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ORIGINAL ARTICLE / ORİJİNAL MAKALE

Development of the ITAKI II Fall Risk Assessment Scale and Evaluation of Its Psychometric Properties

İTAKİ II Düşme Riski Değerlendirme Ölçeği'nin Geliştirilmesi ve Psikometrik Özelliklerinin Değerlendirilmesi

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Abstract

Background: The key to preventing patient falls, which can cause severe injuries, is identifying high-risk individuals, yet current assessment tools remain limited in accuracy.

Objectives: To develop a tool for assessing fall risk in adult patients and evaluate its validity and reliability.

Methods: The study used a methodological, cross-sectional design involving 1,173 patients aged 18+ across 11 hospitals in Türkiye. The risk assessment tool was developed based on a literature review and expert opinions, with its content validity evaluated using the Content Validity Index. Inter-rater reliability was measured using the Kappa statistic, and internal consistency was assessed using the Kuder-Richardson 20 (KR-20) coefficient. The tool's discriminative power was evaluated through Receiver Operating Characteristic (ROC) analysis. The risk factors included in the developed tool were classified according to the World Health Organization's International Classification of Functioning, Disability, and Health Model (ICF). The developed risk assessment tool was called ITAKI II Fall Risk Assessment Tool.

Results: The developed risk assessment tool included a total of 13 risk factors. The tool demonstrated a Content Validity Index of .963, an area under the ROC curve value of .809, an inter-rater agreement (Kappa) of .91, and an internal consistency coefficient (Kuder-Richardson 20) of .568.

Conclusion: The newly developed ITAKI II Fall Risk Assessment Tool effectively identifies patients at high risk of falling. Its structure, which aligns with the ICF model, enhances comparability of data at both national and international levels and contributes to patient safety practices.

Key words: Patient Fall, Risk Assessment, ITAKI, Scale Development

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Öz

Giriş: Hastalarda ciddi yaralanmalara neden olan düşmelerin önlenebilmesi için düşme riski yüksek hastaların belirlenmesi öncelikli girişimdir. Ancak mevcut risk değerlendirme araçları bu konuda sınırlılık göstermektedir.

Amaç: Yetişkin hastaların risk değerlendirmesinde kullanılacak bir aracın geliştirilmesi, geçerlik ve güvenirliğinin değerlendirilmesi hedeflenmiştir.

Yöntem: Araştırma metodolojik ve kesitsel tanımlayıcı bir tasarıma sahiptir. Çalışma, Türkiye'de 11 farklı hastanede 18 yaş üstü 1173 hastayı kapsayacak şekilde gerçekleştirilmiştir. Risk değerlendirme aracı literatür taraması ve uzman görüşleri doğrultusunda geliştirilmiş, içerik geçerliği İçerik Geçerlik İndeksi yöntemiyle değerlendirilmiştir. Değerlendiriciler arası güvenirlik Kappa istatistiği ile, iç tutarlılık ise Kuder-Richardson 20 ile ölçülmüştür. Aracın ayırt etme gücü ROC analiziyle değerlendirilmiştir. Araçta yer alan risk faktörleri Dünya Sağlık Örgütü tarafından geliştirilen İşlevsellik, Yetiyitimi ve Sağlığın Uluslararası Sınıflandırılması Modeli'nin grupları doğrultusunda sınıflandırılmıştır. Geliştirilen risk değerlendirme aracı İTAKİ II Düşme Riski Değerlendirme Aracı olarak isimlendirilmiştir.

Bulgular: Geliştirilen risk değerlendirme aracında toplam 13 risk faktörü yer almıştır. Aracın İçerik Geçerlik İndeksi .963, ROC eğrisi altında kalan alan değeri .809, değerlendiriciler arası uyum değeri (Kappa) .91, iç tutarlılık katsayısı (Kuder Richardson-20) .568 olarak hesaplanmıştır.

Sonuç: Geliştirilen İTAKİ II Düşme Riski Değerlendirme Aracı, düşme riski yüksek hastaları başarılı şekilde ayırt etmektedir. İşlevsellik, Yetiyitimi ve Sağlığın Uluslararası Sınıflandırılması Modeli ile uyumlu yapısı, ulusal ve uluslararası düzeyde veri karşılaştırılabilirliğini artırarak hasta güvenliği uygulamalarına katkı sağlayacaktır.

Anahtar Kelimeler: Hasta Düşmeleri, Risk Değerlendirme, İTAKİ, Ölçek Geliştirme

INTRODUCTION

The American Nurses Association (ANA) defines patient falls as "an unplanned descent to the floor, with or without injury to the patient" (National Quality Forum, 2011). Falls are among the most frequently occurring incidents in healthcare settings and can lead to severe physical and mental complications for patients (Eckstrom et al., 2024). Beyond their detrimental effects on patients, falls also pose a significant financial burden. A study conducted in Türkiye found that falls resulting in serious injuries extend hospital stays by an average of 14.61 days and increase hospital costs by approximately $3,302.60 (Baris et al., 2018). Given their physical, psychological, and economic consequences, preventing patient falls has become a top priority for healthcare professionals and researchers worldwide.

Research has shown that patients with certain characteristics—such as advanced age, cognitive impairment, a history of falls, and vision impairment—are more likely to experience falls (Altın et al., 2020; Jehu et al., 2021). Studies also report that preventive interventions tailored to these risk factors are highly effective in reducing patient falls (Cameron et al., 2018; Bhasin et al., 2020). In this context, assessing patients for these risk factors and identifying those at high risk is considered a key strategy in fall prevention efforts (Montero-Odasso et al., 2022).

Numerous tools have been developed in the literature to assess patient fall risks, including the Morse Fall Scale, Hendrich II Fall Risk Model, and STRATIFY Fall Risk Assessment Tool. However, a major challenge in this process is the limited ability of these assessment tools

to accurately distinguish high-risk patients (Park, 2018; Strini et al., 2021).

In Türkiye, patient falls are considered a critical issue, and the Ministry of Health emphasizes the importance of fall risk assessment in hospitals. According to the Healthcare Quality Standards - Hospital guidelines issued by the Ministry, patients must be evaluated using a nationally or internationally recognized fall risk assessment tool (Ministry of Health, 2020). In line with this standard, the ITAKI Fall Risk Scale, developed by the Ministry of Health, is widely used in both public and private hospitals for adult patients (Ministry of Health, 2020). However, research has shown that the ITAKI scale has limited effectiveness in accurately identifying high-risk patients (Baris et al., 2020).

Accurately classifying risk factors is just as important as identifying them. A standardized, internationally recognized classification of fall risk factors facilitates data comparison across institutions, enhances the interpretation of research findings, and helps prioritize areas for fall prevention strategies (Baris & Intepeler Seren, 2019).

While various classification systems exist in the literature, the lack of a standardized approach remains a significant challenge. As a solution, the World Health Organization's (WHO) International Classification of Functioning, Disability and Health (ICF) model has gained widespread international acceptance for categorizing health-related factors (Govoni et al., 2022; Ong et al., 2023).

This study aims to update the ITAKI Fall Risk Scale by developing a new fall risk assessment tool aligned with the WHO's ICF model. The effectiveness of this updated tool in identifying high-risk patients will also be evaluated. By integrating an internationally recognized classification system, the new tool will enable standardized categorization of patient risk factors, facilitating more accurate interpretation of fall-related causes and helping hospitals and researchers identify priority areas for prevention efforts.

Despite the existence of numerous fall risk assessment tools, no widely used tool has been found that classifies risk factors according to an internationally accepted model (Park et al., 2018; Strini et al., 2021). The decision to adopt the ICF framework was based on its ability to capture the multidimensional nature of fall risk. Unlike conventional classifications that often emphasize only medical or functional aspects, the ICF provides a standardized taxonomy encompassing personal, biological, psychological, and environmental factors. Using this internationally recognized framework ensures that the developed tool is not only clinically meaningful within the Turkish context but also facilitates comparability of data across different countries and healthcare systems. Moreover, the ICF's holistic perspective aligns with the multifactorial nature of patient falls, enhancing the tool's usability in both practice and research.

Purpose

The aim of this study is to update the ITAKI Fall Risk Scale by developing a new fall risk assessment tool aligned with the World Health Organization's (WHO) International Classification of Functioning, Disability, and Health (ICF) model and to evaluate its effectiveness in identifying high-risk patients. To distinguish it from the original ITAKI scale, the newly developed tool is referred to as the ITAKI II Fall Risk Assessment Tool throughout this paper.

METHOD

The Type of the Research

The study adopts a methodological and cross-sectional descriptive design.

The Place of the Research

The study was conducted in 11 different hospitals located in eight cities across seven regions of Türkiye. These hospitals include five university hospitals, one city hospital, and five training and research hospitals. The hospitals where the research was conducted are presented in Table 1.

Tablo 1. Regions and Hospitals

Region	City	Hospital
Marmara	Istanbul	· 1 University · 1 Training and Research
Central Anatolia	Ankara Konya	· 1 University · 1 State
Aegean	Izmir	· 1 University
Mediterranean	Antalya	· 1 Training and Research
Eastern Anatolia	Erzurum	· 1 University · 1 Training and Research
Southeastern Anatolia	Diyarbakir	· 1 University
Black Sea	Samsun	· 1 University · 1 Training and Research

The newly developed scale is intended for use in all adult units. Therefore, to ensure a diverse and representative sample, the study was conducted in one internal medicine unit, one surgical unit, one intensive care unit, and one emergency department within each hospital. The selection of these hospital units was determined through meetings with hospital quality coordinators.

The Universe/Sample of the Research

The target population for the adult fall risk assessment tool developed in this study includes all patients aged 18 and older.

To determine the required sample size, calculations commonly used for diagnostic tools, as outlined by Bujang and Adnan (2016), were utilized. In Türkiye, the prevalence of falls among adult patients has been reported to range between 0.8% and 3.6% (Baris & Intepeler Seren, 2024; Kisacik & Cigerci, 2019). However, for sample size calculations, the minimum prevalence rate of 5%, as suggested by Bujang and Adnan (2016), was used.

Based on a fall prevalence of 5% and assuming a sensitivity range of 70% to 90% for fall risk assessment tools, the required minimum sample size was calculated as 620 patients, including at least 31 patients with a history of falls (80% power, 0.05 statistical significance level).

To account for potential data loss during the research process, the study aims to recruit a total of 1,000 patients, including at least 40 patients who have experienced a fall, for validity assessment.

Data Collection Instrument-Validity and Reliability Information

The fall risk assessment scale for adult patients

was developed in three stages:

- **Development of the risk assessment tool**

Determining the Items for the Risk Assessment Tool

To identify the risk factors to be included in the fall risk assessment tool, a comprehensive literature review was conducted (Eckstrom et al., 2024; Jehu et al., 2021; Altın et al., 2020; Montero-Odasso et al., 2022). Based on the findings from the literature and the researchers' expertise, a preliminary list of potential risk factors was created.

To ensure input from experienced professionals working with diverse patient populations across different hospital types, expert opinions were gathered from 15 nurses. These nurses were selected from a university hospital, a training and research hospital, and a state hospital, covering the internal medicine, surgical, emergency, intensive care, and quality units of each hospital. All nurses had at least five years of professional experience.

Expert feedback was obtained through an online panel discussion, where the literature findings, clinical conditions, usability, and comprehensiveness of the risk assessment tool were evaluated. Based on these discussions, the final set of risk factors to be included in the assessment tool was determined.

Evaluating the Content Validity of the Risk Assessment Tool

The content validity of the developed risk assessment tool was assessed using the Content Validity Index (CVI). Expert opinions were utilized for this evaluation, and 10 experts with doctoral degrees and expertise in patient falls were selected. The experts evaluated each item in the tool using a four-point Likert scale (1 = Not appropriate, 2 = Somewhat appropriate, 3 = Quite appropriate, 4 = Highly appropriate). The Item Content Validity Index (I-CVI) was calculated as the proportion of experts who rated an item as 3 or 4, while the Scale Content Validity Index (S-CVI) was determined as the proportion of items rated 3 or 4 across all items (Polit & Beck, 2006). As a result, the I-CVI values of the developed tool ranged between .90 and 1.00, while the S-CVI value was determined to be .963, indicating a high level of content validity.

- Classification of the Items in the Risk Assessment Tool within the International Classification of Functioning, Disability, and Health (ICF) Model

To support the national and international use of the developed risk assessment tool, the risk factors included in this tool have been classified based on the International Classification of Functioning, Disability, and Health (ICF) model developed by the World Health Organization (WHO). This approach aims to standardize the classification of fall risk factors within an internationally recognized system (Soh et al., 2020; de Clercq et al., 2021). The ICF was selected because it offers a comprehensive, internationally accepted classification system that accounts for the interaction of personal, functional, and environmental factors. This multidimensional framework supports standardization, allows integration into global patient safety datasets, and enhances the interpretability of fall-related research. By mapping fall risk factors to the ICF domains, the tool gains both scientific rigor and practical applicability across diverse healthcare contexts.

The International Classification of Functioning, Disability, and Health (ICF) was developed by the World Health Organization (WHO) in 2001 as a classification system to understand and define the impact of health conditions on functioning and disability. This system was created through a collaborative effort involving more than 60 countries (WHO, 2013). The ICF model is based on the interaction between body functions, body structures, activities and participation, environmental factors, and personal factors. According to WHO guidelines, the ICF can be applied in various fields,

including clinical practice, support services, population statistics, education, and policy-making. Additionally, the guidelines emphasize that the ICF serves as a model for classifying both qualitative and quantitative data (WHO, 2013). ICF domains and definitions;

Body Function and Structure: Physiological and psychological functions of body systems and anatomical structures,

Activity and Participation: Execution of tasks or actions by individuals and their engagement in daily life activities,

Environmental Factors: Physical and organizational conditions and surroundings,

Personel Factors: Individual characteristics that influence performance.

The classification of risk factors included in the developed risk assessment tools according to the core domains of the ICF was conducted by researchers experienced in ICF implementation, in accordance with WHO guidelines (WHO, 2013).

- ***Determining the Inter-Rater Reliability of the Risk Assessment Tool***

As part of the inter-rater reliability assessment of the developed risk assessment tool, two evaluators with at least five years of experience and strong communication skills were selected. They were informed about the study's objectives, goals, and methodology.

The inter-rater reliability study included a total of 30 hospitalized patients over the age of 18, receiving treatment in internal medicine and surgical units of a university hospital in İzmir, selected from hospitals within the study's scope (Johanson & Brooks, 2010). The evaluators visited the units to identify patients meeting the inclusion criteria and assessed them using the developed risk assessment tool.

The evaluation process was conducted independently, ensuring that the evaluators had no knowledge of each other's assessments. Since fall risk factors may change over time, all selected patients were evaluated by both evaluators on the same day to maintain consistency.

After the evaluation process, the research team held a meeting with the evaluators to gather feedback on the assessment process and the usability of the risk assessment tools.

All items included in the risk assessment tools developed within the project have a categorical structure, and patients were assessed by two independent evaluators. Therefore, inter-rater agreement was evaluated using the Cohen's Kappa statistic. The analysis revealed that the Cohen's Kappa statistic for the risk assessment tool developed for adult patients was 0.91, indicating a high level of inter-rater agreement (Tabachnick et al., 2013).

- ***Evaluation of the Validity and Reliability of the Risk Assessment Tool***

The validity and reliability of the risk assessment tool were evaluated using data obtained from the general sample. In this context, nurses working in the hospitals and clinics where the study was conducted assessed patients using the risk assessment tool (Tabachnick et al., 2013; DeVellis, 2017). Before implementing the risk assessment tool, an online training program was organized for the nurses who would be using the tool. This training covered: General information on falls (definition, classification, incidence, key characteristics, and consequences), factors contributing to falls, fall prevention interventions, fall risk assessment, features of the risk assessment tool developed within the study, the patient evaluation process using the developed risk assessment tool. The training session was recorded, allowing nurses who could not attend the synchronous session to access the content asynchronously at their convenience.

After completing the training, a two-week pilot study was conducted. During this period, nurses working in the study's clinical settings were asked to use the developed risk assessment tools for

two weeks and provide feedback. To collect their insights, an online survey form was prepared and shared with the clinical head nurses, who then distributed it to their teams. A total of 26 nurses provided feedback on the risk assessment tool. Following the pilot study, the research team reviewed the participants' feedback and determined that no revisions were needed for the risk assessment tool.

Following the pilot study, the data collection phase of the research began. Data was collected between December 2022 and April 2023. During this phase, nurses assessed hospitalized patients using the developed risk assessment tool. If a patient experienced a fall during their hospital stay, this information was recorded in the form. The completed forms were archived within the clinical units. To ensure the proper implementation of the risk assessment tool and the systematic archiving of completed forms, unit head nurses collaborated with the research team. Additionally, hospital quality directors shared the archived forms with the research team on a monthly basis.

Evaluation of the Data

Within the study, descriptive data was analyzed using frequency, percentage, mean, and standard deviation. To determine the risk factors to be included in the risk assessment tool, a simple binary logistic regression analysis was conducted for each risk factor, with fall occurrence as the dependent variable. Since the items in the developed risk assessment tool were designed as dichotomous (yes/no), no scoring system was initially applied. However, to assign weightings to the items, a multiple binary logistic regression analysis was performed, incorporating all risk factors selected for the final scale. The Odds Ratio (OR) values obtained from this analysis, along with expert opinions, were used to determine the item weightings.

The effectiveness of the developed risk assessment tool in identifying high-risk patients for falls was evaluated using diagnostic performance measures, including: Sensitivity (True Positive Rate), Specificity (True Negative Rate), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Accuracy (Van Golven et al., 2022; Aggarwal et al., 2021). In addition to these diagnostic measures, the tool's ability to distinguish high-risk patients was assessed using Receiver Operating Characteristic (ROC) analysis. Specifically, the Area Under the ROC Curve (AUC) was used to evaluate its discriminative performance (De Hond et al., 2022).

The reliability of the developed scale was assessed using inter-rater reliability and internal consistency analysis. Since all risk factors in the scale were dichotomous, and there were two evaluators, inter-rater reliability was measured using the Cohen's Kappa statistic. Internal consistency was evaluated using the Kuder-Richardson 20 (KR-20) coefficient, which is appropriate for dichotomous items.

Variables of the Research

The study follows a methodological design. In the logistic regression analyses conducted within the research, the dependent variable was the occurrence of a fall, while the independent variables were the identified fall risk factors.

Ethical Aspect of the Research

Ethical approval for the study was obtained from the Non-Interventional Research Ethics Committee of a university (2021/19-15, 23.06.2021). Additionally, permission to conduct the research in the designated hospitals was granted by the General Directorate of Health Services of the Turkish Ministry of Health. The study was conducted in accordance with the Helsinki Declaration and publication ethics principles.

RESULTS

A total of 1,173 patient records were analyzed in the study, including 73 patients who had experienced a fall. The mean age of the patients in the

Tablo 2. Simple And Multiple Logistic Regression Analysis Results

Risk Factor	Simple Logistic Regression			Multiple Logistic Regression		
	OR	95% CI	p	OR	95% CI	p
60-69 Age	4.279	2.636-6.948	.001	34.923	8.288-147.161	.001
70-79 Age	1.833	1.068-3.147	.028	18.766	4.243-82.992	.001
80 and above Age	1.647	.859-3.158	.133	15.590	3.300-73.656	.001
History of Falls	3.260	1.906-5.574	.001	1.619	.884-2.966	.119
Having one or two of the listed diseases/conditions*	1.122	.696-1.809	.720			
Having three or more of the listed diseases/conditions*	3.292	1.925-5.631	.001	2.023	1.085-3.772	.027
Unconscious	2.187	.826-5.794	.122			
Impaired consciousness	2.914	1.664-5.104	.001	1.376	.706-2.683	.348
Balance impairment while walking	2.562	1.586-4.141	.001	1.665	.901-3.078	.104
Muscle weakness	1.752	1.051-2.921	.032	.555	.283-1.087	.086
Morbid obesity	.533	.071-3.989	.540			
Frequent need to use the bathroom	2.530	1.302-4.916	.006	2.079	.989-4.373	.054
Nocturia	.000	.000	.998			
Urinary and fecal incontinence	.903	.423-1.930	.793			
Vision impairment	1.513	.847-2.704	.162	.773	.405-1.473	.433
Assistive walking device	2.621	1.607-4.275	.001	1.612	.865-3.033	.132
Medication use**	1.764	1.086-2.866	.022	1.018	.580-1.788	.950
Equipment use	2.862	1.771-4.626	.001	1.368	.790-2.367	.263
Gender (Male)	1.687	1.030 – 2.77	.038	1.621	.951-2.763	.076
Constant				0.002		.001

* **Diseases/Conditions =** Psychiatric Disorders, Neurological Disorders, Limb Loss, Fractures, Hypotension, Vertigo, Arthritis, Arrhythmia, Osteoporosis, Diabetes, Orthostatic Hypotension.
****Medications =** Benzodiazepines, Narcotics, Hypnotic, Antipsychotics, Antidepressants, Diuretics, Antidiabetics, Opioids, Antiepileptics, Chemotherapy Drug

Based on the results of the simple binary logistic regression analysis, several risk factors included in the risk assessment tool were found not to be statistically significant predictors of patient falls. These factors included “80 years and older (p = .133),” “Having one or two diseases (p = .720),” “Unconsciousness (p = .122),” “Morbid obesity (p = .540),” “Nocturia (p = .998),” “Urinary and fecal incontinence disorder (p = .793),” and “Impaired vision (p = .162).” As a result, these non-significant predictors were removed from the draft risk assessment tool. However, “80 years and older” and “Impaired vision” were retained in the final version based on expert opinions (Table2).

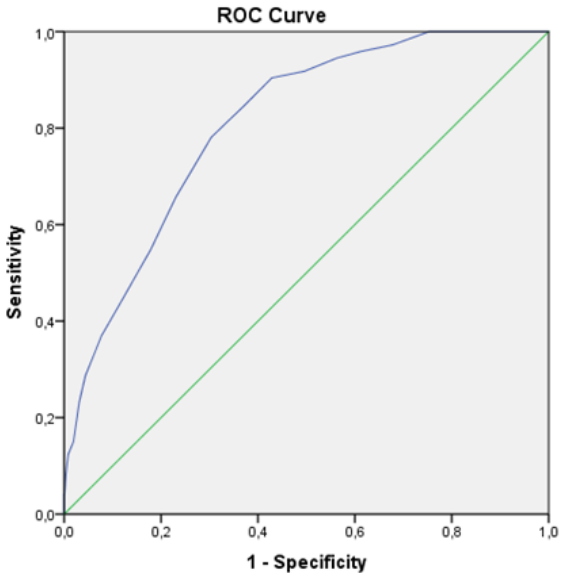

Figure 1. ROC Analysis of the Weighted Total Score for the Developed Risk Assessment Tool for Adult Patients

The statistically significant predictors of patient falls were determined through multiple binary logistic regression analysis, including the variables “80 years and older” and “Impaired vision.” As a result, the variable “Muscle weakness present” (OR = .555) was removed from the risk assessment tool due to its Odds Ratio being significantly lower than 1. However, despite its Odds Ratio being below 1, the “Impaired vision” variable was retained in the tool. Based on the Odds Ratio values obtained from the multiple logistic regression analysis, weightings were assigned to the scale items. The risk factors and their assigned scores in the developed risk assessment tool for adult patients are presented in Table 3.

After weighting the items, the total scale score was calculated, and an ROC analysis was performed. The analysis results showed that the Area Under the ROC Curve (AUC) was .809 (95% CI: .766 – .853, p = .001). The results of the ROC analysis are presented in Figure 1.

Tablo 3. Adult Patient Fall Risk Assessment Scale

ICF DOMAIN	PARAMETERS	RISK FACTORS	SCORE
PERSONEL FACTORS	GENDER	Men	2
	AGE	60-69 Age	7
		70-79 Age	4
		80 Age and above	3
	HISTORY OF FALLS	History of falling within the last 6 months	2
	DISEASES/COMORBITIES	Having three or more of the listed diseases/conditions*	2
BODY FUNCTİON AND STRUCTURE	CONSCIOUS	Impaired consciousness (Confused, dementia, delirium, agitated, lethargic, etc.)	2
	BALANCE DISORDER	Balance impairment while standing/walking (Without using physical support such as a walker, crutches, or assistance from another person)	2
	ELIMINATION NEEDS	Frequent need to use the bathroom (Going to the toilet at intervals of less than two hours while awake – 9 or more times per day)	2
	VISION	Impaired vision (Unable to perform daily activities without glasses or contact lenses)	1
AKTIVITY AND PARTICIPATION	ASSISTIVE WALKING DEVICE	Needs physical support while standing/walking (e.g., walker, crutches, assistance from another person)	2
	MEDICATION USE	The patient is using one or more medications** that increase the risk of falling.	1
ENVIRONMENTAL FACTORS	EQUIPMENT USE (Use of equipment that restricts the patient’s movement)	The patient is connected to three or more medical devices such as IV infusion, ventilator, Foley catheter, chest tube, drain, etc.	1

*** Diseases** = Psychiatric Disorders, Neurological Disorders, Limb Loss, Fractures, Hypotension, Vertigo, Arthritis, Arrhythmia, Osteoporosis, Diabetes, Orthostatic Hypotension.
****Medications** = Benzodiazepines, Narcotics, Hypnotic, Antipsychotics, Antidepressants, Diuretics, Antidiabetics, Opioids, Antiepileptics, Chemotherapy Drug

The cut-off score for the scale was determined based on the sensitivity and specificity values obtained from the ROC analysis at different thresholds. The goal was to identify the value where both sensitivity and specificity were maximized, leading to the selection of 9.5 points as the cut-off score. Accordingly, patients with a total scale score of 9.5 or higher were classified as "High Fall Risk," while those scoring below 9.5 were classified as "Low Fall Risk." The sensitivity and specificity values for different cut-off points of the developed risk assessment tool are presented in Table 4.

Tablo 4. Sensitivity and Specificity Values of the Risk Assessment Tool at Different Cut-Off Points

Cut-Off	Sensitivity	1 - Specificity
-1,0000	1,000	1,000
,5000	1,000	,892
1,5000	1,000	,859
2,5000	1,000	,753
3,5000	,973	,678
4,5000	,959	,613
5,5000	,945	,563
6,5000	,918	,496
7,5000	,904	,429
8,5000	,849	,374
9,5000	**,781**	**,304**
10,5000	,658	,231
11,5000	,548	,178
12,5000	,452	,124
13,5000	,370	,077
14,5000	,288	,044
15,5000	,233	,031
16,5000	,151	,019
17,5000	,123	,008
18,5000	,082	,004
19,5000	,041	,001
20,5000	,041	,000
21,5000	,014	,000
23,0000	,000	,000

To calculate the other performance metrics of the measurement tool, patients in the sample were divided into two groups based on the cut-off score: high fall risk and low fall risk. After classification, of the 73 patients who experienced a fall, 57 were identified as high risk, while 16 were classified as low risk. Of the 1,087 patients who did not experience a fall, 757 were classified as low risk, while 330 were classified as high risk. Using all these data, the performance metrics of the risk assessment tool were calculated as follows: sensitivity .781, specificity .696, positive predictive value .15, negative predictive value .98, and accuracy .70. The performance metrics of the measurement tool are presented in Figure 2.

FALLING STATUS	FALL RISK STATUS	
	High Risk (387 Patients)	*Low Risk (773 Patients)*
Fall (73 Patients)	True Positive (57 Patients)	False Negative (16 Patients)
Not Fall (1087 Patients)	False Positive (330 Patients)	True Negative (757 Patients)

Figure 2. Classification Results of the Fall Risk Assessment Tool

As part of the reliability analyses, the inter-rater reliability was assessed using the Kappa statistic, which was calculated as .91, while the Kuder-Richardson 20 (KR-20) coefficient was determined to be .568.

DISCUSSION

This study developed a fall risk assessment tool for adult patients and evaluated its effectiveness in distinguishing patients at high risk of falling.

The risk factors included in the risk assessment tool align with the existing literature (Eckstrom et al., 2024; Jehu et al., 2021; Altın et al., 2020). However, unlike previous studies, this research found that being in the 60-69 age group was a stronger predictor of falls compared to the 70-79 and 80+ age groups, and being 70-79 years old was a stronger predictor compared to 80 years and older. As age increases, physical issues such as decreased muscle strength and balance problems

heighten the risk of falling (Xu et al., 2022). In this study, the reason why individuals in the 60-69 age group had a higher fall risk could be due to their greater tendency to move independently compared to older adults. Although fall risk is generally higher among the elderly due to physical limitations, older individuals may be more aware of their physical constraints and therefore seek assistance during mobility. In contrast, individuals aged 60-69 may underestimate their fall risk, believing they can move independently without assistance, leading to a higher likelihood of falls. This aligns with findings from Barış et al. (2019), where healthcare professionals reported that patients who tend to move independently experience more falls. Considering all these insights, the original scoring derived from the logistic regression analysis was maintained, and no modifications were made to the scoring system.

The ROC analysis conducted after item score weighting demonstrated that the developed risk assessment tool has a very good ability to distinguish high-risk patients. In ROC analysis, the area under the curve (AUC) can range between 0 and 1. An AUC value of 0.50 indicates that the discriminatory power of the risk assessment tool is entirely random. In other words, using the tool to classify patients would be no different from flipping a coin. An AUC value below 0.70 suggests that the risk assessment tool has "insufficient" discriminatory power. An AUC between 0.70 - 0.80 is considered "acceptable", an AUC between 0.80 - 0.90 is classified as "very good", and an AUC between 0.90 - 1.0 indicates "excellent" discriminatory ability (De Hond et al., 2022).

When examining other fall risk assessment tools in the literature, Barış and colleagues (2020) calculated the area under the ROC curve (AUC) for the ITAKI Fall Risk Scale—widely used in Türkiye to assess fall risk in adult patients—as 0.58. Their study also reported the ITAKI scale's sensitivity at 0.75, specificity at 0.35, positive predictive value (PPV) at 0.38, and negative predictive value (NPV) at 0.73. Meanwhile, Yilmaz Demir and Seren Intepeler (2012) adapted the Morse Fall Risk Assessment Scale to Turkish culture, determining its AUC to be 0.771. They reported a sensitivity of 0.58, specificity of 0.80, PPV of 0.07, and NPV of 0.99. Kus and colleagues (2023) evaluated the ITAKI, Morse, and Hendrich-II fall risk scales, calculating their AUC values as 0.794, 0.773, and 0.724, respectively. Klinkenberg and Potter (2017) found the Johns Hopkins Fall Risk Assessment Scale to have an AUC of 0.69, with a sensitivity of 0.27, specificity of 0.89, PPV of 0.04, and NPV of 0.99. Similarly, Aranda-Gallardo and colleagues (2017) assessed the STRATIFY Fall Risk Assessment Scale, reporting an AUC of 0.69, sensitivity of 0.48, specificity of 0.85, PPV of 0.11, and NPV of 0.98. Based on these comparisons, the fall risk assessment tool developed for adult patients in this project appears to outperform other tools in the literature in identifying patients at high risk of falling. The tool's success may stem not only from insights drawn from the literature but also from effectively incorporating input from clinical and academic experts during its development.

In the reliability analyses, the kappa statistic indicated a very high level of inter-rater agreement (Tabachnick et al., 2013). This finding suggests that different evaluators using the developed risk assessment tool achieved highly consistent results when assessing patients, providing strong evidence for the scale's reliability. However, the calculated Kuder-Richardson value fell below the acceptable threshold of 0.70. Given that all items in the risk assessment tool are dichotomous data, it has been suggested that this characteristic may have contributed to the low Kuder-Richardson 20 value (Tabachnick et al., 2013).

Limitations

The developed risk assessment tool was used by nurses working in the units included in the study to evaluate patient risks. This may have led to nurses from different institutions applying varying approaches during the assessment process. To address this potential limitation, training on the use of the risk assessment tool was provided to all nurses involved in the study. Furthermore, the tool's very high inter-rater agreement supports the conclusion that this variation does not constitute a significant limitation.

Although the study aimed to obtain a sample representative of all patient groups, the risk assessment tool could not be implemented across all adult units. This may have created a limitation in representing certain specialized units—such as obstetrics and gynecology or psychiatry—within the broader categories of internal medicine and surgical branches, which have distinct characteristics.

IMPLICATIONS FOR PRACTICE

The findings indicate that the risk assessment tool developed within the scope of this study is highly effective in identifying patients at high risk of falling. In line with the research goal of updating the ITAKI Fall Risk Scale, the newly developed tool has been named the ITAKI II Fall Risk Assessment Scale.

The ITAKI II Fall Risk Assessment Tool, developed as part of this study, offers significant contributions to patient safety and fall prevention practices at both national and international levels. This risk assessment tool can serve as an effective instrument for preventing patient falls. By accurately identifying high-risk patients, it enables the personalization of fall prevention strategies, thereby enhancing patient safety. The tool's structure aligns with the World Health Organization's ICF model, allowing for the evaluation of fall risk factors in accordance with international standards. This compatibility facilitates data comparability across different healthcare institutions and countries.

Future research could focus on testing the ITAKI II Fall Risk Scale's effectiveness in identifying high-risk patients across diverse patient populations.

Information

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Author Contributions

Study Conception and Design: VKB, SSI, IC, MB Data Analysis: VKB, SSI, IC Writing: VKB, SSI, IC, MB, SE, DK Critical Review: VKB, SSI.

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