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Evaluating Fall Risk in Hemiplegic Patients: A Cross-Sectional Study with FROP-Com Assessment

Hemiplejik Hastalarda Düşme Riskinin Değerlendirilmesi: FROP-Com Değerlendirmesi ile Yapılan Kesitsel Bir Çalışma

Nuran Eyvaz[1], Ahsen Erkaraca[2], Burak Tozluk[2], Ebru Gürel[2], Esra Nur İzmir[2], Furkan Yanga[2], İlkay Yıldırım[2], Ali İzzet Akçin[3]

[1]Department of Physical Medicine and Rehabilitation, School of Medicine, Afyonkarahisar Health Sciences University, Afyonkarahisar, Türkiye
[2]School of Medicine, Afyonkarahisar Health Sciences University, Afyonkarahisar, 03030, Türkiye
[3]Department of Physical Medicine and Rehabilitation, Şanlıurfa Balıklıgöl State Hospital, Şanlıurfa, 63050, Türkiye

ORCID ID of the authors
NE. 0000-0001-7810-9004
AE. 0009-0008-2655-5609
BT. 0009-0003-5036-2253
EG. 0009-0004-9557-6914
ENİ. 0009-0002-4104-7078
FY. 0009-0001-0249-8899
İY. 0009-0006-2986-3151
AİA. 0000-0001-5751-0333

Correspondence / Sorumlu yazar:
Nuran EYVAZ

Department of Physical Medicine and Rehabilitation, School of Medicine, Afyonkarahisar Health Sciences University, Afyonkarahisar, Türkiye

e-mail: eycaznuran@gmail.com

Abstract: Falls are a major concern for hemiplegic stroke patients, often leading to serious injuries and reduced quality of life. Identifying at-risk individuals is crucial for effective prevention. This study assesses fall risk prevalence and associated factors in hemiplegic patients using the Falls Risk for Older People in the Community (FROP-Com) and determines stroke-specific cutoff values. Additionally, it examines its relationship with the Timed Up and Go (TUG) test and Tinetti Performance-Oriented Mobility Assessment (POMA). This cross-sectional study included hemiplegic stroke patients. Fall risk was assessed using the FROP-Com, while mobility was evaluated with the Tinetti POMA and TUG test. Clinical characteristics such as age, stroke duration, functional mobility, and fall history were recorded. Correlations between assessment tools were analyzed, and a cutoff value for high fall risk was established. Sixty patients were analyzed (mean age 59.28±7.02 years; 66.7% male; 72% ischemic stroke). Falls were reported in 41.7% of patients, with 48% sustaining injuries. Most falls occurred indoors (56%), with balance loss being the primary cause (52%). Patients with a history of falls had significantly lower POMA scores and higher FROP-Com and TUG scores ($p<0.05$). The FROP-Com fall risk cutoff was 21 (AUC=0.78, sensitivity=68%, specificity=85.7%). The FROP-Com is a valuable tool for assessing fall risk in hemiplegic stroke patients, aiding in the identification of high-risk individuals and supporting targeted prevention strategies.
Keywords: Hemiplegia, Stroke, Fall risk, FROP-Com.

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Özet: Düşmeler, hemiplejik inme hastalarında ciddi yaralanmalara ve yaşam kalitesinin azalmasına yol açmaktadır. Risk altındaki bireylerin belirlenmesi, önleyici tedbirler için kritik öneme sahiptir. Bu çalışma, hemiplejik hastalarda Düşme Riski için Yaşlı İnsanlarda Değerlendirme Anketi (FROP-Com) ile düşme riski prevalansını ve ilişkili faktörleri değerlendirmeyi amaçlamaktadır. Ayrıca, FROP-Com için inme spesifik eşik değerlerini belirleyerek Timed Up and Go (TUG) testi ve Tinetti Performans Odaklı Mobilite Değerlendirmesi (POMA) ile ilişkisini incelemektedir. Bu kesitsel çalışmada hemiplejik inme hastalarının düşme riski FROP-Com ile, mobiliteleri ise Tinetti POMA ve TUG testi ile değerlendirildi. Yaş, inme süresi, fonksiyonel mobilite ve düşme öyküsü gibi klinik veriler kaydedildi. Değerlendirme araçlarının skorları arasındaki korelasyonlar analiz edilerek FROP-Com için yüksek düşme riski eşik değeri belirlendi. Toplam 60 hasta incelendi (ortalama yaş 59.28±7.02 yıl; %66.7 erkek; %72 iskemik inme). Hastaların %41.7'si düşme öyküsü bildirdi, yaralanma oranı %48'di. Düşmelerin %56'sı iç mekânda, en yaygın yönü öne doğru (%40) ve nedeni denge kaybıydı (%52). Düşen hastalarda POMA skoru düşük, FROP-Com ve TUG skorları anlamlı derecede yüksekti ($p<0.05$). FROP-Com eşik değeri 21 olarak hesaplandı (AUC=0.78, duyarlılık=68%, özgüllük=85.7%). FROP-Com, hemiplejik inme hastalarında düşme riskini belirlemede etkili bir araçtır. Bu bulgular, yüksek riskli bireylerin tespitinde ve önleyici stratejilerin uygulanmasında klinik önemini vurgulamaktadır.
Anahtar Kelimeler: Hemipleji, İnme, Düşme riski, FROP-Com.

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1. Introduction

Stroke is the second leading cause of death globally and is also an important health issue, resulting in considerable morbidity (1). In the post-stroke period, hemiplegic survivors may encounter issues including motor control loss, altered gait patterns, postural instability, spasticity, sensory and proprioceptive deficits, cognitive disorders and balance coordination difficulties (2).

Falling is a prevalent complication in hemiplegic individuals, closely connected to balance loss due to impaired balance reactions and increased postural oscillations. Studies have shown that the prevalence of falls in hemiplegic individuals is nearly twice as high in the chronic phase compared to older adults without a stroke. Approximately 75% of these individuals report having a fall within six months of hospital discharge (3). A high level of fear of falling and frequent falls among hemiplegic patients can limit rehabilitation participation, reduce mobility, and impair independence, potentially increasing mortality (4).

Assessing mobility in stroke patients is crucial, as reduced functional mobility due to an increased fall risk is closely tied to balance and walking performance. Tools like the Tinetti Performance-Oriented Mobility Assessment (POMA) and Timed Up and Go (TUG) tests are particularly useful for this assessment (5).

The FROP-Com (Falls Risk of Older People-Community Setting) tool, originally designed for older people, is also highly relevant for assessing fall risk in hemiplegic patients. Its comprehensive assessment of various factors makes it a valuable resource for healthcare professionals to identify potential risks of falling (6). The FROP-Com screening tool has been extensively used to evaluate fall risk across various populations, including older adults, post-operative patients following unilateral total hip arthroplasty, and diabetic patients (7, 8, 9). More recently, one of the few studies involving community-dwelling stroke survivors and healthy individuals reported that the FROP-Com demonstrated moderate inter-rater and test-retest reliability among stroke survivors (10). On the other hand, few studies have examined the relationship between falls and mobility in stroke patients, with limited research focusing on these factors in stroke rehabilitation (11,5). This study aims to determine the frequency of fall risk and related factors in hemiplegic patients using the FROP-Com assessment. However, the study also seeks to investigate stroke-specific cut-off values for the FROP-Com in evaluating fall risk and examine its relationship with the TUG test and the Tinetti POMA clinical scores.

2. Materials and Methods

a. Study Design

Sixty patients with chronic stroke were prospectively recruited (40 men; mean age, 59.6 years). This observational study was conducted based on assessments made during the inpatient period at the rehabilitation unit of XXX Health Sciences University Hospital. Ethical approval for this study was granted by the XXX Health Sciences University Medical Ethics Committee. The study was conducted in full compliance with the principles outlined in the Declaration of Helsinki.

b. Subjects

Inclusion criteria:
(1) History of ischemic or hemorrhagic stroke at least six months prior
(2) Age between 50 and 80 years
(3) Lower extremity Brunnstrom Recovery Stage (BRS) of 3–5
(4) Ability to walk independently for 5 meters with or without a gait aid

Exclusion criteria:

(1) Bilateral hemiplegia
(2) Cognitive impairment (Mini-Mental State Examination score <23)
(3) Visual or hearing impairments
(4) Severe comorbidities (cardiovascular, hepatic, renal)
(5) Malignancy

c. Study procedures

The researcher thoroughly explained the study procedures to potential participants, addressed their questions, and obtained informed consent from each participant. Demographic information such as participants' age, sex, stroke duration, and stroke type (ischemic, hemorrhagic) was collected at the beginning of the assessments. Subsequently, the Brunnstrom staging level for the lower extremities was assessed. All evaluations were performed in a single session.

Clinical assessments of Mobility and Balance

The Tinetti POMA is widely used in clinical settings to assess mobility and balance, especially in populations with mobility impairments such as stroke patients. It consists of two components: gait (POMA-G) and balance (POMA-B). POMA is a valid and reliable tool for assessing mobility and balance in stroke patients (12). POMA, totaling 28 points, consists of 9 items for balance (POMA-B) and 7 for gait (POMA-G), with a maximum score of 16 for balance and 12 for gait. The balance component assesses the patient's ability to maintain postural control in various situations, including sitting still, rising from a chair, immediately after standing, standing with eyes open and closed, turning 360°, and during external disturbances. The gait component evaluates symmetry, initiation, continuity, path, base of support, and postural sway during walking. In the POMA, individuals who score 19 or below are classified as being at high risk for falls (13).

TUG test is a tool used for assessing dynamic balance, mobility, and fall risk. During the test, the patient begins seated in a standard chair, rises to a standing position, walks a distance of 3 meters at a normal pace, turns around, and returns to sit in the chair. Participants were allowed to use the arms of the chair to assist in both standing up and sitting down. The time taken for each movement was recorded in seconds by a single rater using a handheld stopwatch, with the best of two trials (separated by a 10-minute rest) used for evaluation (14). The TUG test has demonstrated excellent test-retest reliability (ICC = 0.96) in individuals with stroke (15).

Falls risk assessment

FROP-Com is an assessment parameter that evaluates fall risk factors using an ordinal scoring system (0-3) or double scoring to determine the total score. It includes aspects such as fall history, medication review, cognitive and physiological status, environmental assessment, functional ability in daily living, and balance and mobility evaluation. Its comprehensive nature renders it a valuable instrument for assessing multiple dimensions of fall risk in hemiplegic patients. A score between 0-20 indicates a low-moderate fall risk, while a score between 21-60 signifies a high fall risk (16).

d. Statistical analysis

The data were analyzed using IBM SPSS version 25.0. The normality of the distribution of numerical variables was assessed using the Shapiro-Wilk test. For numerical variables that followed a normal distribution (age, Tinetti POMA total, FROP-Com), comparisons between groups were made using the T-test. For variables not following a normal distribution, comparisons were made using the Mann-Whitney U test. Relationships between categorical variables were examined using Chi-square analysis, while relationships between continuous variables were assessed using Pearson correlation analysis. Statistical significance was set at $p < 0.05$. For the measures which were able to discriminate fallers from the non-fallers, the Receiver Operating Characteristics (ROC) and the Area Under the ROC Curve (AUC) were calculated, including the 95% confidence intervals. AUC was classified as follows: AUC <0.5 indicates chance; $0.5 < AUC \leq 0.7$ indicates low accuracy; $0.7 < AUC \leq 0.9$ indicates moderate accuracy; and $0.9 < AUC < 1.0$ indicates high accuracy.

3. Results

Out of the 70 individuals screened, 10 were excluded, including 6 for cognitive impairments, 1 for a non-stroke-related condition, and 3 for bilateral stroke. The demographic data of the 60 patients included in this study are presented in Table 1. The mean age of the participants was 59,28 years (SD = 7.02), and 66.7% of them were male. Right hemiplegia was observed in 58.3% of the patients. Approximately 72% of the participants had an ischemic stroke. Furthermore, 41.7% had experienced at least one fall in the past year. In patients who experienced a fall, the injury rate following the fall was found to be 48%.

The medication use investigated in this study comprises several categories, including antihypertensives, antiarrhythmics, anticoagulants, antidiabetics, antispasmodics, antidepressants, central analgesics, and osteoporosis medications. When the number of medication groups used by the patients was assessed, it was found that approximately 73.3% were using more than four groups of medications (Table 1). The most commonly used medication groups were antihypertensives at 53.3%, antiplatelet therapy at 50%, and central analgesics at 36.7%.

Analysis of the environments in which patients experienced falls revealed that 56% of these incidents occurred indoors. The most common direction of the fall was forward (40%).When considering the time of the falls, 60% of the falls in patients occurred between 6:00 AM and 6:00 PM, with the most frequent occurrence observed between 3:00 PM and

4:00 PM (27%) . As for the cause of the fall, 52% of the patients reported losing their balance (Figure 1). The rate of injuries following falls was found to be 48%. Among these injuries, the most frequent were bruises (66.7%), followed by fractures (16.7%), and muscle, joint, or tendon injuries (5.6%).

Table 2 presents a comparison of POMA-B and POMA-G scores, TUG test, and FROP-Com fall risk scores between the groups. In the comparison of the two groups, individuals who experienced falls demonstrated statistically significant lower scores in POMA-B, POMA-G, and POMA total assessments, while the TUG test and FROP-Com fall risk scores were significantly higher (p=0.044, p=0.025, p=0.042, p= 0.040, p= 0.000, respectively).

The patients' data were analyzed using Pearson correlation analysis. A moderate positive correlation was observed between Brunnstrom lower extremity stages and Tinetti POMA scores, as well as in fall risk assessment using the TUG test and FROP-Com scores. A strong negative correlation was observed between TUG test and Tinetti POMA scores (POMA total r= -0.80, POMA - B r= -0.77, POMA - G r=-0.75 p=0.001 respectively)(Figure 2A). As the duration of the TUG test, which assesses patients' functional mobility, increased—indicative of poorer mobility where patients required more time to walk the same distance—a corresponding increase in the POMA scores was observed. Additionally, a moderate negative correlation was present between FROP-Com scores and the Tinetti POMA scores (POMA total r= -0.61, POMA - B r= -0.053, POMA - G r=-0.61, p=0.001) . A moderate positive correlation was found between TUG test duration and FROP-com scores, indicating a high fall risk (r = 0.61 p=0.000)(Figure 2B). It was observed that patients who fell obtained higher risk scores on the FROP-Com assessment.

In the conducted ROC analysis, the cut-off value for FROP-Com was determined to be 21 in hemiplegic patients. When this established cut-off score was applied, the accuracy was evaluated at 78%, with a sensitivity of 68.0% and a specificity of 85.7% (Figure 3).

Table 1. Baseline characteristics of the participants with stroke

Characteristics		**Entire Sample n=60**	**Non-fallers n=35 (%)**	**Fallers n=25 (%)**	**p**
Age (year) (mean±SD)		59,28±7.02	58.65±7.10	60.01±6.96	0.418
Sex, n	**Female**	20 (33.3)	10 (28.6)	10 (40)	0.355
	Male	40 (66.7)	25 (71.4)	15(60)	
Stroke type	**Ischaemic**	43 (71.6)	25(71.4)	18(72)	0.961
	Hemorrhagic	17 (28.3)	10 (28.6)	7 (28)	
Post-stroke time (year, mean±SD)		39.03±47.63	40.45±54.45	37.04±38.02	0.787
Hemiplegic side	**Right/Left**	35/25	19/16	16/9	0.452
BRS-LE	**3/4/5**	34/9/15	18/5/12	16/6/3	0.238
Number of taking medicine	**1-2**	11	9(25.7)	2 (8)	0.170
	3	5	3(8.6)	2(8)	
	>4	44	23 (65.7)	21(84)	
Taking centrally acting drugs	**Yes**	22 (36.7)	13(37.1)	9(36)	0.928
	No	38 (63.3)	22(62.9)	16(64)	
Mobility aid use	**Cane/unaided**	30/ 30	15/20	15/10	0.140

n, number; SD, standard deviation, BRS-LE: Brunnstrom recovery stage lower extremity,

Table 2. Clinical parameters of participants with stroke (non-fallers versus fallers)

Characteristics	Entire sample	Non-fallers (mean±SD)	Fallers (mean±SD)	Mean differences	Effect size	P
POMA-B	10.40±3.91	11.05±4.24	9.48±3.26	1.57	0.408	**0.044***
POMA-G	5.81±2.69	6.51±2.93	4.84±1.99	1.67	0.647	**0.025***
POMA-Total	16.10±6.02	17.37±6.51	14.32±4.83	3.05	0.519	**0.042***
TUG	34.6±20.2	30.85±19.45	39.88±20.59	-9.02	0.267	**0.040***
FROP-Com	19.6±7.4	16.17±5.49	24.48±7.29	-8.30	0.306	**0.000***

*n, number; SD, standard deviation, POMA-B: Performance-oriented mobility assessment balance, POMA-G: Performance-oriented mobility assessment gait, TUG: Timed-up and go test, FROP-com : The falls risk for older people in the community screening tool, * p < 0.05.*

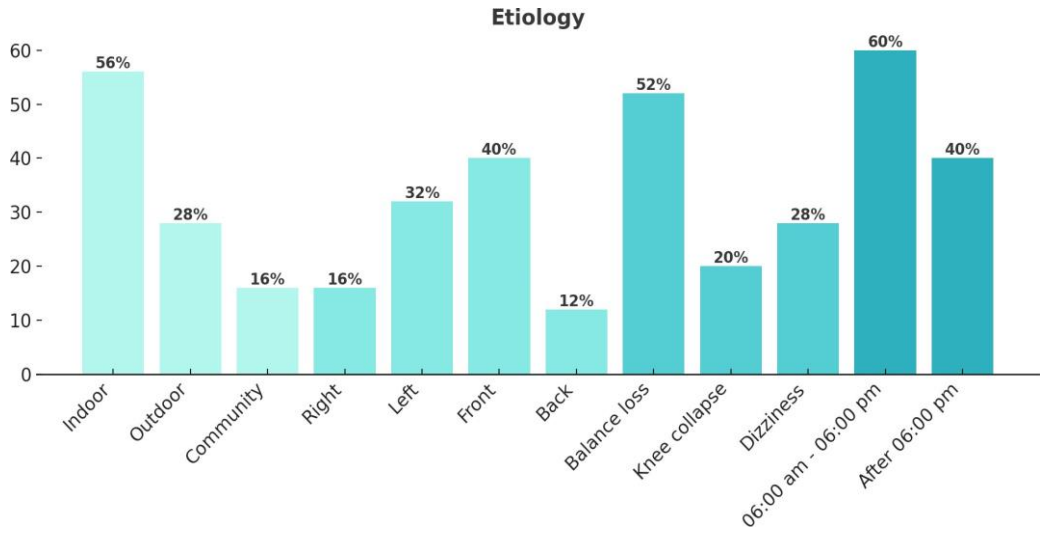

Figure 1. Falls etiology

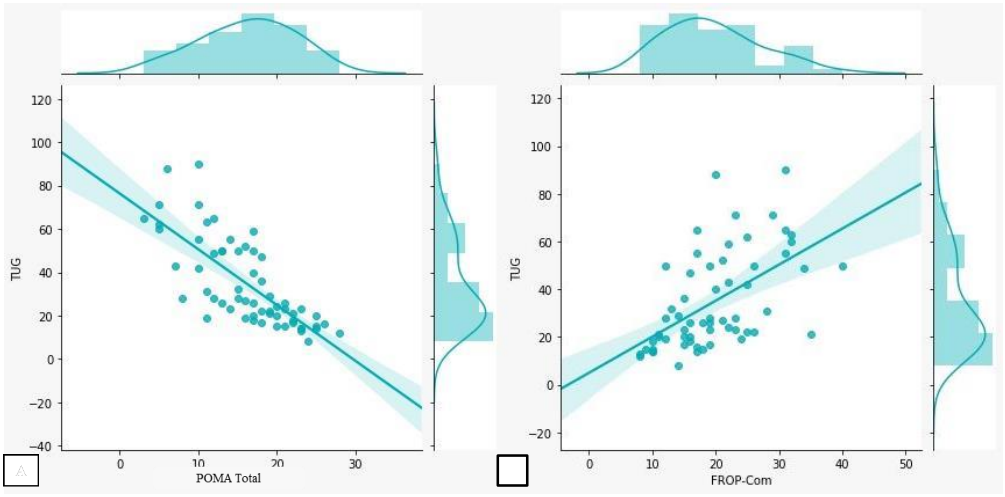

Figure 2. Correlation Analysis of Clinical Scores; A: TUG and POMA total correlation, B: TUG and FROP-Com correlation.

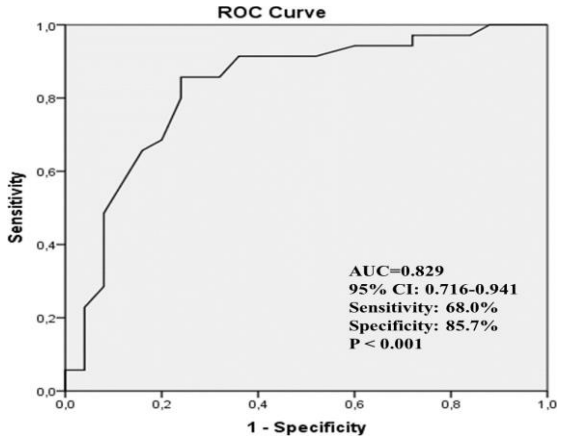

Figure 3. ROC curve of FROP-com assessment

4. Discussion

The main findings of this study indicate a negative correlation between the Tinetti POMA and FROP-Com scores, and a positive correlation between TUG test and FROP-Com scores in chronic stroke survivors. Patients with low mobility and balance scores tend to have higher scores in the comprehensive fall risk assessment using FROP-Com (especially with a cut off of 21), clearly indicating an increased fall risk in this population.

Falls are a common and critical issue among stroke survivors, with 14% to 65% experiencing falls during hospitalization and up to 73% reporting at least one fall within the first six months following discharge (17). Gren et al.'s study found that among 143 patients who had experienced a stroke one year prior, the fall rate was 35.3% during the first 9 months (18). Other studies have reported that the fall rate for experiencing at least one fall within 12 months post-stroke is approximately 40% (19,20). In alignment with the existing literature, the findings of this study revealed that 41.7% of hemiplegic patients experienced a fall within the past year.

Polypharmacy is an important parameter among the risk factors for falls. In this study it was found that 73.3% of the fallers were using four or more medications (most commonly antihypertensives, at 53.3%). Saverino et al. reported that, similar to our findings, 93% of patients who experienced falls in a rehabilitation center were on polypharmacy, with antihypertensives being the most commonly used medication group at 76% (21). Tsur et al. reported that, in stroke patients, 89% of those who

experienced falls were using multiple medications, including antihypertensive, antidiabetic, sedative, or neuroleptic drugs (22). In a study similar to this one, antihypertensive drugs were the most commonly used medication group among stroke patients who experienced falls, accounting for 64.7% (23). On the other hand, a recent systematic review and meta-analysis revealed a three-fold increased risk of falls associated with the use of sedative/psychotropic medications as a risk factor for falls among community stroke survivors (24).

In the literature, it is well-documented that falls frequently occur indoors (especially at home), aligning with the findings of our study (25). It has been reported that indoor falls are associated with tripping hazards, such as loose carpets and poor lighting, and in our study, patients indicated that environmental modifications were needed (26). Studies on the environments where patient falls occur have reported that, during hospital monitoring, 38.8% of falls happen in the bathroom, while 27.8% occur near the bedside (27). Tsur et al. noted that falls most frequently occurred near the patient's bed (62%), particularly during transfers from a sitting to a standing position. Other common locations included the bathroom/toilet, corridor, physiotherapy unit, and dining room. (22).

Mackintosh et al. emphasized that a low Berg Balance Score is an effective predictor of two or more falls within 6 months after discharge from stroke rehabilitation. This aligns with our findings, as more than half of our patients (52%) identified loss of balance as the cause of their fall (28). In the literature, as in our study, it is stated that falls occur most frequently during the daytime in stroke patients (ranging from 45% to 85%) (29, 30, 22). Although the exact time interval for falls varies across studies, Track KA et al. observed that the periods between 6:00 AM and 10:00 AM and between 4:00 PM and 8:00 PM are riskier (31).

In our study, the rate of injuries following falls was found to be 48%, while Hydman et al. reported that 31% of falls resulted in injury. In parallel with our findings, the most common injuries were bruises, grazes, and lacerations (24%), followed by fractures (6%) (e.g., fractures of the collarbone, pelvis, ribs, and thumb) (32). On the other hand, they found no significant differences in the number and types of injuries between one-time fallers and repeat fallers. Similarly, Simpson et al. evaluated 40 stroke patients and observed that bruises were the most common injury in both single and repeated falls. (25).

Balance has been widely identified as an independent predictor of falls in individuals with a history of stroke (33). Simpson et al. reported that TUG test performance is a robust predictor of fall risk in individuals with chronic stroke, demonstrating that prolonged TUG times, which reflect impairments in both balance and gait abilities, are associated with an increased risk of falls in patients with scores exceeding 15 seconds (25). Additionally, a recent study confirmed the POMA's effectiveness as a reliable tool for assessing balance and mobility in stroke survivors, showing that it not only evaluates balance ability but also predicts fall risk. With a cutoff value of 12.5, the study found that stroke patients with a balance score below this threshold had a 0.304-fold increase in fall risk (34). Similarly, in our study, the statistically significant differences in TUG and POMA-B scores in favor of the fallers can also be attributed to this finding.

Additionally, according to the results of the correlation analysis, higher Tinetti POMA-B scores are associated with shorter TUG test durations and lower FROP-Com scores, suggesting that as clinical scores improve, the risk of falls decreases. Furthermore, the moderate positive correlation observed between the TUG test and FROP-Com scores in our study aligns with findings from previous literature (10). As reported by Shamay et al., the FROP-Com test demonstrates a strong correlation with self-reported balance confidence levels compared to dynamic balance measures such as the BBS and the TUG test, while also exhibiting strong concurrent validity with objective balance measures and a strong correlation with subjective balance confidence assessments, along with moderate inter-rater and test-retest reliability (10).

In another study, involving 213 individuals aged 60 to 90 years who presented to the emergency department following a fall and were diagnosed with a variety of diseases, the FROP-Com screening tool was employed to assess fall risk. With a cut-off score of ≥19, the tool demonstrated a sensitivity of 43. 4% and a specificity of 79. 4% in predicting future falls. The higher sensitivity observed in our study may be attributed to the more homogeneous nature of our sample, which comprised individuals with similar risk factors (9).

The FROP-Com, with the stroke-specific cut-off value identified in our study, demonstrates considerable potential as a reliable tool for fall risk assessment. By incorporating these thresholds, targeted rehabilitation strategies can be devised,

thereby contributing to the effective prevention of fall-related comorbidities.

Limitation

The major strength of the present study was the establishment of specific FROP-Com cut-off value for individuals who have had stroke. However, the study has some limitations. The sample size is relatively small, which may limit generalizability across different subgroups of stroke survivors. Additionally, the use of medications that can affect balance (e.g., hypnotics, sedatives, and blood pressure medications) is another limitation. Future studies should focus on larger and more diverse stroke samples, taking into account differences in stroke severity and duration, to increase the generalizability of the findings.

5. Conclusion

Balance impairments and reduced mobility in stroke patients are significant contributors to an increased risk of falls. Clinical assessments, including the TUG test, the POMA, and the FROP-Com scale, are valuable tools for evaluating fall risk in this population. This study underscores the importance of integrating these assessments into clinical practice to inform targeted rehabilitation and fall-prevention strategies. Notably, the FROP-Com, with a recommended cut-off score of 21 points, effectively distinguishes fallers from non-fallers among individuals with chronic stroke. Integrating such assessments into rehabilitation can help design individualized interventions to improve mobility and reduce long-term fall risk, particularly through focused strategies during and post-rehabilitation.

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