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Fall risk in lewy body dementia: Clinical correlates using the Morse Fall Scale and falls

Lewy cisimcikli demansta düşme riski: Morse Düşme Ölçeği kullanılarak klinik korelatların ve düşmelerin incelenmesi

Ozlem Totuk[1], Ozge Gonul Oner[2]

[1]Department of Neurology, University of Health Sciences, Hamidiye Faculty of Medicine, Sancaktepe Prof. Dr. İlhan Varank Training and Research Hospital, İstanbul, Türkiye
[2]Department of Neurology, İstanbul Province Health Directorate Göztepe Prof. Dr. Süleyman Yalçın City Hospital, İstanbul, Türkiye

ABSTRACT

Background: In this study, clinical fall risk in patients diagnosed with dementia with Lewy bodies (DLB) was assessed using the Morse Fall Scale (MFS), and its relationships with cognitive performance, mood status, motor severity, and autonomic dysfunction were examined.

Materials and Methods: Between May 2018 and January 2026, 44 patients (21 males, 23 females; mean age: 77.97±7.38 years; range 61 to 95 years) with probable LBD were included in this retrospective, single-center cross sectional study. Participants were categorized into low (n = 5), moderate (n = 10), and high (n = 29) fall risk groups based on MFS scores. Continuous variables were presented as median (interquartile range), and nonparametric tests were used for group comparisons. Multivariable logistic regression analysis was performed to explore factors associated with falls.

Results: Among the 44 patients, 65.9% were classified as high risk according to MFS. No significant differences were observed between MFS risk groups in terms of age, education, cognitive performance, or autonomic dysfunction ($p > 0.05$). In the subgroup with available fall data (n = 31), urinary incontinence was significantly associated with falls ($p = 0.023$). In univariate analyses, patients who experienced falls had higher education levels and higher Addenbrooke's cognitive examination-III (ACE-III) scores.

Conclusion: Most patients with LBD exhibit a high clinical risk of falls. However, falls cannot be explained solely by advanced cognitive or motor impairment. Urinary incontinence was significantly associated with actual falls, which, alongside preserved mobility, likely heightens fall susceptibility. Conversely, the higher education and ACE-III scores observed among fallers may suggest a greater exposure to risk due to their relatively preserved functional capacity. These findings support a multidimensional clinical approach to fall risk assessment in LBD.

Keywords: Autonomic dysfunction, dementia with Lewy bodies, falls, Morse Fall Scale, urinary incontinence.

ÖZ

Amaç: Bu çalışmada, Lewy cisimcikli demans (LCD) tanılı hastalarda Morse Düşme Ölçeği (MDÖ) kullanılarak klinik düşme riski değerlendirildi; bilişsel performans, duygu durumu, motor şiddet ve otonom disfonksiyon ile olan ilişkileri incelendi.

Hastalar ve Yöntemler: Bu retrospektif, tek merkezli kesitsel çalışmaya, Mayıs 2018 - Ocak 2026 tarihleri arasında olası LCD tanısı alan 44 hasta (21 erkek, 23 kadın; ortalama yaş: 77.97±7.38; dağılım: 61-95 yıl) dahil edildi. Katılımcılar MDÖ puanlarına göre düşük (n = 5), orta (n = 10) ve yüksek (n = 29) düşme riski gruplarına ayrıldı. Sürekli değişkenler ortanca (çeyrekler arası aralık) olarak sunuldu ve gruplar arası karşılaştırmalarda parametrik olmayan testler kullanıldı. Düşme ile ilişkili faktörleri incelemek amacıyla çok değişkenli lojistik regresyon analizi yapıldı.

Bulgular: İncelenen 44 hastanın %65.9'u MDÖ'ye göre yüksek riskli olarak sınıflandırıldı. MDÖ risk grupları arasında yaş, eğitim, bilişsel performans veya otonom disfonksiyon açısından anlamlı bir fark saptanmadı ($p > 0.05$). Düşme verisine ulaşılan alt grupta (n = 31), üriner inkontinans ile düşmeler arasında anlamlı bir ilişki bulundu ($p = 0.023$). Tek değişkenli analizlerde, düşme öyküsü olan hastaların daha yüksek eğitim düzeyine ve daha yüksek Addenbrooke kognitif muayene-III (ACE-III) skorlarına sahip olduğu görüldü.

Sonuç: Lewy cisimcikli demans tanılı hastaların çoğunda klinik düşme riski yüksektir. Ancak düşmeler, yalnızca ileri evre bilişsel veya motor bozuklukla açıklanamaz. Üriner inkontinans gerçek düşmelerle anlamlı düzeyde ilişkiliydi ve bu durum, korunmuş mobilite ile birleştiğinde düşme eğilimini muhtemelen artırmaktaydı. Öte yandan, düşme olgularında gözlemlenen daha yüksek eğitim seviyesi ve ACE-III puanları, nispeten korunmuş fonksiyonel kapasiteleri nedeniyle daha büyük bir risk altında olduklarını gösterebilir. Bu bulgular, LBD'de düşme riski değerlendirmesine yönelik çok boyutlu bir klinik yaklaşımı desteklemektedir.

Anahtar sözcükler: Otonom disfonksiyon, Lewy cisimcikli demans, düşme, Morse Düşme Ölçeği, üriner inkontinans.

Corresponding author: Özge Gönül Öner, MD. Göztepe Prof. Dr. Süleyman Yalçın Şehir Hastanesi, Nöroloji Kliniği 34722 Kadıköy, İstanbul, Türkiye.

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Lewy body dementia (LBD) is the second most common cause of primary neurodegenerative dementia, characterized by core clinical features including parkinsonism, cognitive fluctuations, visual hallucinations, and rapid eye movement (REM) sleep behavior disorder (RBD).[1] Although considered a supportive clinical feature, autonomic nervous system dysfunction is increasingly recognized as an early and prominent component of LBD.[1-3]

Cardiovascular autonomic dysfunction is of particular importance in LBD due to its clinical consequences. Orthostatic hypotension (OH) has a reported prevalence of approximately 50%, while postprandial hypotension may occur even more frequently, indicating a broad spectrum of cardiovascular autonomic instability in LBD.[2,3] These hemodynamic disturbances, which may begin in the preclinical stage and are often difficult to manage, can lead to cerebral hypoperfusion, resulting in dizziness, presyncope, syncope, and falls.[4]

Falls are a major cause of morbidity and mortality in patients with dementia, contributing to increased hospitalizations, institutionalization, and substantial socioeconomic burden.[5] Individuals with dementia have a significantly higher incidence of falls compared to healthy controls, with the Lewy body spectrum representing one of the highest-risk groups.[6] Both motor and non-motor factors have been implicated in this increased risk, including depression, symptomatic autonomic dysfunction, hallucinations, postural instability, higher body mass index, bradykinesia, and overall disease severity.[6-8] Therefore, early and accurate identification of fall risk is of critical clinical importance.

Many previous studies have focused on prospectively recorded fall events, whereas in routine clinical practice, fall risk is often estimated using standardized assessment tools.[6-9] The Morse Fall Scale (MFS) is a widely used clinical tool with established validity across different populations.[9] However, studies evaluating MFS-based clinical fall risk in LBD in relation to cognitive status, mood, and autonomic dysfunction remain limited.[1,6,8,10,21]

In this context, the present study aimed to evaluate fall risk levels determined by the MFS in patients with LBD and to examine the relationship between fall risk and autonomic dysfunction, motor stage, cognitive performance, depressive symptoms, and educational level. In addition, among patients with available fall data, we explored whether clinically assessed fall risk and selected clinical features were associated with actual falls.

PATIENTS AND METHODS

Study design and population

This retrospective, single-center cross sectional study was conducted at the Dementia Outpatient Clinic of the Neurology Department of a tertiary referral center at University of Health Sciences between May 2018 and January 2026. Initially, medical records of approximately 1,700 patients were screened, from which 117 participants meeting the diagnostic criteria for probable LBD were identified. Patients were eligible for inclusion if they met the revised 2017 consensus criteria for probable LBD.[10] Detailed chart reviews were subsequently conducted for this subgroup to ensure eligibility based on predefined clinical criteria. Following the application of inclusion and exclusion criteria, a final cohort of 44 patients (21 males, 23 females; mean age: 77.97±7.38 years; range 61 to 95 years) was included in the analysis. Participants were categorized into three groups based on their clinical fall risk according to the MFS: the low-risk group (n = 5, 11.4%), the moderate-risk group (n = 10, 22.7%), and the high-risk group (n = 29, 65.9%). All included patients had been evaluated during routine clinical assessments using the MFS, Addenbrooke's cognitive examination-III (ACE-III), and the Geriatric Depression Scale (GDS). Autonomic symptoms, including urinary incontinence and constipation, were recorded as present or absent based on patient and caregiver reports, whereas OH was defined based on clinically confirmed measurements. All patients meeting the inclusion criteria were evaluated regardless of dementia stage. Patients were excluded if they had conditions directly contributing to falls, such as acute orthopedic disorders, or were bedridden. Further exclusion criteria included a history of chronic alcohol use, the use of antidepressants or antipsychotics with potential sedative effects, and the absence of an MFS assessment. Cases with incomplete clinical data were also excluded. The exclusion of patients receiving sedative psychotropic medications may have reduced the representation of more clinically vulnerable individuals and should be considered when interpreting the findings. A written informed consent was obtained from each patient. The study protocol was approved by the Sancaktepe Prof. Dr. İlhan Varank Training and Research Hospital Ethics Committee (Date: 16.03.2026, Approval No: 2026/140) and conducted in accordance with the Declaration of Helsinki.

Clinical definitions and assessments

A fall was defined as an unintentional descent to the ground or a lower surface, including a bed, chair, or bedside mat, that was not caused by a major external force, trauma, or loss of consciousness. Falls were identified based on documented clinical records and caregiver reports referring to events occurring within the preceding follow-up period.

Constipation and urinary incontinence were assessed based on patient and caregiver history. Constipation was defined as the presence of symptoms such as fewer than three bowel movements per week, hard stools, excessive straining, or a sensation of incomplete evacuation. Urinary incontinence was defined as the occurrence of involuntary urine leakage.

Demographic and clinical data, including age, sex, education level, disease duration, comorbidities, and medication use, were systematically obtained from patient records and the hospital information system.

Measures

All assessment tools used in this study are widely applied in clinical practice and have established Turkish validity and reliability.

Morse Fall Scale:

The MFS, developed by Morse, assesses fall risk based on six variables: history of falling, secondary diagnosis, ambulatory aid, intravenous therapy or heparin use, gait/transfer, and mental status.[11,12] The scale predicts fall propensity independently of accidental events and is widely used across clinical populations, with reported sensitivity of 70-80% and specificity of 40-60%.

Addenbrooke's cognitive examination-III:

The ACE-III is a comprehensive cognitive screening tool assessing attention, memory, language, and visuospatial abilities.[13,14]

Geriatric Depression Scale:

The GDS is a 30-item self-report instrument used to assess depressive symptoms in older adults, with scores ranging from 0 to 30.[15,16]

Hoehn and Yahr staging scale:

This is a five-stage scale used to evaluate the severity of parkinsonism. Patients were categorized as mild (Stages 1-2), moderate (Stage 3), or severe (Stages 4-5) based on motor involvement.[17]

Autonomic dysfunction was evaluated based on the presence of OH, constipation, and urinary incontinence. Orthostatic hypotension was defined according to international consensus criteria as a decrease of ≥ 20 mmHg in systolic blood pressure and/or ≥ 10 mmHg in diastolic blood pressure within the first three minutes of standing.[18]

Orthostatic blood pressure measurements were performed by a trained clinical nurse using a standardized protocol with an intermittent non-invasive sphygmomanometer (Philips, M1574A, Amsterdam, Netherlands). After at least 5 min of rest in the supine position, baseline blood pressure and heart rate were recorded. Measurements were then repeated at the first and third minutes after standing, in accordance with recommended diagnostic procedures.[19] Constipation and urinary incontinence were assessed based on patient and caregiver reports. Constipation was defined as fewer than three bowel movements per week, hard stools, excessive straining, or a sensation of incomplete evacuation. Urinary incontinence was defined as any episode of involuntary urine leakage.

The presence of RBD and insomnia was recorded as present or absent based on clinical neurological evaluations. RBD was confirmed by polysomnography performed in accredited sleep centers approved by the national health authority, using standard recording protocols.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 27.0 software (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using visual methods (histograms and Q-Q plots) and tested for normality with the Shapiro-Wilk test. Due to the limited sample size and the non-normal distribution of most variables, continuous data were presented as median and interquartile range (IQR), while categorical variables were expressed as counts and percentages.

Patients were categorized into three groups based on MFS scores: low risk (0-24), moderate risk (25-44), and high risk (≥ 45). Comparisons of continuous variables across MFS risk groups were performed using the Kruskal-Wallis test. Categorical variables were compared using the chi-square test or Fisher exact test when expected cell counts were less than five.

For the analysis of actual falls (present/absent), univariate comparisons were conducted using the

Table 1. Autonomic and sleep variables across MFS risk groups

	Low		Moderate		High		
Variables	n	%	n	%	n	%	*p*
Orthostatic hypotension	0	0.0	2	20.0	2	6.9	0.31
Constipation	2	40.0	4	40.0	12	41.4	0.99
Urinary incontinence	3	60.0	6	60.0	21	72.4	0.73
REM sleep behavior disorder	2	40.0	5	50.0	16	55.2	0.88
Insomnia	1	20.0	3	30.0	12	41.4	0.62
Any autonomic symptom	3	60.0	9	90.0	26	89.7	0.29
Any sleep disorder	3	60.0	7	70.0	23	79.3	0.52

MFS, Morse Fall Scale; RBD, REM sleep behavior disorder.

Mann-Whitney U test for continuous variables and the chi-square or Fisher exact test for categorical variables.

To identify independent factors associated with falls, multivariable logistic regression analysis was performed. The dependent variable was the presence of falls (1 = yes, 0 = no). Clinically relevant variables (age, sex, education level, Hoehn-Yahr stage, urinary incontinence, and OH) were included in the model. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs).

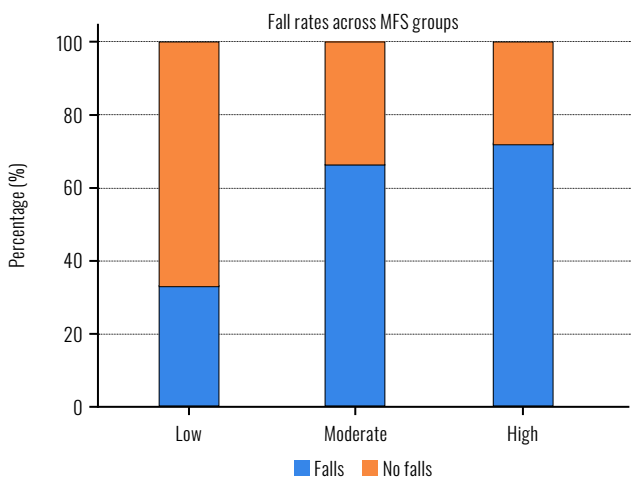

Figure 1. Fall rates across Morse Fall Scale (MFS) risk groups. Stacked bar chart showing the proportion of patients with and without falls across low, moderate, and high MFS risk categories. Although fall rates increased with higher MFS scores, the difference was not statistically significant ($p = 0.417$).

Due to potential multicollinearity between cognitive measures, ACE-III and education level were not included in the model simultaneously. Education level was retained in the final model due to its greater clinical interpretability.

All statistical tests were two-tailed, and a p-value < 0.05 was considered statistically significant. Given the limited sample size and the number of fall events, the multivariable model should be considered exploratory, and the results interpreted with caution.

RESULTS

Autonomic dysfunction and sleep findings

Orthostatic hypotension was present in four patients (9.1%), constipation in 18 (40.9%), and urinary incontinence in 30 (68.2%). The RBD was observed in 23 patients (52.3%), and insomnia in 16 (36.4%). Overall, 38 patients (86.4%) had at least one autonomic symptom, and 33 (75.0%) had at least one sleep disorder.

No statistically significant associations were found between MFS risk groups and autonomic or sleep-related variables, as shown in Table 1 (all $p > 0.05$).

Analysis of actual falls

Fall data were available for 31 of the 44 patients, and analyses were conducted on this subgroup. The prevalence of falls was 64.5% (20/31).

Fall rates across MFS risk groups were 33.3% (1/3) in the low-risk group, 60.0% (6/10) in the moderate-risk group, and 72.2% (13/18) in the high-risk group.

However, this difference did not reach statistical significance (chi-square test, $p = 0.400$) (Figure 1).

Comparison of patients with and without falls

Demographic and clinical characteristics of patients with and without falls are presented in Table 2. Patients who experienced falls had significantly higher education levels (median [IQR]: 5.0 [2.2-8.0] *vs.* 0.0 [0.0-4.0]; $p = 0.022$) and higher ACE-III scores (53.0 [37.0-72.0] *vs.* 34.5 [28.0-39.8]; $p = 0.039$).

Urinary incontinence was significantly more frequent among patients with falls (16/20 [80.0%] *vs.* 4/11 [36.4%]; OR = 7.00, 95% CI 1.35-36.31; $p = 0.023$). No significant differences were observed between groups in terms of age, Hoehn-Yahr stage, constipation, OH, RBD, or insomnia (all $p > 0.05$).

Multivariable logistic regression analysis

Results of the multivariable logistic regression analysis for falls are presented in Table 3. The multivariable model was statistically significant overall; however, none of the individual predictors reached statistical significance, likely reflecting limited statistical power and wide confidence intervals (likelihood ratio $p = 0.0196$). Education level (OR = 1.58, $p = 0.070$) and urinary incontinence (OR = 14.24, $p = 0.103$) demonstrated trends toward association with falls, while all other variables had p-values > 0.05.

DISCUSSION

This study evaluated fall risk in patients with LBD using the MFS and examined its relationship with cognitive status, mood, motor severity, and autonomic dysfunction. In addition, actual fall events were assessed, allowing comparison between clinically estimated fall risk and real-world outcomes.

Our findings indicate that a substantial proportion of patients with LBD are classified as having a high

Table 2. Comparison of patients with and without falls (n = 31)

	Falls (n = 20)				No Falls (n = 11)				
Variables	n	%	Median	IQR	n	%	Median	IQR	*p*
Age (year)			81.0	74.8-86.0			80.0	77.0-84.0	0.68
Education (year)			5.0	2.2-8.0			0.0	0.0-4.0	**0.022**
ACE-III score			53.0	37.0-72.0			34.5	28.0-39.8	**0.039**
Hoehn-Yahr stage			1.0	1.0-2.0			1.0	0.5-2.0	0.59
MFS score			50.0	40.0-67.5			45.0	26.2-60.0	0.37
Urinary incontinence	16	80.0			4	36.4			0.023

IQR, interquartile range; ACE-III, Addenbrooke's cognitive examination-III; MFS, Morse Fall Scale.

Table 3. Multivariable logistic regression analysis for falls (n = 31)

Variables	OR	95% CI	*p*
Age	1.02	0.85-1.21	0.78
Male sex	1.69	0.07-40.74	0.53
Education (per unit increase)	1.58	0.96-2.60	**0.070**
Hoehn–Yahr	1.50	0.61-3.68	0.38
Urinary incontinence	14.24	0.58-348.12	0.103
Orthostatic hypotension	0.81	0.03-26.33	0.87

OR, odds ratio; CI, confidence interval. Model overall significance: Likelihood ratio, LR $p = 0.0196$.

clinical risk of falls (65.9%). However, MFS risk categories did not demonstrate clear discrimination in terms of cognitive performance, depressive symptoms, or autonomic dysfunction. In contrast, urinary incontinence demonstrated the strongest association with actual falls. Moreover, higher education attainment was observed among patients who experienced falls.

High clinical fall risk in LBD: An expected but important finding

Falls have long been recognized as a supportive clinical feature of LBD.[10] In our study, more than two-thirds of patients were classified as high risk according to the MFS, supporting previous prospective findings that fall incidence is elevated in dementia populations, particularly within the Lewy body spectrum.[6] These results suggest that in LBD, fall risk is not only frequent at the event level but also highly prevalent at the level of clinical risk profiling.

This perspective emphasizes real-world clinical risk assessment rather than reliance solely on prospective fall recording. In routine clinical practice, falls are more often anticipated using standardized risk assessment tools than systematically tracked through fall diaries. The MFS is one of the most widely used instruments in clinical settings, with demonstrated validity across populations.[9] In this context, our findings highlight the clinical relevance of identifying patients with increased fall vulnerability rather than focusing solely on fall occurrence, a perspective further supported by the inclusion of actual fall data in our study.

Contrary to previous studies reporting an association between fall risk and both increasing age and the severity of motor symptoms, we did not observe such a relationship in either MFS-based risk assessment or actual fall data.[8,9]

Autonomic dysfunction and fall risk: Absence of the expected association

Autonomic dysfunction is recognized as an early and prominent feature of LBD.[1] Orthostatic hypotension has been reported to affect approximately 50% of patients, while postprandial hypotension may occur even more frequently, reflecting a broad spectrum of cardiovascular autonomic instability.[2,3] These hemodynamic disturbances are thought to contribute to falls through cerebral hypoperfusion.[4]

However, in our cohort, the prevalence of OH was relatively low (9.3%), and no significant association was found between MFS risk groups and OH or overall autonomic dysfunction. The relatively low prevalence of OH in our cohort may reflect underdetection related to single-visit measurements, day-to-day hemodynamic variability, and the absence of systematic assessment of postprandial hypotension. In addition, the MFS primarily captures general functional and clinical parameters rather than dynamic hemodynamic changes; therefore, subclinical autonomic instability may not be adequately reflected in MFS scores.

In contrast, urinary incontinence, an established marker of autonomic dysfunction, was both highly prevalent and significantly associated with falls. This suggests that specific components of autonomic dysfunction may be more relevant to fall risk than others.

Autonomic dysfunction in LBD has also been linked not only to falls but also to overall disease progression and survival.[20] Therefore, a comprehensive assessment of autonomic symptoms may be essential for a more accurate evaluation of clinical vulnerability in this population.

Cognitive status and falls: A finding beyond expectations

The relationship between cognitive impairment and falls remains heterogeneous in the literature, with conflicting findings reported across studies.[6-8] In LBD, recurrent falls have been associated with hallucinations, cognitive fluctuations, and postural instability.[7] Based on this evidence, our initial hypothesis was that worsening cognitive performance would be associated with increased fall risk.

However, no significant association was observed between MFS risk categories and ACE-III scores. More notably, in the subgroup analysis of actual falls, patients who experienced falls had higher education levels and higher ACE-III scores. This finding diverges from the conventional model, suggesting that greater cognitive impairment leads to increased fall risk.

Although ACE-III scores were associated with falls in univariate analysis, they were not included in the multivariable model due to collinearity with education level.

One explanation for this seemingly paradoxical finding is an activity-exposure effect. Patients with better cognitive function and higher educational attainment may maintain greater mobility and independence, leading to increased exposure to situations associated with fall risk. Similarly, the

complex relationship between disease severity and mobility may influence fall risk in a non-linear manner.[8]

Taken together, these findings suggest that fall risk in LBD cannot be explained solely by the degree of neurocognitive impairment, but rather reflects a more complex interplay between cognitive reserve, mobility, and functional status.

Neuropsychiatric symptoms

Previous studies have suggested an association between depressive symptoms and increased fall risk, with some evidence indicating that treatment of depression may reduce fall incidence.[1,6] In contrast, our study did not demonstrate a significant relationship between depression and either clinical fall risk or actual falls. This may reflect limited statistical power, sample size constraints, or differences in patient selection following exclusion criteria.

Urinary incontinence: A strong clinical marker of falls

In our cohort, urinary incontinence emerged as the factor most strongly associated with actual falls. In univariate analysis, the presence of incontinence significantly increased the likelihood of falling. This finding suggests that specific components of autonomic dysfunction may play a more prominent role in fall risk than global autonomic measures.

Urinary incontinence may contribute to falls through mechanisms such as urgency, nocturnal mobility, and hurried movements, all of which increase exposure to fall risk. Moreover, incontinence is a common autonomic symptom in LBD and may reflect widespread neurodegenerative involvement.[1] From this perspective, urinary incontinence may represent not only a symptom but also a marker of broader clinical vulnerability.

Although fall rates increased across MFS risk categories, this trend did not reach statistical significance. The most likely explanations are the relatively small sample size and the incomplete availability of fall data. In addition, previous studies have suggested that the performance of the MFS may be more complex in older populations with cognitive impairment.[6,8,9,21] This raises the possibility that the scale may have limited sensitivity in heterogeneous clinical conditions such as LBD, potentially explaining the discrepancy observed between MFS-based risk classification and actual fall outcomes in our study.

Nevertheless, falls in neurodegenerative disorders are known to result in significant orthopedic complications and increased morbidity.[5] Therefore, optimizing clinical tools for fall risk assessment remains a critical priority.

Our findings suggest that fall risk in LBD cannot be explained solely by motor instability or cognitive impairment. Rather, falls appear to represent a multidimensional phenomenon arising from the interaction of motor, autonomic, cognitive, and behavioral factors.

In this context, our results point toward a potential "fall-prone phenotype" in LBD, characterized by the coexistence of autonomic vulnerability, particularly urinary incontinence, and relatively preserved mobility and cognitive function. However, this should be interpreted as a potential clinical profile rather than a definitively established phenotype.

Importantly, this approach emphasizes real-world clinical risk profiling rather than reliance solely on prospective fall counts, offering a framework that may be more directly applicable to routine clinical practice.

The main strength of this study lies in the combined evaluation of fall risk in patients with LBD using both real-world fall events and a widely utilized clinical risk assessment tool. This approach provides a perspective that is closely aligned with routine clinical decision-making and represents a meaningful contribution to the existing literature. Second, patient selection was conducted through a systematic screening process. Among approximately 1,700 patients followed in the clinic, 117 met the diagnostic criteria for LBD, and a final sample of 44 patients was obtained after applying predefined inclusion and exclusion criteria. This transparent selection process strengthens the methodological rigor of the study. Third, the study adopts a multidimensional approach by evaluating not only motor features but also cognitive performance, mood, and autonomic symptoms. This comprehensive framework supports the conceptualization of a potential "fall-prone phenotype" in LBD.

Several limitations should be acknowledged. First, the sample size was relatively small, and data on actual falls were incomplete for a subset of patients. In addition, the limited number of patients with available fall outcomes may have reduced statistical power and contributed to wide confidence intervals in the multivariable analysis. Second, the study has a retrospective, single-center cross sectional design, which limits causal inference. Third, although medications with sedative effects were considered

in the exclusion criteria, polypharmacy was not systematically assessed. Finally, the single-center design may limit the generalizability of the findings.

Future studies should aim to validate these findings in larger, multicenter cohorts. Incorporating more detailed hemodynamic assessments, including postprandial hypotension, may provide a more comprehensive understanding of autonomic contributions to fall risk. In addition, the use of digital mobility tracking and wearable sensors could offer objective measures of activity and improve the accuracy of fall risk evaluation. Furthermore, developing integrative models that examine the interaction between cognitive reserve, mobility, and autonomic dysfunction in LBD may contribute to a more precise classification of fall risk and enhance individualized risk stratification.

In conclusion, this study demonstrates that a substantial proportion of patients with LBD exhibit a high clinical risk of falls. However, risk categories defined by the MFS did not clearly differentiate patients in terms of cognitive performance, mood, or autonomic dysfunction. Urinary incontinence emerged as the factor most strongly associated with actual falls, while higher education level and better cognitive performance were also linked to fall occurrence. These findings suggest that falls in LBD cannot be explained solely by advanced cognitive or motor impairment but rather reflect a multidimensional vulnerability profile. In clinical practice, fall risk assessment should extend beyond motor severity to include autonomic symptoms and the patient's level of mobility.

Author Contributions

O.T.: Conceptualization, methodology, data curation, formal analysis, ınvestigation, project administration, resources, writing of first draft, writing-review and editing, supervision; O.G.O.: Conceptualization, methodology, formal analysis, ınvestigation, project administration, resources, supervision, writing-review and editing.

Conflict of Interest

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The data that support the findings of this study are available from the corresponding author upon reasonable request.

AI Disclosure

The authors declare that artificial intelligence (AI) tools were not used, or were used solely for language editing, and had no role in data analysis, interpretation, or the formulation of conclusions. All scientific content, data interpretation, and conclusions are the sole responsibility of the authors. The authors further confirm that AI tools were not used to generate, fabricate, or 'hallucinate' references, and that all references have been carefully verified for accuracy.

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