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Validation of the Turkish version of the Lewy body composite risk score

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ABSTRACT

The Lewy Body Composite Risk Score (LBCRS) has been developed to increase the sensitivity and specificity of the diagnosis attributable to Lewy body pathology outside of specialty centers. We aimed to assess the validity and reliability of the Turkish version of the LBCRS in patients with dementia with Lewy Bodies (DLB) and investigate the discriminative power of the test in Turkish patients with Alzheimer's disease (AD) and DLB, and control group. The sample population (n = 512) comprised DLB (n = 113), DLB-Mild Cognitive Impairment (MCI)(n = 12), AD (n = 42), AD-MCI (n = 21), and control group (n = 324). A significant group difference was observed in the Turkish version of the LBCRS scores of the five groups ($p < .001$). The Cronbach's α value was 0.82 (95% CI: 0.799–0.868). The test–retest reliability score of the scale was r = 0.94 and $p < .001$. The subscales of the LBCRS (motor and nonmotor subdomains of the disease) were determined to explain 65.961% of the total variance with an eigenvalue >1. In patients with DLB, the cutoff score of ≥3 showed sensitivity (92%) and specificity (81%) (area under the curve [AUC] = 0.883, 95% CI: 0.815–0.951), $p < .001$) compared with the AD. Compared to the control group, the cutoff score of ≥3 showed a sensitivity of 98% and specificity of 97% (AUC = 0.994, 95% CI: 0.989–0.999, $p < .001$). The Turkish version of LBCRS permits accurate diagnosis of DLB with high sensitivity and specificity. Also, it can be useful to inform the caregivers regarding the course of the disease during the follow-up.

KEYWORDS

Alzheimer's disease; dementia with lewy bodies; mild cognitive impairment; neuropsychological assessment; older adult

Introduction

In individuals aged above 65 years, the second most common neurodegenerative dementia is dementia with Lewy bodies (DLB) following Alzheimer's disease (AD) (Ballard et al., 2013; Yang et al., 2018). The disease accounts for approximately 5% of all dementia cases in older populations (Hogan et al., 2016). However, the true prevalence is much higher than the clinically recognized cases for several reasons (Jones & O'Brien, 2014).

DLB is a heterogeneous disease with cognitive and non-cognitive signs and symptoms (Farina et al., 2009; Isik et al., 2019). The main symptoms are progressive deterioration in memory with prominent cognitive fluctuations, visual hallucinations, rapid eye movement (REM) sleep behavior disorder, and parkinsonism with many supportive clinical features, including dysautonomia, antipsychotic sensitivity, repeated falls accompanied by postural instability, and neuropsychiatric features (McKeith et al., 2017). The disease symptoms occur in varying combinations and levels of severity in each patient, thus, making it challenging to diagnose (Dost et al., 2022; Hershey & Coleman-Jackson, 2019; Isik, 2010; Mueller et al., 2019). Therefore, in the early stages of the disease and in patients with mixed pathologies, challenges in the diagnosis of DLB are common (Chin et al., 2019). DLB is frequently misdiagnosed as AD, as reported in a recent meta-analysis (Rizzo et al., 2018), because symptoms of both diseases are similar and accompanying AD-type pathology is not uncommon in DLB (Echávarri et al., 2012). In contrast, patients with DLB have been reported to have a worse quality of life, leading to a higher caregiver burden and higher care costs than patients with AD (Mueller et al., 2018; Thomas et al., 2006). Patients with DLB had approximately two years shorter time to nursing home admission than those with AD (Rongve et al., 2014). The disease must be diagnosed promptly by setting comprehensive treatment strategies for avoiding certain medications such as antipsychotics and anticholinergics owing to the increased risk of sensitivity to them and initiation of cholinesterase inhibitors for the patients.

Considering all these aspects, accurate and early recognition of patients with DLB is critical. It was reported in a large autopsy series that the diagnostic criteria might not have adequate diagnostic accuracy to diagnose the disease definitely (Shim et al., 2013). Moreover, this diagnostic accuracy insufficiency appeared to be mostly outside the specialty centers underscoring a need for a functional

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standard scale suitable for clinical practice. In these contexts, based on autopsy-verified cases with DLB to improve the ability to detect the disease, a rating scale, the Lewy body composite risk score (LBCRS), has been developed. In LBCRS, aiming to increase the sensitivity and specificity of the diagnosis attributable to Lewy body pathology outside of specialty centers, consensus core, suggestive and supportive criteria were operationalized in a standardized manner (Karantzoulis & Galvin, 2013). The scale provides structured questions to be completed by the physician to assess clinical signs and symptoms highly associated with the underlying pathology. LBCRS consisting of both motor and nonmotor subdomains of the disease, has several advantages, including its brief duration, simply scoring the motor subdomains with yes/no without having to grade them, not confounded by the age and education of the patient. It could detect dementia and mild cognitive impairment owing to DLB and differentiate DLB from patients with AD and other dementias (Galvin, 2015). However, the validity of the scale has been demonstrated in only Korean older adults with dementia to date (Ryu et al., 2017); therefore, the utility of the scale should be further evaluated in other settings and populations. Therefore, we aimed to assess the validity and reliability of the Turkish version of the LBCRS in patients with DLB and investigate the discriminative power of the test in Turkish patients with AD and DLB, and healthy participants.

Materials and methods

Design

To evaluate the reliability and validity of the LBCRS, a cross-sectional and methodological study design was used. The Ethical Committee of the Dokuz Eylul University (Noninvasive Research Ethics Board) approved the study (approval number: 2018/11–44, date: May 3, 2018). Written consent was provided by the participants in accordance with the principles of the Declaration of Helsinki.

Participants

The data were collected between April 2020 and March 2022. The sample population (n = 512) comprised DLB (n = 113, clinical dementia rating [CDR] > 0.5), DLB-MCI (n = 12, CDR = 0.5), AD (n = 42), Mild Cognitive Impairment (AD-MCI, n = 21), and control groups (n = 324) were recruited from the outpatient department at the Department of Geriatrics in Dokuz Eylul University Hospital. All participants had undergone a comprehensive geriatric assessment (CGA) including a complete medical history evaluation, neurological and neuropsychological assessment, brain imaging, and the standard laboratory tests. Dementia was diagnosed using the Diagnostic and Statistics Manual of Mental Disorders-Fifth Edition (Roehr, 2013). The published clinical criteria were used for the clinical diagnosis of AD (McKhann et al., 2011) and DLB (McKeith et al., 2017). Additionally, most of the patients with dementia had cerebrospinal fluid biomarkers for AD. The control group consisted of patients who had forgetfulness despite normal CGA including normal cognitive assessment, physical, and neurological examinations, or those who attended our geriatric outpatient clinic for prevention programs because of other medical issues.

Patients with dementia, except those with probable AD (McKhann et al., 2011) and probable DLB (McKeith et al., 2017), were excluded from the study. Those with delirium, infection, malignancy, chronic inflammatory disease, and acute cerebrovascular disease were also excluded.

Data collection

Additionally, the results of LBCRS-TR; demographic characteristics (age, sex, and years of education); age-adjusted Charlson Comorbidity Index (ACCI) (Kahl et al., 2017); Mini-Mental State Examination (MMSE) (Güngen et al., 2002); Instrumental Activities of Daily Living (IADL) (Lawton & Brody, 1969); Geriatric Depression Scale (GDS) (Durmaz et al., 2018); and Epworth Sleepiness Scale (ESS) (Izci et al., 2008) were recorded. The severity of dementia was evaluated using the CDR (Morris, 1991) and its sum of boxes (CDR-SB). CDR comprises six domains, which are as follows: memory, orientation, judgment and problem-solving, community affairs, home and hobbies, and personal care. CDR score of 0 means no dementia; 0.5 for MCI or very mild dementia; and scores of 1, 2, or 3 represent mild, moderate, or severe dementia. For determining the comorbid conditions of the participants, the Charlson Comorbidity Index (Charlson et al., 1987) was used. Additionally, the caregiver burden inventory (Yildiz et al., 2016) was applied to the caregivers.

The Lewy body compound risk score (LBCRS)

LBCRS-TR comprises 10 questions; the motor dysfunctions are questioned in the first four questions, the fifth question evaluates sleep disorders, 6 and 7 determine fluctuation, question 8 tests behavioral disorders, while questions 9 and 10 test medical complaints and findings. It is determined whether the physical findings have occurred at least three times in the last six months. The question is answered as a yes or no, and negative answers receive 1 point. The maximum score is 10 points, with a higher probability of diagnosing LBD as the scale score increases. The duration of LBCRS-TR was 6.2 ± 2.1 min, according to our experience. Higher LBCRS scores indicate poor performance.

Statistical analysis

The Statistical Package for the Social Sciences version 22.0 (SPSS Inc., Chicago, IL, USA) and Analysis of Moment Structures version 25.0 were used for the statistical evaluation of the data. The demographics and characteristics of participants, LBCRS-TR, and other scales were analyzed using descriptive statistics. Reliability was determined using test–retest, Cronbach's alpha, and item-total correlations based on internal consistency and invariance.

Exploratory Factor Analysis and confirmatory factor analysis (CFA) were used to measure construct validity. The Kaiser-Meyer Olkin (KMO) coefficient and Bartlett Sphericity test were used to determine whether the data were sufficient and suitable for factor analysis. The principal component and varimax return methods were used to determine the scale's construct validity. For CFA, data were analyzed using fit indices.

To confirm the discriminative ability of LBCRS-TR, receiver operating characteristic (ROC) curves were drawn, where comparison groups were (1) DLB vs. AD; (2) DLB-MCI vs. AD-MCI; and (3) DLB vs. control groups. To determine the most appropriate cutoff scores, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were also calculated.

Translation of the LBCRS

The scale was translated from English to Turkish by the study investigators. Each item on the scale was examined for linguistic accuracy, significance, and conceptual equivalence. The scale was back-translated by a professional bilingual translator to ensure the accuracy of the translation.

Results

Demographics and participant characteristics

The mean age of the sample was 72.8 years (standard deviation [SD] = 7.97, min–max: 48–96), the mean education of 7.32 years (SD = 4.56, min–max: 0–20), 68.4% were women, the mean MMSE score was 24.46 (SD = 6.95, min–max: 1–30), and mean of CDR was 2.47 (SD = 4.23, min–max: 0–18).

The five groups were as follows: DLB (n = 113), DLB-MCI (n = 12), AD (n = 42), AD-MCI (n = 21), and control (n = 324). Demographics and characteristics of participants, LBCRS-TR score, and assessment results are presented in Table 1. A significant group difference was observed in the LBCRS-TR scores of the five groups ($F = 312{,}855$, df = 4, $p < .001$). Post-hoc comparisons of the LBCRS-TR scores showed significant differences with DLB-AD (Cohen's d = 1.60, $p < .001$), DLB-control group (Cohen's d = 5.04, $p < .001$), (DLB-MCI)-AD (Cohen's d = 2.03, $p < .001$), (DLB-MCI)- (AD-MCI) (Cohen's d = 1.65, $p < .001$), and (DLB-MCI)-control group (Cohen's d = 0.93, $p < .001$). The mean ACCI was 3.85 (SD = 1.7, min–max:1–11). The mean ACCI of DLB was significantly higher than that in other groups ($F = 74{,}547$, df = 4, $p < .001$). Post-hoc comparisons of the ACCI scores showed significant differences in DLB-AD, DLB-MCI, DLB-control, and (DLB-MCI)-control groups.

Reliability of the LBCRS-TR

The Cronbach's α value calculated for the LBCRS-TR was 0.82 (95% confidence interval [CI]: 0.799–0.868). Owing to the split-half analysis, Cronbach's α values of the first and second halves were 0.60 and 0.80, respectively. The Spearman–Brown coefficient was 0.81. An item-total correlation analysis was conducted to elucidate the relationship between the scores of the scale items and the total score of the scale. The correlations of the items with the total scale score were determined to be between 0.27 and 0.69.

Test–retest was administered to 48 participants, including 8 with MCI, 20 in the control groups, 8 with AD, and 12 with DLB. The mean retest period was 18–22 days. A significant positive relationship was observed between the test–retest score of the LBCRS-TR. The test–retest reliability score of the scale was r = 0.94 and $p < .001$. There was no significant difference at the 0.05 level owing to the t-test between the scores in the dependent groups.

Validity of the LBCRS-TR

Based on the factor analysis results, the KMO was 0.792, the Bartlett test result was $x^2 = 2{,}191.007$, and statistical significance was observed ($p < .001$). All the item's factor loadings were found to be > 0.30, and the two subscales were determined to explain 65.961% of the total variance with an eigenvalue > 1. Based on the CFA results, factor loadings were between 0.33 and 0.56. Model fit indicators were determined as follows: CFI

Table 1. Characteristics of participants among groups.

	DLB (n = 113)	DLB-MCI (n = 12)	AD (n = 42)	AD-MCI (n = 21)	Control group (n = 324)	*p* Value
Age[a] (years)	78.91 (7.12)	73.67 (7.91)	73.02 (9.23)	72.67 (7.18)	70.64 (7.05)	<.001
Gender, % female	61.9	50.0	69.0	57.1	81.8	.422
Education[a] (years)	5.50 (4.10)	8.08 (5.26)	7.38 (4.65)	6.58 (4.57)	7.97 (4.48)	<.001
CDR-SB[a]	8.99 (3.72)	3.04 (0.88)	7.31 (4.07)	4.13 (2.67)	0.01 (0.12)	<.001
CDR[a]	1.62 (0.72)	0.46 (0.14)	1.303 (0.72)	0.720 (0.43)	0.003 (0.04)	<.001
MMSE[a]	15.47 (4.62)	19.88 (7.26)	15.88 (6.65)	22.80 (3.38)	29.04 (1.14)	<.001
ACCI[a]	5.56 (1.37)	5.25 (0.87)	4.40 (1.43)	4.04 (0.81)	3.12 (1.36)	<.001
IADL[a]	9.07 (6.18)	18.08 (3.47)	12.93 (6.34)	15.83 (4.16)	21.39 (3.57)	<.001
Fluctuation % (n)	74.3 (84)	91.7 (11)	21.4 (9)	4.8 (1)	0.6 (2)	<.001
ESS[a]	7.23 (5.33)	8.75 (7.36)	5.12 (5.01)	5.69 (5.85)	5.08 (4.25)	.111
GDS[a]	0.42 (0.49)	0.25 (0.45)	0.40 (0.49)	0.47 (0.51)	0.42 (0.42)	<.001
Up&Go test[a] (seconds)	19.61 (12.24)	13.30 (4.26)	13.67 (6.11)	11.71 (3.44)	10.76 (4.07)	<.001
LBCRS-TR[a]	5.66 (1.85)	5.25 (2.05)	2.36 (1.97)	1.81 (1.40)	0.73 (0.87)	<.001
Caregiver Burden[a]	38.81 (22.72)	–	25.50 (18.37)	–	–	.113

Note: A *p* value less than .05 is statistically significant.

[a]Mean (SD); ACCI: age-adjusted Charlson Comorbidity Index; AD: Alzheimer's disease; CDR: clinical dementia rating; CDR-SB: clinical dementia rating (CDR) sum of boxes; DLB: dementia with Lewy bodies; ESS: Epworth Sleepiness Scale; GDS: Geriatric Depression Scale; IADL: Instrumental Activities Of Daily Living; LBCRS-TR: the Turkish version of the Lewy Body Composite Risk Score (LBCRS-TR); MCI: mild cognitive impairment; MMSE: Mini-Mental State Examination.

= 0.832, GFI = 0.843, IFI = 0.842, $\chi 2$/degrees of freedom ($\chi 2$/df) = 2.527, $p < .001$, and RMSEA = 0.071.

Concurrent validity of LBCRS-TR was performed, and the results are presented in Table 2. LBCRS-TR total score had significant correlations with ACCI, CDR, MMSE, IADL, cognitive fluctuation, ESS, and the Up&Go test.

Responses of the LBCRS-TR items across DLB, AD, MCI, and control groups scores of LBCRS-TR in each group had a different distribution. The frequency of response for LBCRS-TR items was calculated to examine the different distributions of responses to particular items in the five groups. The responses of the MCI and control groups showed lower responses than that of the DLB group. The MCI group revealed lower mean responses than the DLB group (Table 3).

Discrimination ability of the LBCRS-TR

The discrimination ability of the LBCRS-TR was examined to distinguish between DLB and other groups (AD, MCI, control groups) using ROC curves. Patients with LBD were compared with those with AD; the discrimination ability was striking owing to the area under the curve (AUC) of 0.883 (95%CI: 0.815–0.951). The cutoff score of ≥3 showed sensitivity of 92% and specificity of 81% (AUC = 0.883; 95% CI: 0.815–0.951, $p < .001$), PPV of 86%, and NPV of 92% compared with the AD (Figure 1). Compared to MCI, the cutoff score of ≥3 showed a sensitivity of 97% and specificity of 77% (AUC = 0.949, 95% CI: 0.904–0.994, $p < .001$), PPV of 94%, and NPV of 87% (Figure 2). And, compared to the control group, the optimal cutoff score of ≥3 showed a sensitivity of 98% and specificity of 97% (AUC = 0.994, 95% CI: 0.989–0.999, $p < .001$), PPV of 90%, and NPV of 99% (Figure 3). The 10-item LBCRS-TR performed moderately well in a native Turkish population in a clinical setting.

Discussion

This study demonstrated LBCRS-TR as a reliable and valid instrument for evaluating DLB in Turkish older adults with the power to distinguish patients with DLB from AD or cognitively healthy older adults with acceptable psychometric properties. It also demonstrated that LBCRS-TR has a highly satisfying sensitivity and specificity level, test–retest reliability, concurrent validity, as well as internal consistency to differentiate DLB.

Table 2. Results of concurrent validity with the LBCRS-TR.

Measure	Mean (SD)	r	*p* Value
Age (years)	72.81 (7.99)	0.212	<.001
Education (years)	6.47 (4.53)	−0.117	.011
ACCI	4.96 (1.58)	0.325	<.001
CDR	0.47 (0.79)	0.411	<.001
MMSE	24.54 (6.95)	−0.396	<.001
IADL	17.91 (6.57)	−0.373	<.001
GDS	0.29 (0.45)	0.078	.095
Fluctuation	0.45 (0.49)	0.718	<.001
ESS	5.71 (4.82)	0.199	.011

Notes: A *p* value less than .05 is statistically significant. ACCI: age-adjusted Charlson Comorbidity Index; CDR: clinical dementia rating; ESS: Epworth Sleepiness Scale; GDS: Geriatric Depression Scale; IADL: Instrumental Activities Of Daily Living; LBCRS-TR: the Turkish version of the Lewy Body Composite Risk Score (LBCRS-TR); MMSE: Mini-Mental State Examination.

Table 3. Responses to items of the Turkish version of LBCRS in patients with DLB.

	DLB (n = 113)	DLB-MCI (n = 12)	AD (n = 42)	AD-MCI (n = 21)	Control group (n = 324)	*p* Value
Bradykinesia n (%)	32 (28.3)	4 (33.3)	6 (14.3)	0 (0)	3 (0.9)	<.001
Rigidity n (%)	57 (50.4)	2 (16.2)	3 (7.1)	1 (4.8)	2 (0.6)	<.001
Postural instability n (%)	86 (76.1)	7 (58.3)	21 (50)	10 (47.6)	120 (37)	<.001
Tremor n (%)	63 (55.8)	7 (58.3)	9 (21.4)	11 (52.4)	12 (3.7)	<.001
Daytime sleepiness n (%)	47 (41.6)	5 (41.7)	14 (33.3)	4 (19)	43 (13.3)	<.001
Illogical thoughts n (%)	84 (74.3)	11 (91.7)	9 (21.4)	1 (4.8)	0 (0)	<.001
Staring spells n (%)	31 (27.4)	4 (33.3)	6 (14.3)	0 (0)	2 (0.6)	<.001
Hallucinations n (%)	93 (82.3)	8 (66.7)	12 (28.6)	2 (9.5)	0 (0)	<.001
RBD n (%)	98 (86.7)	11 (91.7)	11 (26.2)	6 (28.6)	35 (10.8)	<.001
Autonomic insufficiency n (%)	49 (43.4)	4 (33.3)	10 (23.8)	3 (14.3)	19 (5.9)	<.001
LBCRS-TR, mean (SD)	5.66 (1.85)	5.25 (2.05)	2.36 (1.97)	1.81 (1.40)	0.73 (0.87)	<.001

Notes: RBD: REM sleep behavior disorder; LBCRS-TR: Turkish version of the Lewy Body Composite Risk Score (LBCRS-TR). A *p* value less than .05 is statistically significant.

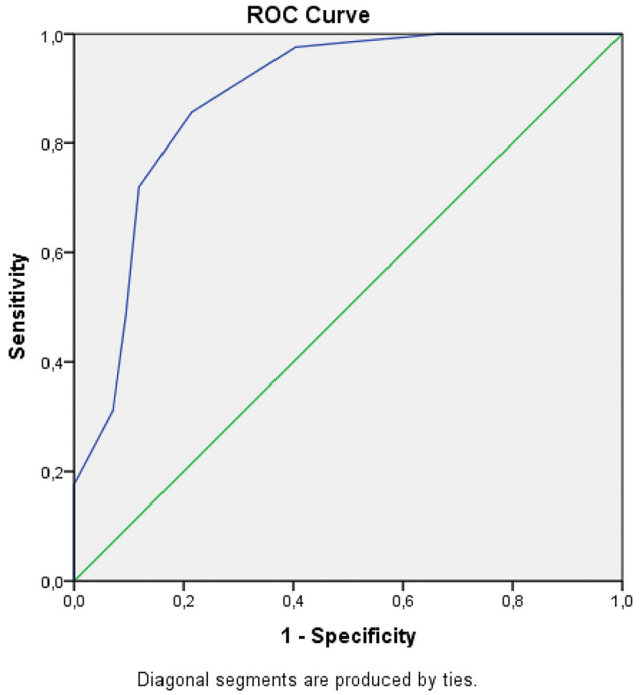


Figure 1. Receiver operating characteristic (ROC) test analysis (dementia with Lewy bodies [DLB] and Alzheimer's disease [AD]). ROC test analysis showed a sensitivity of 92%, a specificity of 81%, PPV of 86%, and NPV of 92% with a cut-off of 3. The area under the ROC curve is 0.883 (confidence interval [CI] 0.815–0.951: $p < .001$).

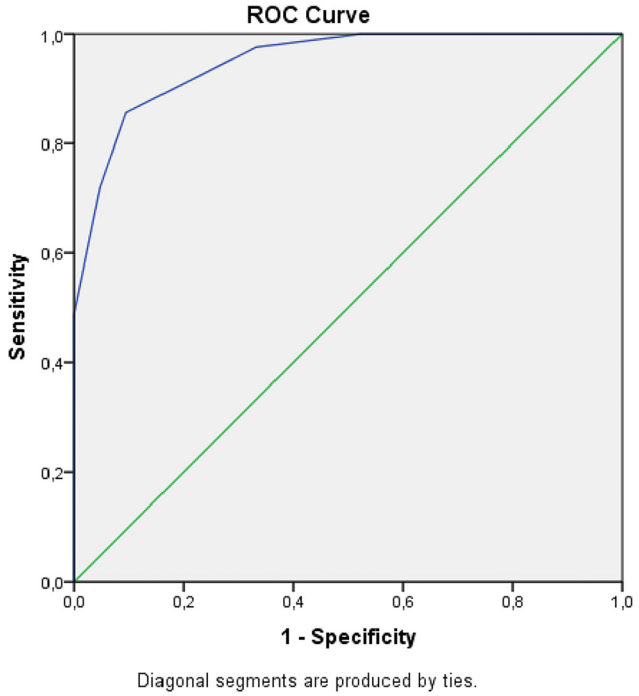


Figure 2. Receiver operating characteristic (ROC) test analysis (dementia with Lewy bodies [DLB] and MCI). ROC test analysis showed a sensitivity of 97%, a specificity of 77%, PPV of 94%, and NPV of 87% with a cutoff of 3. The area under the ROC curve is 0.949 (confidence interval [CI] 0.904–0.994: $p < .001$).

Despite their limitations for a definitive diagnosis, clinical scales for detecting cognitive impairments or dementias are inevitable (Isik et al., 2018; Kaya et al., 2016, 2022; Nasreddine et al., 2005).

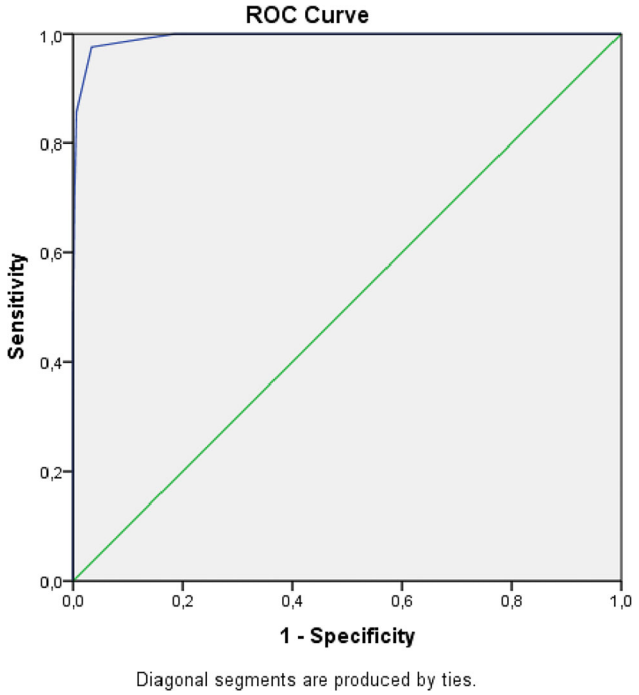


Figure 3. Receiver operating characteristic (ROC) test analysis (dementia with Lewy bodies [DLB] and control groups). ROC test analysis shows a sensitivity of 98%, a specificity of 97%, PPV of 90%, and NPV of 99% with a cutoff of 3. The area under the ROC curve is 0.994 (confidence interval [CI] 0.989–0.999: $p < .001$).

Moreover, DLB is a disease that has a wide range of heterogeneity with no biomarker to diagnose it unambiguously to date. Within this perspective, LBRCS has been created from autopsy-verified cases with Lewy body pathology, and its validity and reliability in a clinical phenotype for DLB have been established (Galvin, 2015). It was shown to increase the diagnostic probability of DLB in a research sample. Moreover, with a cutoff score of 3, the scale could discriminate DLB from other causes of dementia, including AD, and MCI-DLB from MCI-AD (Galvin, 2015). In addition, a Korean version of LBCRS was shown to be valid and reliable, with the same cutoff in discriminating AD from DLB, in 54 patients with AD and 30 patients with DLB (Ryu et al., 2017). In the present study, the LBCRS-T with a cutoff score of 3 discriminated DLB from AD with a sensitivity of 92% and a specificity of 81%.

The scale also exhibited good data quality for item and scale score variability with a substantial distribution of scores, internal consistency, and construct validity. Furthermore, based on the split-half analysis, both motor and nonmotor subdomains revealed sufficient discrimination features regardless of the patient's age and education. Therefore, LBCRS-T may help to guide treatment choices and discuss prognosis and disease course in patients and their families. On the other hand, it may be challenging for any scale to achieve an optimal cutoff with low type 1 and 2 errors and to maximize overall accuracy (Wahl, 2004). As these two types of error are inversely proportional, it should be considered that the approaches to decrease type 1 error (the number of false positive cases) in the cutoff thresholds may also increase the risk of type 2 error (the number of false negative cases)

(Harrison et al., 2013; Wahl, 2004). As such, given that DLB is a devastating disorder, apart from LBCRS-T, detailed history, physical examination, neuroimaging, and other supportive diagnostic methods are of great importance to minimize the number of false positive DLB cases.

Recently, the ALBA screening instrument (ASI) has been reported to be a reliable, valid, and effective instrument for screening DLB in two different populations (Garcia Basalo et al., 2017; Kaya et al., 2022). The Turkish version of ASI had 81% specificity and 86% sensitivity to distinguish patients with DLB from controls, and compared to patients with AD, it showed high sensitivity (86%) and specificity (70%). Considering the high discrimination ability of LBCRS regarding the detection of DLB and AD, a combination of screening patients with ASI and scoring them with LBCRS may reduce the risk of misdiagnosis in clinical practice rather than performing only one of them. However, further research is needed to demonstrate this interpretation.

One of the strengths of the study was that the clinic utility of the scale was shown in a "real-world" clinic setting with patients referred from the community rather than in only a research sample. Another strength is unlike the original; this study has been validated with the new DLB diagnostic consensus criteria of 2017. Furthermore, it had a sufficient sample size to demonstrate its discrimination ability accurately. Consequently, the scale was demonstrated to be useful for discriminating Turkish patients with MCI owing to DLB and AD, which could clinically be sometimes challenging to differentiate from others and where global screening tools revealed no differences between them.

In contrast, this study has several limitations; all patients with dementia were diagnosed by clinical criteria without neuropathological confirmation. Future studies should corroborate our findings with a larger number of patients and include other types of dementia.

Thus, the present study suggests highly sufficient validity and reliability of the Turkish version of LBCRS and provides quantitative data regarding cognitive impairment in older patients with DLB. Therefore, the Turkish version of LBCRS permits accurate diagnosis of DLB with high sensitivity and specificity. It will assist patients with appropriate symptomatic therapies and avoid inappropriate ones. Also, it can be useful to inform the caregivers regarding the course of the disease during the follow-up.

Author contributions

AT Isik designed the study. F Mutlay, E Ates Bulut, and M S Ontan collected the data and worked in the interpretation of the results. B Soylemez Akpinar was responsible for the statistical analysis. F Mutlay and D Kaya wrote the draft of the paper. AT Isik supervised and made the critical review.

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