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Investigation of commonly used assessment methods for predicting fall risk in the elderly

Aziz DENGİZ [a], Ahmet AYTEPE [b,*], Bayram SIRRI [a], Mehmet EFE [b]

[a] Muş Alparslan University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Muş, Türkiye
[b] Muş Alparslan University, Faculty of Health Sciences, Department of Gerontology, Muş, Türkiye

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ABSTRACT

Aim: This study aimed to evaluate the effectiveness of four different commonly used assessment methods Berg Balance Scale (BBS), Timed Up and Go Test (TUG), Modified Falls Efficacy Scale (MFES), and Morse Fall Scale (MFS) in predicting fall risk in elderly.
Method: The study included 195 participants (97 female, mean age: 69.82 ± 7.45 years) aged 60 and above. The BBS, TUG, MFES, and MFS were used to asses fall risk. Logistic regression analysis was conduct.
Results: The addition of independent variables significantly reduced the −2 Log Likelihood value (from 222.015 to 49.196), and the Nagelkerke R^2 value was 0.865. The Hosmer-Lemeshow goodness-of-fit test (p = .738) and ROC analysis (AUC 0.958–0.972) confirmed the model's strong fit and high discriminative power. The MFS (B = 0.120, p = .001, Exp(B) = 1.128) and the TUG(B = 0.542, p = .004, Exp(B) = 1.720) were significantly associated with fall risk. In contrast, the MFES and BBS did not show statistically significant effects.
Conclusions: The MFS and TUG are particularly effective in identifying fall risk in elderly individuals. However, using these tests alone may have limited predictive power, highlighting the importance of a multidisciplinary approach for fall risk assessment.

1. Introduction

Recent global and national developments in health and technology have resulted in a marked increase in life expectancy. Consequently, the proportion of elderly individuals in the population has increased substantially. According to the estimated data of the World Health Organization (2024), the proportion of the global population aged 60 years and over is projected to rise from 16 % in 2020 to 18 % in 2030. The number of individuals aged 60 and over is projected to rise from 1 billion in 2020 to 1.4 billion. The same report states that by 2050, the population aged 60 and over is expected to double to 2.1 billion worldwide, while the number of people aged 80 and over is expected to triple from 426 million in 2020 to 1.4 billion in 2050. This rising trend in the elderly population is not limited to certain countries; it is evident that the elderly population is increasing both in absolute value and proportionally on a global scale (World Health Organization [WHO], 2024). According to data from the Turkish Statistical Institute, the population aged 65 and over increased by 21.4 % between 2018 and 2023, from 7 million 186 thousand 204 people in 2018 to 8 million 722 thousand 806 people in 2023 (Turkish Statistical Institute [TÜIK], 2023).

The process of aging is associated with the emergence of various deficiencies in physiological, psychological and social domains. This situation can have negative effects on the daily life activities and general health of elderly individuals (Küçük and Karadeniz, 2021). While the incidence of accidents varies among individuals, the elderly population is disproportionately susceptible to such incidents due to the natural decline in health and physical abilities that accompanies the aging process (Küçük and Karadeniz, 2021). The most prevalent type of accident experienced by elderly individuals is falls. Falls are among the most prevalent and significant causes of morbidity and mortality in elderly individuals (Telatar et al., 2020). Research indicates that approximately one-third of individuals aged 65 and over experience at least one fall annually, with an average of 1.6 falls per bed per year reported in nursing homes. Notably, falls are the second most prevalent cause of fatal injuries worldwide, responsible for 684,000 deaths annually. A 53 % increase in such deaths has been recorded globally between 2000 and 2019 (World Health Organization [WHO], 2021).

A number of factors have been identified as contributing to an increased risk of falling in old age. These include decreased muscle strength, loss of balance, and changes in cognitive functions. This can

* Corresponding author.
E-mail addresses: ahmet.aytepee@gmail.com, ahmet.aytepe@alparslan.edu.tr (A. AYTEPE).

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result in adverse outcomes, including loss of independence, prolonged hospitalisation, and diminished quality of life (World Health Organization [WHO], 2021). Consequently, this issue should be recognised as a significant problem area, both in terms of its impact on individuals and the necessity for systematic preventive measures. Regular physical activity and muscle strengthening practices have been identified as significant factors in mitigating the adverse effects associated with this condition. Regular physical activity is a critical factor in maintaining health, functional abilities, and supporting both quality of life and physical well-being in older individuals (Zapata-Lamana et al., 2022). Strength training has been identified as a pivotal strategy that not only prevents falls but also promotes healthy aging by enhancing quality of life (Rivera Miranda et al., 2024). Specifically, the strengthening of lower extremity muscles has been shown to reduce the risk of falls and contribute to maintaining balance and functional independence (Rivera Miranda et al., 2024). Consequently, the identification of physiological, psychological, and environmental risks is imperative for the formulation of effective prevention strategies.

A plethora of studies have been conducted in the existing literature to ascertain the risk of falling (Caner and Avci, 2022; Mert and Özkan, 2023; Hawkins et al., 2024; Katiri et al., 2024). Given the serious health complications that falls can cause in older individuals and the consequent reduction in individual autonomy, it is essential to address risk factors using a holistic approach (İncirkuş et al., 2024).

In addition to individual, environmental and health-related factors, the evaluation of psychosocial elements such as fear of falling will significantly increase the effectiveness of preventive strategies (Kaldık, 2022). Multi-faceted analysis of risk factors contributes to more targeted and sustainable intervention plans. The use of reliable tools that will help predict this risk at an early stage is critical to the protection of older individuals, as is the determination of factors such as decreased muscle strength, impaired balance or environmental factors that lead to falls.

Despite the extensive utilisation of fall risk assessment tools, a scientific consensus on the predictive accuracy and applicability of these tools across diverse elderly populations and care settings (e.g., community, hospital, nursing home) remains elusive. In this context, the validity and reliability of fall risk assessment tools are intensely debated in the literature. This underscores the necessity for comparative studies to ascertain the efficacy of these tools in various contexts. In this context, predictive assessment tools have been developed to statistically predict fall risk, and the validity and reliability of these methods have been discussed in detail in different scientific studies (Morse et al., 1989; Clemson et al., 2003; Tezcan and Karabacak, 2021; Barış et al., 2020). Nevertheless, the reliability of these methods for assessing fall risk in older individuals remains a contentious issue in the present day. The present study was conceived with the objective of comparatively examining the predictive power of four widely utilised methods for estimating fall risk in older individuals.

Fall Risk Assessment Methods

A plethora of assessment methods have been developed to determine and prevent the risk of falls in elderly individuals. Among these methods, the Berg Balance Scale (BBS), the Timed Up and Go Test (TUG), the Modified Falls Efficacy Scale (MFES), and the Morse Falls Scale (MFS) are the most widely utilised (Podsiadlo and Richardson, 1991; Berg et al., 1989; Morse, 1997; Tinetti, 1986). However, it has been reported that there are differences in the sensitivity and specificity levels of these scales (Shumway-Cook et al., 1997).

Despite the fact that BBS assesses both static and dynamic balance, it is possible that the instrument may exhibit a ceiling effect in individuals who are more independent and physically active, thereby reducing measurement sensitivity. Consequently, its ability to accurately predict fall risk in elderly individuals is constrained (Shumway-Cook et al., 2000). The TUG test is a practical, short-term, and easily applicable tool in clinical applications. However, the reliability of the results is contingent on the competence of the assessor and the environmental conditions, and it may not adequately reflect some internal factors, such as cognitive decline (Podsiadlo and Richardson, 1991). MFES provides important information in terms of assessing fear of falling and the subjective perception of the individual. However, as it is based solely on the individual's self-assessment, there is significant variability and it does not provide direct data on objective physical capacity (Tinetti et al., 1990; Scheffer et al., 2008). Conversely, MFS has been found to be functional in clinical settings, as it incorporates significant factors such as medication use, ambulatory status, and fall history (Tinetti et al., 1990; Scheffer et al., 2008). Nevertheless, it has been observed to demonstrate low sensitivity in relation to sudden physical or cognitive status changes, and it does not adequately address environmental factors (Morse, 1997; Demir and İntepeler, 2012). It is emphasised in the literature that these tests alone are insufficient to fully predict the risk of falling, therefore more comprehensive and holistic assessment approaches are needed (Montero-Odasso et al., 2022; Delbaere et al., 2010) (see Table 1). In light of the limitations inherent in existing assessment tools, there is a clear necessity for more comprehensive comparative studies to predict the risk of falling in older individuals. To address this need, the present study aims to analyse the predictive power of four common methods.

2. Method

2.1. Participants

The study was conducted at the 60+ Refreshment University affiliated to xxx University. The study voluntarily included 195 people over the age of 60. The study was conducted in accordance with the latest revision of the Declaration of Helsinki. The necessary permissions were obtained and the study was approved by the xxx University Scientific Research and Publication Ethics Committee with decision number XXX. This study included individuals aged 60 years and older, who were able to carry out activities of daily living independently or with minimal assistance, whose cognitive functions were at a level to understand assessment tests (MMT $\geq$ 24), and who could walk at least 10 m independently or with an assistive device. It was taken into account whether the participants had a history of falls within the last year and they were required to be able to safely complete balance, gait and functional tests. Exclusion criteria included individuals with severe cognitive impairment (MMT $\leq$ 23), acute musculoskeletal problems (fracture, severe arthritis, acute inflammation, etc.), stroke, neurological diseases such as Parkinson's disease or multiple sclerosis. In addition, individuals who could not safely perform mobility tests due to cardiovascular diseases such as uncontrolled hypertension, end-stage heart failure or severe arrhythmia, and those with severe vision or hearing loss were excluded.

Table 1
Comparative characteristics of fall risk assessment tools.

Tool	Strengths	Limitations	Most Appropriate Use
BBS	Evaluates static and dynamic balance	Ceiling effect; sensitivity decreases in high functioning individuals	Community-dwelling, moderate-risk elderly individuals
TUG	Fast and easy to apply	Sensitive to the evaluator and the environment	Polyclinics, busy clinical environments
MFES	Offers psychological insight into fear of falling	Subjective; does not provide direct information about physical capacity	Post-fall psychological assessments
MFS	Includes clinical variables (medication, walking, etc.)	Limited sensitivity to acute functional changes and environmental risks	Hospital and inpatient settings

BBS: Berg Balance scale, TUG: Time up and Go Test, MFES: Modified Fall Efficacy scale, MFS: Morse Fall scale.

Finally, individuals who had undergone major orthopaedic surgery (e.g. hip or knee replacement surgery) within the previous six months were also excluded. After collecting the participants' demographic data, their fall history was assessed, followed by evaluations using the BBS, TUG, MFES, and MFS.

2.2. Study design

The students included in the study were informed about the study and informed consent was obtained. The evaluation form included demographic information such as age, height, weight, and exercise status, as well as BBS, TUG, MFES, and MFS.

2.2.1. Timed Up and Go Test (TUG)

Was used to assess physical performance and is associated with functional mobility and walking speed. It is a test that assesses the risk of falls and gait in the elderly. A chair and stopwatch are required for this test. A three-metre area in front of the chair is determined and the participant is asked to get up from the chair, walk this distance at normal speed and sit down again. The elapsed time gives the result of the test. The average values for this test are 8.1 (7.1–9.0) seconds for 60–69 years, 9.2 (8.2–10.2) seconds for 70–79 years and 11.3 (10.0–12.7) seconds for 80–99 years. Results above these values indicate the risk of falling (Browne and Nair, 2018).

2.2.2. The Berg Balance Scale (BBS)

Was used to assess to determine the risk of falls. It consists of 14 items for direct observation of performance. For the application, a ruler, stopwatch, chair, step, an area that can be rotated 360 degrees and 15–20 min are required. Each item is scored between 0 and 4 according to the patient's ability to meet the time and distance requirements of the test. A score of four indicates the ability to complete the task independently. The highest score is 56, scores between 0 and 20 indicate balance impairment, scores between 21 and 40 indicate that balance is acceptable, and scores between 41 and 56 indicate that balance is good (Sahin et al., 2008).

2.2.3. Modified Fall Efficacy Scale (MFES)

Was developed to assess the fear of falling in elderly individuals. It was first developed by Tinetti et al. (1990) and then revised by Hill et al. (1996). It is a visual analogue scale consisting of fourteen items and each item is rated between 0 and 10 (0 = not at all safe, 10 = completely safe). The adaptation of the scale into Turkish and its validity-reliability study was carried out by Korkmaz et al. (2019). The Cronbach's alpha coefficient of the scale, which has a single-factor structure, was found to be 0.97. Scoring is calculated by dividing the sum of the scores obtained from each question by the number of questions. A higher score indicates that the person feels more confident and competent about falling.

2.2.4. Morse Falls Scale (MFS)

Used to determine fall risk. According to the criteria of this fall risk diagnostic tool, if the patient is evaluated with <25 points, he/she is in the low risk group for falls, if he/she is evaluated with a score between 25 and 50 points, he/she is in the medium risk group for falls, and if he/she is evaluated with 51 or more points, he/she is in the high risk group for falls (Yılmaz Demir and Serenİntepeler, 2012).

2.3. Sample size

The minimum expected effect size (slope H1) under the alternative hypothesis was set at 0.30, based on data derived from the study by Arnold and Faulkner (2007), in order to achieve a medium effect size. As a result of the power analysis performed by assuming a statistical power of 95 % (0.95) and a type I error rate (α) of 0.05, a total of 111 participants were needed to reach the required statistical power. This calculation was performed using standard software such as G*Power (Faul et al., 2009).

2.4. Statistical analysis

Quantitative data were presented as mean ± standard deviation, and The conformity of the data to normal distribution was evaluated by shapiro wilk test. Mann whitney *U* test was used to compare the differences between the groups since the normality test assumptions were not met. Qualitative data were expressed as frequency and percentage (n, %). Group differences were analysed using the chi-square (χ^2) test or Fisher's exact test, as appropriate. Kappa coefficients were calculated to assess the consistency of risk assessments across different tests in predicting fall incidence. No multiple comparison correction was applied. In this study, logistic regression analysis was applied to examine the relationship between the probability of experiencing a fall and various scale scores. The MFES, MFS, TUG and BBS scores were included in the model as independent variables. Before the analysis, the data set was checked for missing values and it was determined that there were no missing observations ($N = 195$). VIF (Variance Inflation Factor) values were analysed to evaluate whether there was a multicollinearity problem between the independent variables and it was found to be at an acceptable level for all variables (VIF = 1.896–4.031).

The following statistical criteria were used to evaluate the suitability of the model:

- Omnibus Test: It was used to test whether the model is generally significant.
- Hosmer-Lemeshow Fit Test: It was applied to test whether the model shows a good fit in terms of observed and predicted values.
- 2 Log Likelihood, Nagelkerke R^2: It was used to evaluate the explanatory power of the model.
- Classification Table: It was created to determine the prediction accuracy of the model.
- Odds Ratio (Exp(B)) and 95 % Confidence Interval (95 % CI): It was used to interpret the effect of each independent variable on the probability of experiencing a fall.

Receiver Operating Characteristic (ROC) analysis was applied to evaluate the discriminative performance of the test variables with high power to predict the risk of falls. ROC analysis was used to determine the prediction performance of the model by examining the relationship between sensitivity and specificity values. The classification success of the model was evaluated with the Area Under the Curve (AUC) value. Within the scope of the analysis, ROC curves were generated for four different test variables and AUC values were calculated. In order to interpret the discriminative power of the model, AUC values were evaluated according to the following criteria: AUC = 0.50 → Model has no discriminative power (equivalent to random guessing), 0.70 ≤ AUC < 0.80 → Model has moderate discriminative power, 0.80 ≤ AUC < 0.90 → Model has good discriminative power, AUC ≥ 0.90 → Model has excellent discriminative power (Hosmer Jr. et al., 2013). In addition, Youden Index was used to determine the most appropriate threshold value. Analyses were performed using IBM SPSS Statistics 26 programme and significance level was accepted as $p < .05$.

3. Results

The study included 195 people (97 women (49.7 %)) with a mean age of 69.82 (7.45) years. One hundred of the participants were on continuous medication (hypertension, diabetes and cardiac medication, etc.). The regular exercise habits of the participants were very low. Only 46 (23.6 %) of 195 participants stated that they exercised regularly. 101 of the participants stated that they had a fear of falling. The findings of the study show that there are significant relationships between the risk of falls in elderly individuals and age, medication use, chronic diseases, fear of falling and not exercising regularly. The group that experienced a fall was significantly older than the group that did not experience a fall ($p < .001$), suggesting that age is an important factor that increases the risk of falls. No significant difference was observed in terms of gender on the risk of falls ($p = .966$). However, the rate of falls was significantly higher in individuals who used medication ($p < .001$) and 82 % of the group who experienced a fall used medication. In contrast, the risk of falls was significantly lower in individuals who exercised regularly ($p = .025$), indicating that physical activity is effective in reducing the risk of falls. In addition, the risk of falls was significantly higher in individuals with fear of falling (p < .001) and 86 % of the group who experienced a fall were found to experience fear of falling. It was also found that the rate of falls was significantly higher in individuals with chronic diseases (p < .001), and it was observed that the rate of falls increased especially in individuals with hypertension, diabetes, heart disease and lung disease (Table 2).

When the test scores of the groups with and without falls were analysed, MFS, MFES and TUG scores were higher in the group with falls, while BBS scores were lower in the group with falls (p: 0.0001, Table 3).

The MFS demonstrated the highest predictive accuracy, with 95.0 % of high-risk individuals experiencing falls, and a kappa value of −0.179 (p < .001). Similarly, the TUG test classified 92.1 % of high-risk individuals correctly, but with a negative kappa value (−0.163), indicating inconsistency in its predictive power. The BBS and the MFES also showed moderate classification consistency, with kappa values of. 158 and − 0.147, respectively (Table 4).

Morse Falls Scale (B = 0.120, $p = .001$) and TUG (B = 0.542, $p = .004$) variables had a significant effect on the probability of experiencing a fall. However, Modified Fall Efficacy Scale (B = 0.027, $p = .229$) and BBS (B = −0.027, $p = .626$) variables were not found significant. Exp(B) values show that each one-unit increase in the MFS score increases the probability of falling by 12.8 % (Exp(B) = 1.128), and each one-second increase in the TUG duration increases the probability of falling by 72.0 % (Exp(B) = 1.720) (Table 5).

ROC curves were used to analyse the accuracy of predictions of the MFES, MFS, TUG, and BBS based on the actual occurrence of falls (Fig. 1). The results showed that the AUC values of the Timed Up and Go Test, MFS, Modified Falls Efficacy Scale, and BBS were, respectively, 0.972, 0.970, 0.958, and. 958 (Table 6).

4. Discussion

This study addressed the gap in the early identification of fall risk by evaluating the predictive power of commonly used assessment tools in community-dwelling older adults The present study therefore sought to examine the effectiveness of four frequently used outcome measures in determining fall risk in the elderly. This was achieved using a cross-sectional study design and logistic regression analysis to examine the effect of fall-related variables on the probability of experiencing a fall.

4.1. Comparison with literature

The MFS is a widely utilised tool in the care of elderly individuals, with a significant body of research highlighting its efficacy in assessing the risk of falls in this demographic (Demir and İntepeler, 2012). In a study examining fall risk assessment strategies in long-term elderly care facilities, it was emphasised that the MFS is a widely used tool in assessing the risk of falls in older adults and is effective in identifying high-risk individuals (Miura and Kanoya, 2025). In a similar vein, Dani et al. asserted that the MFS is a valuable instrument in evaluating the risk of falls in elderly individuals. The present study emphasises the efficacy of the MFS in identifying high-risk individuals in the long-term care process and its potential for utilising in the selection of fall prevention interventions (Dani and Kurane, 2023). As with these studies, the extant literature has demonstrated that the scale's sensitivity and selectivity rates are adequate for determining the risk of falls, though these rates vary across different studies. These variations are attributed to the methodological framework, the composition of the sample groups, and the cut-off scores employed (Demir and İntepeler, 2012). Nevertheless, the effectiveness of the MFS in predicting falls remains to be elucidated in studies employing the MFS in elderly individuals residing in the community. The present study found that the MFS had a significant effect in predicting the risk of falling. Consequently, it can be posited that the MFS is a reliable instrument for evaluating the risk of falling in older adults. While the MFS is a tool that is suitable for clinical use and offers rapid assessment, current studies indicate that there is no ideal fall risk assessment tool, and that using more than one scale

Table 2
Baseline characteristics of the participants ($N = 195$).

Characteristics	Total (n = 195)	Fall group (n = 50)	Non-fall group (n = 145)	Z/χ^2	P
Age (years) M ± SD	69.82 ± 7.45	75.8 ± 9.44	67.75 ± 5.26	−5.141	0.000
Height (cm) M ± SD	168.32 ± 11.22	167.46 ± 7.96	168.62 ± 12.15	−1.546	0.122
Weight (kg) M ± SD	78.45 ± 11.81	77.54 ± 10.97	78.77 ± 12.11	−0.396	0.692
BMI (kg/m^2) M ± SD	27.38 ± 3.17	27.63 ± 2.95	27.3 ± 3.25	−1.072	0.284
Sex (n, %)	–	–	–	0.002	0.966
Male	98 (50.3 %)	25 (50.0 %)	73 (50.3 %)	–	–
Female	97 (49.7 %)	25 (50.0 %)	72 (49.7 %)	–	–
Medication Use (n, %)	–	–	–	25.396	0.000
Yes	100 (51.3 %)	41 (82.0 %)	59 (40.7 %)	–	–
No	95 (48.7 %)	9 (18.0 %)	86 (59.3 %)	–	–
Smoking (n, %)	–	–	–	0.015	0.902
Yes	52 (26.7 %)	13 (26.0 %)	39 (26.9 %)	–	–
No	143 (73.3 %)	37 (74.0 %)	106 (73.1 %)	–	–
Regular Exercise (n, %)	–	–	–	5.011	0.025
Yes	46 (23.6 %)	6 (12.0 %)	40 (27.6 %)	–	–
No	149 (76.4 %)	44 (88.0 %)	105 (72.4 %)	–	–
Fear of Falling (n, %)	–	–	–	31.509	0.000
Yes	101 (51.8 %)	43 (86.0 %)	58 (40.0 %)	–	–
No	94 (48.2 %)	7 (14.0 %)	87 (60.0 %)	–	–
Chronic Disease (n, %)	–	–	–	27.103	0.000
Yes	98 (50.3 %)	41 (82.0 %)	57 (39.3 %)	–	–
No	97 (49.7 %)	9 (18.0 %)	88 (60.7 %)	–	–
Type of Chronic Disease (n, %)	–	–	–	31.975	0.000
Hypertension	34 (17.4 %)	11 (22.0 %)	23 (15.9 %)	–	–
Diabetes	35 (17.9 %)	14 (28.0 %)	21 (14.5 %)	–	–
Heart Disease	16 (8.2 %)	8 (16.0 %)	8 (5.5 %)	–	–
Lung Disease	13 (6.7 %)	8 (16.0 %)	5 (3.4 %)	–	–
None	97 (49.7 %)	9 (18.0 %)	88 (60.7 %)	–	–

Categorical data are presented as number with percentage (n, %) and compared by chi-square test. Continuous data are presented as mean ± SD, Mann-Whitney U test.
Abbreviations: BMI: body mass index, M ± SD: mean ± standard deviation.

Table 3
Assessment Tools Scores of the Fall and Non-Fall Groups.

Test	Non-Fall Group (n = 145) Median (Q1-Q3)	Fall Group (n = 50) Median (Q1-Q3)	Z	p
Morse Fall Scale (MFS)	42.5 (26.25–58.75)	57.5 (36.25–78.75)	10.516	0.0001
Berg Balance Scale (BBS)	39.0 (31.5–46.5)	23.5 (11.75–35.25)	−9.747	0.0001
Modified Falls Efficacy Scale (MFES)	40.0 (25.0–55.0)	75.5 (48.25–102.75)	−9.153	0.0001
Time Up and Go (TUG)	12.0 (9.0–15.0)	38.0 (23.5–52.5)	−9.942	0.0001

n: sample size, Q1-Q3: First quartile – third quartile, z: Mann-Whitney *U* test statistics.

Table 4
Consistency Between the Fall Risk and the Actual Incidence of Falls.

Test	Risk Group	Fall Group (*n* = 50)	Non-Fall Group (*n* = 145)	Total	Kappa [b]	P
Berg Balance Scale (BBS)	High risk	35 (41.7 %)	49 (58.3 %)	84	0.158	0.000
Berg Balance Scale (BBS)	Moderate to Low risk	1 (0.9 %)	110 (99.1 %)	111	–	–
Time Up and Go (TUG)	High risk	35 (92.1 %)	15 (7.9 %)	38	−0.163	0.000
Time Up and Go (TUG)	Moderate to Low risk	3 (7.9 %)	142 (92.1 %)	157	–	–
Modified Falls Efficacy Scale (MFES)	High risk	31 (62.0 %)	19 (38.0 %)	162	−0.147	0.000
Modified Falls Efficacy Scale (MFES)	Moderate to Low risk	19 (38.0 %)	143 (62.0 %)	33	–	–
Morse Fall Scale (MFS)	High risk	38 (95.0 %)	12 (5.0 %)	40	−0.179	0.000
Morse Fall Scale (MFS)	Moderate to Low risk	2 (5.0 %)	143 (95.0 %)	155	–	–

n: sample size.
[b] A 0.4 < kappa <0.6 indicated general consistency, 0.6 < kappa <0.8 indicated higher consistency, kappa >0.8 indicated good consistency, and kappa <0.4. indicated a poor consistency.

together is more effective (Strini et al., 2021). Consequently, it may be advisable to employ the MFS in conjunction with other risk factors (e.g., frailty, polypharmacy, or environmental hazards), taking into account the individual characteristics of older adults.

The study revealed that the TUG test is a significant predictor of risk of falling in elderly individuals. The TUG test is a widely utilised tool for evaluating the risk of falling in elderly individuals. However, previous studies have indicated that the TUG test has a limited ability to predict the risk of falling and may be insufficient to identify high-risk individuals when used alone (Barry et al., 2014). Consequently, Nunan et al. proposed that the TUG test should be utilised in conjunction with other measurements, as it possesses a limited ability to determine the risk of falling in isolation (Nunan et al., 2018). While these studies indicated that the TUG test was not a significant predictor of the risk of falling in the elderly, it was observed that the test was a highly sensitive outcome measure in determining the risk of falling in the population included in the study. The study by Jalali et al. also demonstrated that a time of 13.75 s above the TUG test predicted the risk of falling with 84.7 % sensitivity and 56 % specificity (Jalali et al., 2015). In fact, it has been reported that the prolongation of the TUG period is associated with a decrease in the individual's muscle strength, lack of postural control and functional capacity, and that dynamic balance and functional mobility increase the risk of falling in elderly individuals (Kwan et al., 2011). This finding lends further support to the notion of a strong correlation between the TUG period and the risk of falling, thereby providing a rationale for the observations made in this study. Consequently, TUG could serve as a valuable tool in the early identification of individuals at risk of falling. Moreover, the simplicity and rapidity of the TUG test offer significant advantages in clinical settings. However, studies reporting contradictory findings suggest that the test should be supported by other measurements. Consequently, TUG alone may not be adequate for evaluating fall risk, and its utilisation in conjunction with measurements known to be sensitive in determining fall risk, such as the Minimum Data Set, will enhance clinical accuracy. Furthermore, while MFS and TUG correlated with fall history in this study, their prospective predictive accuracy requires confirmation in longitudinal designs.

Table 5
Coefficients of Logistic Regression Model.

Variable	B	S.E.	p	Exp (B)	%95 CI (lower - upper)
Modified Falls Efficacy Scale (MFES)	0,027	0,023	0,229	1028	0,983–1074
Morse Fall Scale (MFS)	0,120	0,035	0,001	1128	1053–1208
Time Up and Go (TUG)	0,542	0,191	0,004	1720	1184–2499
Berg Balance Scale (BBS)	−0,027	0,054	0,626	0,974	0,875–1083
Sabit (Constant)	−12,095	2351	0,000	–	–

B = Regression coefficient; S.E. = Standard Error, p = Significance level; Exp(B) = Exponentiated coefficient (Odds Ratio), 95 % CI = 95 % Confidence Interval (Lower – Upper).

In the present study, it was determined that BBS and MFES did not have a significant effect in predicting the risk of falling. Despite the literature asserting a general association between BBS and risk prediction, this relationship was not found to be significant in the present study (Park, 2018; Lima et al., 2018). A recent study posits that BBS is predominantly employed to evaluate balance and mobility, yet its capacity to predict falls remains constrained (Strini et al., 2021). Another study posits that balance tests are generally useful for measuring physical performance, but they may not be directly used to predict the risk of falling (Miura and Kanoya, 2025). Consequently, it can be concluded that BBS alone may be inadequate for evaluating the risk of falling. This can be explained by the fact that the scale focuses more on assessing static balance and is not directly related to daily living activities that require dynamic balance (Miura and Kanoya, 2025). Moreover, the lack of significance for BBS may reflect its ceiling effect in higher-functioning older adults (like our sample). Nevertheless, given the prevalence of BBS in clinical practice for balance and mobility assessment in older adults, its integration with more advanced measurement tools to enhance fall risk prediction holds potential.

The MFES is a practical questionnaire that evaluates individuals' fear of falling and avoidance behaviours related to falling activities. A study with a publication history (McColl et al., 2024) reported a significant relationship between fear of falling and fall risk estimation in older adults. However, the present study revealed that MFES was insufficient in estimating fall risk. MFES's reliance on self-reported confidence could be influenced by recall bias or cultural perceptions of fear. Additionally,

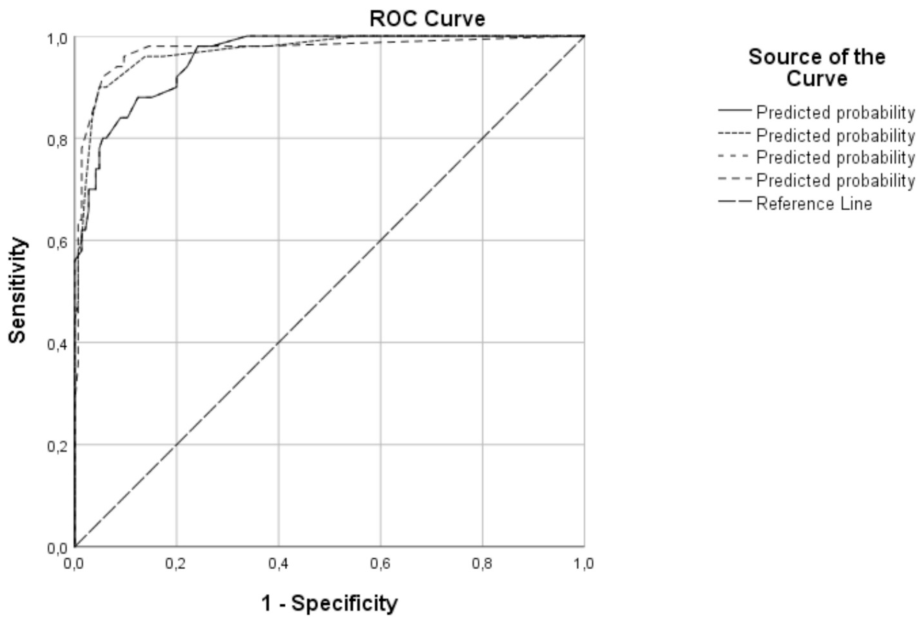

Fig. 1. Predictive values of the assessment for fall risk in older adults.

Table 6
ROC Analysis Results and AUC Values.

Test Variable (Predicted Probability)	AUC Values
Predicted Probability 1	0.958
Predicted Probability 2	0.970
Predicted Probability 3	0.958
Predicted Probability 4	0.972

ROC: Receiver Operating Characteristic, AUC: Area Under the Curve.

the findings of the present study demonstrate that fall risk is more closely associated with physical factors, and that fear of falling may play a lesser role in determining fall risk in higher-functioning populations. This may be explained by the finding that some older individuals use balance strategies effectively despite high fear of falling, or have a risk of falling despite low fear of falling. Nevertheless, given the potential of fear of falling to heighten the risk of falling, it would be beneficial to evaluate the scale in a larger sample or across different age ranges.

A recent study emphasises that multifactorial models are more successful in predicting fall risk (Miura and Kanoya, 2025). In a similar vein, Nunan et al. (2018) posit that models incorporating multiple risk factors demonstrate greater efficacy than a singular test. The utilisation of multifactorial fall risk models has been demonstrated to facilitate enhanced accuracy in clinical decision-making processes. Consequently, when conducting fall risk assessments, it is advised to utilise multifactorial tests such as the Mini-Mental Status Examination and the Tinetti Performance-Based Test in conjunction with a singular scale.

4.2. Limitations and future directions

This study has several limitations that should be acknowledged. First, the cross-sectional design restricts the ability to assess long-term predictive validity or causal relationships between assessment methods and fall risk. A longitudinal approach would provide stronger evidence on the sustained effectiveness of these tools. Second, while logistic regression was used to evaluate predictive ability, potential interaction effects (e.g., between age and assessment methods) were not explored, possibly overlooking important moderating factors. Third, the single-center recruitment and relatively small sample size may limit the generalizability of findings, as fall risk factors and assessment effectiveness could vary across different populations and cultural contexts. Participants were primarily independent older adults in community programs; thus, findings may not generalize to frailer populations or long-term care settings. Fourth, the study focused on physical and psychological assessments (BBS, TUG, MFES, MFS) but did not account for environmental or social support factors, which are known to influence fall risk. To address these limitations, future research should adopt a longitudinal design to assess predictive validity over time, incorporate interaction terms (e.g., age and assessment method) in statistical models, expand to multicenter studies with diverse populations and integrate multidimensional assessments (e.g., environmental and social factors) to optimize fall risk stratification.

5. Conclusions

This study demonstrates that the MFS and TUG tests are significant predictors of fall risk and can yield reliable results in a clinical setting. Our findings suggest that incorporating TUG and MFS assessments into routine geriatric evaluations may facilitate early identification of fall risk and inform targeted interventions.

Multifactorial assessment models have been demonstrated to be more successful. Therefore, it is recommended that a multifaceted approach be employed when evaluating fall risk, incorporating multiple measurement tools. These findings may contribute to the optimisation of clinical assessment processes in older adults and the development of fall prevention strategies.

In clinical practice, it is imperative to determine fall risk measures specifically for the individual. Consequently, in subsequent studies, the development of more comprehensive models is recommended, incorporating fear of falling along with psychosocial and motor factors, as well as other risk factors (e.g., age, medication use, environmental and social factors). Furthermore, conducting studies that evaluate the impact of these variables across diverse populations will enhance the generalisability of the findings.

CRediT authorship contribution statement

Aziz DENGİZ: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Ahmet AYTEPE:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Data curation, Conceptualization. **Bayram**

SIRRI: Writing – review & editing, Writing – original draft, Validation, Software, Resources. **Mehmet EFE:** Investigation, Formal analysis, Data curation, Conceptualization.

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Declaration of competing interest

No potential competing interest was reported by the author(s).

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Data availability

Data will be made available on request.

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