divided into 4 groups according to their age and education level.

The diagnosis of dementia was based on the original National Institute of Aging and Alzheimer's Association (NIA-AA) criteria for Alzheimer's Disease (AD) and the major neurocognitive disorder definition on the Diagnostic and Statistical Manual of Mental Disorders-V (DSM-V).[15,16] The diagnosis of MCI was made according to Petersen's criteria.[17] All of the MCI patients enrolled in the study were amnestic MCI patients.

Participants were assessed by a consultant geriatrician who was blind to the scores of the aforementioned cognitive screening tests. Participants were categorized into 3 groups (SMC, MCI, or dementia) by this same geriatrician after anamnesis, clinical examination, neuropsychological assessment performed by a trained psychologist using categorical fluency, abstract thinking, praxis, clock drawing, neuroimaging, and the Clinical Dementia Rating (CDRD) test.[18]

All patients underwent comprehensive geriatric assessment to evaluate daily living and instrumental daily living activities, nutritional status, cognitive and mood disorders; including Katz activities of daily living,[19] Lawton Brody instrumental activities of daily living,[20] Yesavage Depression Scale[21] and Mini Nutritional Assessment–Short Form.[22]

Patients with severe dementia, clinically active cerebrovascular disease or other neurological conditions resulting in cognitive impairment, psychiatric disorders including major depressive disorder (patients who had depression diagnosis and who were on antidepressant therapy), delirium in the last 3 months, and/or severe visual and hearing impairment were excluded from the study.

The Screening Instruments

Other cognitive screening tests, including the Mini-Mental State Examination (MMSE), the Montreal Cognitive Assessment (MoCA), and the Quick Mild Cognitive Impairment (QMCI-TR) were performed on every patient.

The DemTect screen is comprised of 5 subtests: word list, number transcoding, verbal fluency, digit span reverse, and word list delayed recall. The test has a total score of 18 and takes 8–10 minutes to complete. For each subtest, the results are assessed separately for those aged 60 and above, and those under the age of 60. The maximum scores for each subtest ranges from 3 (word list, number transcoding, digit span) to 4 (verbal fluency) and up to 5 (delayed recall). Additionally, an education correction is provided. Here, it was defined as adding one point is to the transformed total score in subjects with only basic education ($\leq$11 years). Due to the transformed total DemTect scores, the recommended cut-offs are interpreted as 13–18 points appropriate for the subjects age, 9–12 points MCI or ≤ 8 points suspected dementia.[11]

The MoCA has 7 subtests: visuospatial/executive, naming, attention, language, abstraction, delayed recall, and orientation. It is scored out of 30 points (score range: 0–30, impaired to

normal) and takes approximately 10 minutes to complete. The recommended cut-off for cognitive impairment is <26 out of 30 (8) and ≤21 for Turkish population.[10]

The QMCI consists of 6 different categories which are orientation, registration, clock drawing, delayed recall, verbal fluency, and logical memory. It is scored out of 100 points. The recommended cut-off for cognitive impairment is 62 out of 100.[23] The QMCI has been found to have higher accuracy than the MoCA in discriminating MCI in the Turkish population.[24]

The 30-point MMSE (score range: 0–30, impaired to normal) was used and <24 scores was considered as cognitive impairment.[25]

Translation and Adaptation Process

A native speaking translator translated the DemTect into Turkish using a forward–backward translation approach. The Turkish version was reviewed by a committee including health-care professionals fluent in Turkish. A professional, native English-speaking translator, without knowledge of the concepts behind the screening tool, completed the back-translation. After the back-translation the committee approved the translated version. No further changes were necessary. The final version of the DemTect screen was tested on a small group of patients with normal cognition before it was used in this study.

Reliability

In order to test interrater reliability, the DemTect screen was administered to 11 patients (with MCI or dementia), sequentially, on the same day, in different rooms by the 2 trained raters blind to the eventual diagnosis. The same raters scored the DemTect tool a second time on the same 11 patients (with MCI or dementia) within 2 weeks to establish test–retest reliability.

Statistical Analyses

All statistical analyses were conducted using IBM SPSS Statistics ver. 23 (IBM Corp., Armonk, NY). Data were presented as mean ± SD for normally distributed variables and as median (min-max) for non-parametric variables. Number and frequencies were used for categorical variables.

For non-parametric variables (age, Katz, Lawton-Brody, Yesavage Depression Scale (YDS) and Mini Nutritional Assessment scores (MNA)), the difference between the all groups was analyzed with the *Kruskal Wallis* and post hoc analyses were performed with the *Mann Whitney U* test. For categorical variables (sex, educational level), the difference among the groups was compared with the *Chi-square* test. *One-way Analysis of Variance (ANOVA)* was used to compare DemTect and other test scores among the 3 groups (SMC, MCI, and dementia). P value <0.05 was considered statistically significant. Post hoc testing was performed using *Tukey Multiple Comparisons* test. For testing construct validity, the *Pearson or Spearman Correlation* test was used to determine the correlation between the DemTect and the other tests. The *intraclass correlation coefficient (ICC)* was used to determine inter-rater and intra-rater (test-retest) reliabilities. The diagnostic accuracy of the instruments was analyzed by measuring the area under the curve (AUC) from *receiver operating characteristic (ROC) curve* analysis. The optimal cut-off score was calculated from the ROC curves for each tool. To test the effects of age and education, binary logistic regression was used.

Ethical Statement

Ethical approval was obtained from the local Ethical committee with the ID: GO 17/350-19 number. This research was completed in accordance with the guidelines of the Helsinki Declaration. Written informed consent was obtained from all participants and it was further obtained from the caregivers of patients with dementia.

Results

Demographic Characteristics

A total of 200 patients (54 MCI, 55 with AD and 91 with SMC) were included. The median age of the patients overall was 73 (min-max: 65–90) years, 54.5% were female. Education time was less than 5 years in 31% of the study population. The age variable was different between the SMC and MCI groups ($z = -2.160$, $p = 0.031$), between the SMC and Dementia groups ($z = -4.775$, $p < 0.001$) and between the MCI and Dementia groups ($Z = -2.426$, $p = 0.015$). These results suggest that patients with dementia and with MCI were significantly older than the SMC group. Comprehensive geriatric assessment scores and demographic characteristics are shown in Table 1.

Female patients were higher than males in the MCI and dementia groups and lower in the SMC group ($X^2 = 6.836$, $p < 0.033$). Educational level of patients in the SMC group was found to be significantly higher than in patients in the MCI and dementia groups. However, the educational levels of patients in the MCI and dementia groups were similar, this indicates that the eductional level between SMC and dementia were significantly different ($X^2 = 25.029$, $p < 0.001$). The KATZ score was different between SMC and MCI ($z = -2.379$, $p = 0.017$), between SMC and dementia ($z = -4.992$, $p < 0.001$) and between MCI and dementia ($z = -2.481$, $p = 0.013$). These results suggest that KATZ scores were significantly higher in SMC and MCI groups than dementia group. The Lawton Brody score was different between SMC and MCI ($z = -2.563$, $p = 0.010$), between SMC and dementia ($z = -7.312$, $p < 0.001$) and between MCI and dementia ($z = -4.664$, $p < 0.001$). The results revealed that Lawton Brody scores were significantly higher in SMC and MCI groups than dementia group. The YDS score was different between SMC and MCI ($z = -2.318$, $p = 0.020$), between SMC and dementia ($Z = -2.232$, $p = 0.026$) and between MCI and dementia ($Z = -0.145$, $p = 0.885$). These results suggest that YDS scores were similar in MCI and dementia groups but lower in SMC group. The MNA scores were different between SMC and MCI ($z = -1.746$, $p =$

Table 1. Demographic Properties and Comprehensive Geriatric Assessment Scores of the Study Population.

	MCI (n = 54)	Dementia (n = 55)	SMC (n = 91)	x^2	P
Age (yrs)	75 (66–84)	78 (66–90)	71 (65–90)	22.932	<0.001
Sex (n, % female)	37 (68.5%)	30 (54.5%)	42 (46.1%)	6.836*	0.033
Education level (%)					
<5 yrs	48.2	43.6	13.2	25.029*	<0.001
≥5 yrs	51.8	56.4	86.8		
Katz	6 (3–6)	6 (0–6)	6 (5–6)	25.340	<0.001
Lawton Brody	8 (2–8)	6 (0–8)	8 (5–8)	58.494	<0.001
YDS	1 (0–10)	1 (0–13)	0 (0–8)	7.384	0.025
MNA	14 (9–14)	12 (5–14)	14 (10–14)	30.555	<0.001

SMC: Subjective Memory Complaint, MCI: Mild Cognitive Impairment, YDS: Yesavage Geriatric Depression scale, MNA: Mini Nutritional Assessment, CDR: Clinical Dementia Rating score, X^2: Chi-square. Results were shown as median (min-max) for non-parametric variables (age, Katz, Lawton-Brody, YDS and MNA scores), the difference between the all groups was analyzed with *Kruskal Wallis* and post hoc analyses was performed with *Mann Whitney U* test. For categorical variables (sex, educational level), the difference among the groups was compared with *Chi-square* test (*).CDR scores were 0 in the SMC groups, 0.5 in the MCI group and 1 in the dementia group.
Kruskall Wallis test, Chi-Square test, $p < 0.05$.

Table 2. Post hoc Analyses Results of the Group Variables Mann Whitney U test, $p < 0.05$.

Variable	Groups (I/J)	Z	P
Age	SMC/MCI	−2.160	0.031
	SMC/DEMENTIA	−4.775	<0.001
	MCI/DEMENTIA	−2.426	0.015
KATZ	SMC/MCI	−2.379	0.017
	SMC/DEMENTIA	−4.992	<0.001
	MCI/DEMENTIA	−2.481	0.013
Lawton Brody	SMC/MCI	−2.563	0.010
	SMC/DEMENTIA	−7.312	<0.001
	MCI/DEMENTIA	−4.664	<0.001
YDS	SMC/MCI	−2.318	0.020
	SMC/DEMENTIA	−2.232	0.026
	MCI/DEMENTIA	−0.145	NS
MNA	SMC/MCI	−1.746	NS
	SMC/DEMENTIA	−5.494	<0.001
	MCI/DEMENTIA	−3.137	0.002

SMC: Subjective Memory Complaint, MCI: Mild Cognitive Impairment, YDS: Yesavage Depression Scale, MNA: Mini Nutritional Assessment.

0.081), between SMC and dementia ($Z = -5.494$, $p < 0.001$) and between MCI and dementia ($Z = -3.137$, $p = 0.002$). These results suggest that MNA scores were similar in SMC and MCI groups but significantly lower in dementia group. Results of posthoc pairwise comparisons are shown in Table 2.

Consultant geriatrician assessment revealed that CDR scores were 0 in the SMC groups, 0.5 in the MCI group and 1 in the dementia group.

Results of the Screening Tools

Results from 1 way ANOVA indicate that the DemTect scores ($F = 262.019$, $p < 0.001$), MMSE scores ($F = 75.446$, $p < 0.001$), QMCI scores ($F = 188.788$, $p < 0.001$) and MOCA scores ($F = 181.003$, $p < 0.001$) were found to be different among the groups (see Table 3). As can be seen in Table 3, all scores were significantly different from each other among the 3 groups.

Results from post hoc analysis indicate that the DemTect score was different between SMC and MCI (Mean Difference $= 6.365$, $p < 0.001$), between SMC and dementia (Mean Difference $= 9.621$, $p < 0.001$), and between MCI and dementia (Mean Difference $= 3.256$, $p < 0.001$). These results indicate that DemTect scores were higher in the SMC than in the MCI and dementia groups. The DemTect scores were significantly different across all 3 categories (SMC/MCI, SMC/Dementia, MCI/Dementia) (See Tables 3 and 4).

The MMSE score was different between SMC and MCI (Mean Difference = 3.061, $p < 0.001$), between SMC and dementia (Mean Difference = 7.675, $p < 0.001$), and between MCI and dementia (Mean Difference = 4.614, $p < 0.001$). These results indicate that MMSE scores were found to be highest in SMC group and lowest in dementia groups (See Tables 3 and 4).

The QMCI score was different between SMC and MCI (Mean Difference = 18.067, $p < 0.001$), between SMC and dementia (Mean Difference = 34.374, $p < 0.001$), and between MCI and dementia (Mean Difference = 16.307, $p < 0.001$).These results indicate that QMCI scores were found to be highest in SMC group and lowest in dementia groups (See Tables 3 and 4).

The MoCA score was different between SMC and MCI (Mean Difference = 8.614, $p < 0.001$), between SMC and dementia (Mean Difference = 13.180, $p < 0.001$), and between MCI and dementia (Mean Difference = 4.567, $p < 0.001$). These results indicate that MoCA scores were found to be highest in SMC group and lowest in dementia groups (See Tables 3 and 4).

Reliability

With respect to reliability of DemTect, the intra-class correlation coefficient was 0.873 (95% CI: 0.598–0.964) for inter-rater reliability and 0.966 (95% 0.777–0.982) for intra-rater (test-retest) reliability.

Table 3. Results of 1 Way Analysis of Variance Test Determining the Difference Between Screening Tools ($p < 0.05$).

	SMC (n = 91)	MCI (n = 54)	Dementia (n = 55)	F	p
DemTect	14.44 ± 2.172	8.07 ± 2.760	4.82 ± 2.970	262.019	<0.001
MMSE	28.86 ± 1.252	25.80 ± 3.579	21.18 ± 5.803	75.446	<0.001
QMCI-TR	64.96 ± 8.451	46.89 ± 11.489	30.58 ± 12.360	188.788	<0.001
MoCA	22.78 ± 3.200	14.17 ± 5.094	9.60 ± 4.771	181.003	<0.001

SMC: Subjective Memory Complaint, MCI: Mild Cognitive Impairment, MMSE: Mini Mental State Examination, QMCI-TR: Quick Mild Cognitive Impairment, MoCA: Montreal Cognitive Assessment.

Table 4. The Post Hoc Analysis Results of the SMC, MCI and Dementia Groups. Tukey Multiple Comparison Test, $p < 0.001$.

Groups (I/J)	Mean Difference	p
DemTect		
SMC/MCI	6.365*	<0.001
SMC/Dementia	9.621*	<0.001
MCI/Dementia	3.256*	<0.001
MMSE		
SMC/MCI	3.061*	<0.001
SMC/Dementia	7.675*	<0.001
MCI/Dementia	4.614*	<0.001
QMCI-TR		
SMC/MCI	18.067*	<0.001
SMC/Dementia	34.374*	<0.001
MCI/Dementia	16.307*	<0.001
MoCA		
SMC/MCI	8.614*	<0.001
SMC/Dementia	13.180*	<0.001
MCI/Dementia	4.567*	<0.001

SMC: Subjective Memory Complaint, MCI: Mild Cognitive Impairment, MMSE: Mini Mental State Examination, QMCI-TR: Quick Mild Cognitive Impairment, MoCA: Montreal Cognitive Assessment.

Construct Validity

We found a positive and strong correlation between the DemTect scores and the MMSE, the QMCI, and the MoCA ($r = 0.725$, $r = 0.816$, $r = 0.821$, respectively; $p < 0.001$).

Cut-Off Values

Cut-off values for the DemTect, QMCI-TR, MoCA, and the MMSE including the AUC, Sensitivity, Specificity, PPV, and NPV are shown in Table 5. In ROC analysis, the cut-off point of the DemTect to differentiate MCI from SMC was 11.5 with 93% sensitivity, 91.2% specificity, AUC 0.973, the cut-off point of the DemTect to differentiate dementia from SMC was 9.5 with 96.4% sensitivity, 100% specificity, AUC 0.916 and the cut-off point to differentiate MCI from dementia was 7.5 with 83% sensitivity, 62% specifity, AUC 0.801. The Cronbach α was 0.823 (Figure 1) (Table 5).

Cut off values for the DemTect, the QMCI-TR, the MoCA and the MMSE according to the age and education are shown in Table 6. The cut-off point of the DemTect to differentiate MCI from SMC in patients younger than 75 years and with educational level less than 5 years was 9 with 66% sensitivity, 100% specificity, AUC 0.927, in patients younger than 75 years and with educational level greater than or equal to 5 years was 11.5 with 86% sensitivity, 94% specificity, AUC 0.962, in patients aged 75 years and older and with educational level less than 5 years was 11.5 with 85% sensitivity, 100% specificity, AUC 0.982 and in patients with aged 75 years and older and with educational level greater than or equal to 5 years was 11.5 with 100% sensitivity, 92% specificity, AUC 0.988.

The cut-off point of the DemTect to differentiate SMC from dementia in patients younger than 75 years and with educational level less than 5 years was 9 with 85% sensitivity, 100% specificity, AUC 0.875, in patients younger than 75 years and with educational level greater than or equal to 5 years was 9 with 100% sensitivity, 100% specificity, AUC 1.000, in patients aged 75 years and older and with educational level less than 5 years was 10 with 100% sensitivity, 100% specificity, AUC 1.000 and in patients aged 75 years and older and with educational level greater than or equal to 5 years was 10 with 95% sensitivity, 100% specificity, AUC 0.993.

The cut-off point of the DemTect to differentiate MCI from dementia in patients younger than 75 years and with educational level less than 5 years was 3.5 with 57% sensitivity, 83% specificity, AUC 0.690, in patients younger than 75 years and with educational level greater than or equal to 5 years was 7.5 with 87% sensitivity, 93% specificity, AUC 0.946, in patients aged 75 years and older and with educational level less than 5 years was 4.5 with 88% sensitivity, 78% specificity, AUC 0.895 and in patients aged 75 years and older and with educational level greater than or equal to 5 years was 8.5 with 87% sensitivity, 61% specificity, AUC 0.793.

Discussion

The results of this study indicate that the DemTect seems to be a valid and reliable screening tool to differentiate MCI and dementia from patients with SMC in Turkish geriatric population.

The cognitive screening tool, the DemTect, was first published in 2000 in a German version[12] and in 2004 in an English version.[11] Additionally Polish[26] and French[27] versions are being used in clinical practice. The DemTect has attracted much attention since then and is not only recommended by German national guidelines and authors reviewing cognitive screening tools but also by international guidelines and recommendations to be used as a brief cognitive test for early detection of dementia and mild cognitive impairment (MCI).[28,29] The DemTect is easy to perform (it takes about 8 minutes to administer), and provides an objective assessment of a patient's cognitive status. A major advantage is that it

Table 5. Cut-off Values for the DemTect, QMCI-TR, MoCA, and the MMSE Including the AUC, Sensitivity, Specificity, PPV, and NPV.

	Cutoff Value	AUC	Sensitivity, %	Specificity, %	PPV, %	NPV, %	p
SMC vs MCI							
DemTect	11.5	0.973	93	91	86	95	<0.001
QMCI-TR	52.5	0.896	74	93	86	86	<0.001
MoCA	19.5	0.909	85	92	86	91	<0.001
MMSE	27.5	0.830	64	87	74	80	<0.001
SMC vs Dementia							
DemTect	9.5	0.916	96	100	100	98	<0.001
QMCI-TR	53.5	0.989	98	92	88	99	<0.001
MoCA	18.5	0.982	96	94	91	97	<0.001
MMSE	26.5	0.916	82	94	89	90	<0.001
MCI vs Dementia							
DemTect	7.5	0.801	83	62	69	78	<0.001
QMCI-TR	43.5	0.822	83	63	70	78	<0.001
MoCA	12.5	0.743	72	67	70	70	<0.001
MMSE	24.5	0.754	70	78	76	72	<0.001

SMC: Subjective Memory Complaint, MCI: Mild Cognitive Impairment, QMCI-TR: Quick Mild Cognitive Impairment, MoCA: Montreal Cognitive Assessment, MMSE: Mini Mental State Examination.

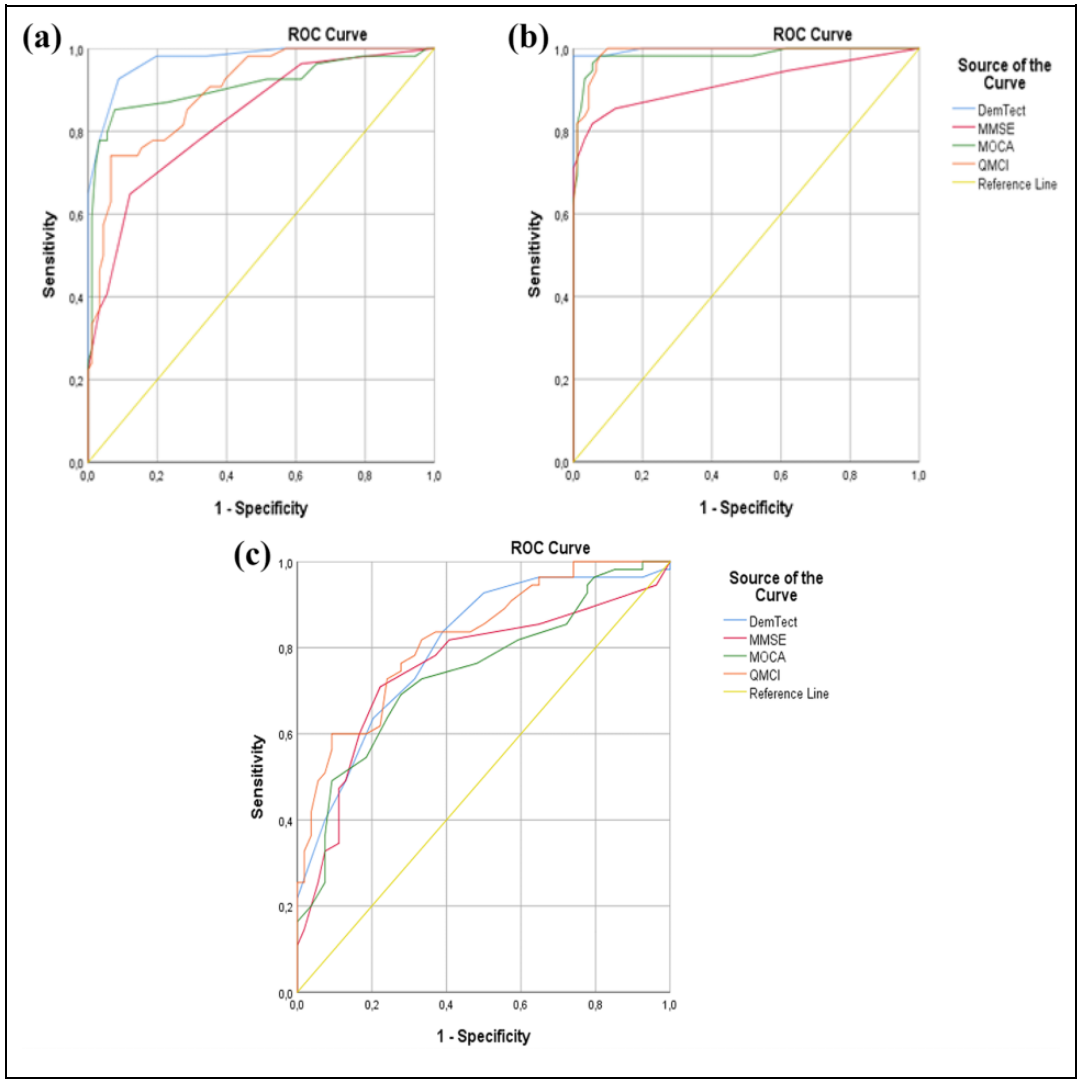

Figure 1. ROC curves for DemTect to differentiate MCI from SMC (1a) and dementia from SMC (1b) and MCI from dementia (1c). SMC: subjective memory complaint, MCI: mild cognitive impairment.

Table 6. Cut-off Values for the DemTect, QMCI-TR, MoCA, and the MMSE Including the AUC, Sensitivity, Specificity, PPV, and NPV According to Age (<75, ≥75) and Education (<5, ≥5 years).

	Cut-off value	AUC	Sensitivity, %	Specificity, %	PPV, %	NPV, %	p
SMC vs MCI							
	<75, <5						
DemTect	9	0.927	66	100	1	83	0.002
MMSE	26.5	0.875	58	100	1	80	0.005
QMCI-TR	48	0.766	66	87	75	81	0.049
MoCA	17.5	0.906	100	75	70	100	0.003
	<75, ≥5						
DemTect	11.5	0.962	86	94	89	92	<0.001
MMSE	29.5	0.692	93	42	49	91	0.024
QMCI-TR	64.5	0.906	86	74	66	90	<0.001
MoCA	19.5	0.809	60	98	95	81	<0.001
	≥75,<5						
DemTect	11.5	0.982	85	100	100	92	0.004
MMSE	27.5	0.904	85	100	100	92	0.006
QMCI-TR	42	0.830	64	100	100	82	0.049
MoCA	16	1	100	100	100	100	0.003
	≥75, ≥5						
DemTect	11.5	0.988	100	92	88	100	<0.001
MMSE	28.5	0.822	84	72	64	88	0.001
QMCI-TR	53	0.886	76	92	85	87	<0.001
MoCA	19.5	0.897	84	96	93	91	<0.001
SMC vs Dementia							
	<75,<5						
DemTect	9	0.875	85	100	100	92	0.015
MMSE	26	0.946	85	100	100	92	0.004
QMCI-TR	53	0.938	100	75	71	100	0.005
MoCA	14	0.982	100	87	82	100	0.002
	<75, ≥5						
DemTect	9	1	100	100	100	100	<0.001
MMSE	26.5	0.890	87	92	87	92	<0.001
QMCI-TR	55.5	0.995	100	94	91	100	<0.001
MoCA	17.5	0.928	87.5	100	100	93	<0.001
	≥75,<5						
	Cut-off Value	AUC	Sensitivity, %	Specificity, %	PPV, %	NPV, %	p
DemTect	10	1	100	100	100	100	0.002
MMSE	26	1	100	100	100	100	0.002
QMCI-TR	42	1	100	100	100	100	0.002
MoCA	13.5	0.971	94	100	100	97	0.004
	≥75, ≥5						
DemTect	10	0.993	95	100	100	97	<0.001
MMSE	27.5	0.855	73	88	79	84	<0.001
QMCI-TR	54	0.988	100	92	88	100	<0.001
MoCA	19.5	0.994	100	96	94	100	<0.001
MCI vs Dementia							
	<75,<5						
DemTect	3.5	0.690	57	83	77	65	0.176
MMSE	24.5	0.786	71	83	81	74	0.043
QMCI-TR	44	0.798	85	66	72	81	0.035
MoCA	8.5	0.869	85	91	91	86	0.009
	<75, ≥5						
DemTect	7.5	0.946	87	93	93	88	0.001
MMSE	26.5	0.829	87	86	86	87	0.011
QMCI-TR	48	0.867	87	80	82	86	0.005
MoCA	12	0.833	62	100	100	72	0.010
	≥75,<5						
DemTect	4.5	0.895	88	78	80	86	<0.001

(continued)

Table 6. (continued)

	Cut-off value	AUC	Sensitivity, %	Specificity, %	PPV, %	NPV, %	p
MMSE	23.5	0.807	88	64	71	84	0.004
QMCI-TR	31.5	0.905	94	78	81	93	<0.001
MoCA	8.5 ≥75, ≥5	0.782	82	71	74	79	0.008
DemTect	8.5	0.793	87	61	69	82	0.004
MMSE	26.5	0.679	65	84	81	70	0.078
QMCI-TR	40.5	0.793	73	76	76	73	0.004
MoCA	12.5	0.722	56	84	78	65	0.029

SMC: Subjective Memory Complaint, MCI: Mild Cognitive Impairment, MMSE: Mini Mental State Examination, QMCI-TR: Quick Mild Cognitive Impairment, MoCA: Montreal Cognitive Assessment.

can be carried out by a number of different trained staff such as nurses and doctors. This is an efficient use of time.

In the original study, Kalbe E and colleagues demonstrated that the DemTect was superior in identifying both the MCI and the AD group as compared to the MMSE, with high sensitivities of 80% and 100%, respectively. The cut-off value was 8 points for the diagnosis of probable AD and 13 points for the diagnosis of MCI.[11] In the validation study of the Polish language version, the DemTect was found to be more sensitive in identifying cognitive impairment than the MMSE.[26] The cut-off values are 10 and 15 points for AD and MCI, respectively. In this study, results indicate that the cut-off values for the DemTect were 11.5 to differentiate SMC from MCI with 93% sensitivity and 91% specificity, 9.5 to differentiate SMC from dementia with 96% sensitivity and 100% specificity and 7.5 to differentiate MCI from dementia with 83% sensitivity and 62% specificity. Cut-off values were lower for the Turkish population than in original study. This can be explained by cultural differences, the lower education level and higher illiteracy frequency of this geriatric population.[30] Furthermore, this may be due to the relatively small sample size to determine the clinically feasible cut-off value. Further studies with larger samples are needed to determine the cut-off values that can be used in clinical practice. Additional to the general cut off values, we determined cut off values for each education level and age groups. This is one of the strongest outcomes of our study. This is the first study comparing the DemTect with not only the MMSE but also with the QMCI-TR and the MoCA. When compared on age and education groups, the DemTect was not inferior to any of these tests. As such, the Demtect was found to be a reliable and brief tool to accurately detect MCI and dementia in the Turkish population.

Cognitive screening tools are affected by education level and scores may be lower even in the absence of dementia and this may negatively affect the evaluation of cognitive status in the geriatric population. One of the major advantages of the tool is that DemTect may be used in patients with low education level that providing an education and age correction allows for more accurate assessment.[11] Because there was an education and age effect in several subtests, corrections for both parameters are defined in the transformation algorithms. Thus, the final score was independent of age and education level. It is important to use such tests in a country with a low education level, such as Turkey, which has a rate of 19.6% illiterate older adults. Although the MMSE and the MoCA have cut off values according to the education level, older adults have difficulty in naming. It is known that the MoCA requires a minimum level of education of 5 years. The QMCI does not require such an education level and is thought to be more useful in low educated patients.[24] Increasing the number of short cognitive screening tests for low educated and illiterate patients is important for making a comprehensive assessment and detecting cognitive dysfunction easily at early stages. In this study, the Turkish version of the DemTect showed excellent accuracy for detecting MCI and dementia at different levels of education. These results reveal that the DemTect can be a choice of cognitive screening in patients with low literacy. The optimal cut-off values for the Turkish translations of the scales were different from those previously published in English. This can be explained by the cultural differences, lower levels of education in this study population, and the smaller sample size. Therefore, these cut-off values may not be appropriate for clinical practice. A larger study comparing the cutoff values should be conducted in order to determine the cutoff scores to be used in clinical practice.

The major limitation of the study is that the sample size was relatively small. As the power was not enough to determine generalizable cut-off scores, further studies should be conducted to determine cut-off values. Another point to be considered is that the groups were not matched for age and gender. However, it has been previously shown that gender has no significant effect on the results of cognitive screening tools.[31] Additionally we have conducted analyses for different age groups and different AUC values for each age group were determined. From these analyses, we have ruled out the effect of this limitation on results. We can say that groups not being age and gender match did not create bias on the results of the study. The study sample consisted of individuals with SMC, MCI, and dementia. Another limitation is that a sample of healthy, aged matched controls was not included. As we conducted the study in a geriatric medicine clinic, the number of patients without any memory complaints is very few.

Therefore, we included patients with subjective memory complaints as a control group. We think that this choice reflects real life better than normal controls. Therefore, this situation is not regarded as a limitation.

Conclusion

The DemTect is a very reliable and valid screening tool to assess MCI in Turkish population. We determined the validity of the tool for different age groups and education levels in this study. The construct validity of the DemTect as compared to other screening tools, was very strong. However further studies are required to find out representative cutoffs.

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