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Available online at: https://dergipark.org.tr/tr/pub/jnef
Doi: 10.46483/jnef.1650810

ORIGINAL ARTICLE / ORİJİNAL MAKALE

Development of HARIZMI II Pediatric Fall Risk Assessment Scale and Evaluation of Its Validity and Reliability

HARİZMİ II Pediatrik Düşme Riski Değerlendirme Ölçeği'nin Geliştirilmesi ve Geçerlik ve Güvenirliğinin Değerlendirilmesi

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Geliş: 04.03.2025 **Kabul:** 11.09.2025

Abstract

Background: Pediatric patients face a high fall risk due to developmental and additional contributing factors, which current assessment tools often fail to accurately identify.

Objectives: To develop a pediatric fall risk assessment tool and evaluate its validity, reliability, and discriminative performance.

Methods: This methodological, cross-sectional study was conducted in 10 hospitals across seven Turkish cities, targeting pediatric patients 18 and under. Literature findings and expert opinions were utilized in the development of the risk assessment tool. The risk factors in the tool were classified using the International Classification of Functioning, Disability and Health Model developed by the World Health Organization. The content validity of the scale was measured via the Content Validity Index; inter-rater reliability (Cohen's Kappa = 0.87) and internal consistency (KR-20 = 0.651) were also established. Discriminative ability was evaluated using ROC analysis. The risk assessment tool was named HARIZMI II Fall Risk Assessment Tool.

Results: A total of 1056 pediatric patients were evaluated with the developed tool and 54 of these experienced a fall. The content validity index of the scale was 0.921, the inter-rater reliability value (Kappa) was 0.87, the internal consistency coefficient (Kuder-Richardson 20) was 0.651, the Area Under the ROC Curve Value developed as a result of ROC analysis was 0.758, the sensitivity was 0.722, and the specificity was 0.669.

Conclusion: The HARIZMI II Fall Risk Assessment Tool is valid and reliable in identifying children at high risk for falls.

Keywords: Pediatric Patient Safety, Fall Risk, Risk Assessment, ICF Model

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Nasıl Atıf Yapılır: Barış VK, Çelik İ, İntepeler ŞS, Bektaş M, Gökmen Kavak D, Engeloğlu Development of HARIZMI II Pediatric Fall Risk Assessment Scale and Evaluation of Its Validity and Reliability. Etkili Hemşirelik Dergisi. 2026;19(3): 397-409

Journal of Nursing Effect published by Cetus Publishing.

Öz

Giriş: Pediatrik hastalar gelişim özellikleri nedeniyle yüksek düşme riski taşır. Ancak bazı ek faktörler de bu riski artırabilir. Mevcut risk değerlendirme araçları ise bu faktörleri belirlemede yetersiz kalmaktadır.

Amaç: Bu araştırma ile pediatrik hastalarda düşme riski değerlendirme aracının geliştirilmesi ve bu aracın geçerlik, güvenirlik ile ayırt edicilik özelliklerini incelenmesi amaçlanmıştır.

Yöntem: Araştırma metodolojik ve kesitsel tasarımda olup, Türkiye genelindeki yedi şehirde 10 farklı hastanede yürütülmüştür. Araştırmanın hedef popülasyonu 18 yaş ve altı pediatrik hastalardır. Risk değerlendirme aracının geliştirilmesinde literatür bulguları ve uzman görüşlerinden faydalanılmıştır. Geliştirilen risk değerlendirme aracında yer alan risk faktörleri Dünya Sağlık Örgütü tarafından geliştirilen İşlevsellik, Yetiyitimi ve Sağlığın Uluslararası Sınıflandırılması Modeli kullanılarak sınıflandırılmıştır. Ölçeğin içerik geçerliği İçerik Geçerlik İndeksi, değerlendiriciler arası güvenirliği Cohen Kappa istatistiği ile (0.87), iç tutarlılığı ise Kuder-Richardson 20 (KR-20 = 0.651) ile değerlendirilmiştir. Ölçeğin ayırt ediciliği ROC analizi ile incelenmiştir. Risk değerlendirme aracı HARİZMİ II Düşme Riski Değerlendirme Aracı olarak isimlendirilmiştir.

Bulgular: Araştırma toplam 1056 pediatrik hasta geliştirilen risk değerlendirme aracı ile değerlendirilmiş, bu hastalardan 54'ü düşme deneyimi yaşamıştır. Ölçeğin içerik geçerlik indeksi 0.921, değerlendiriciler arası güvenirlik değeri (Kappa) 0.87, iç tutarlılık katsayısı (Kuder-Richardson 20) 0.651, ROC analizi sonucunda geliştirilen ROC Eğrisi Altında Kalan Alan Değeri 0.758 olarak hesaplanmış, duyarlılığı 0.722, özgüllüğü ise 0.669 olarak belirlenmiştir.

Sonuç: HARİZMİ II Düşme riski değerlendirme aracı, düşme riski yüksek çocukları ayırt etmede geçerli ve güvenilirdir.

Anahtar Kelimeler: Pediatrik Hasta Güvenliği, Düşme Riski, Risk Değerlendirme, ICF Modeli

INTRODUCTION

Patient falls in hospitals are a significant issue contributing to morbidity, mortality, and prolonged hospital stays among adult and elderly patients. Falls among hospitalized pediatric patients are equally concerning and prevalent; however, there is limited research addressing falls in this population (Kim et al., 2019).

Patient falls are defined as "an unplanned descent to the ground by a patient, with or without injury" (National Quality Forum, 2011). In the United States, pediatric fall rates range from 0.23 to 1.2 per 1000 patient days (Parker et al., 2020; Morrissey et al., 2024). In contrast, studies conducted in Türkiye have calculated this rate to be between 5 and 5.4 per 1000 patient days (Demir et al., 2013; Camurcu et al., 2020).

The unique developmental characteristics of children, such as their evolving motor skills and natural curiosity, increase their susceptibility to falls. Various studies have highlighted numerous fall risk factors for pediatric patients, including age, cognitive and developmental status, history of previous falls, cognitive and visual impairments, and environmental hazards (Morrissey et al., 2024; Wang et al., 2022). These findings have enabled the identification of risk factors specific to pediatric patients, making it possible to distinguish those at high risk of falling. As a result, tailored fall prevention interventions can be developed for at-risk patients, allowing for more effective use of resources. Consequently, assessing patients for fall risk stands out

as a critical step in the fall prevention process (Chang et al., 2021).

One of the most significant issues in the fall risk assessment process is the low ability of the risk assessment tools used to distinguish patients with a high risk of falling (Kim et al., 2019). The literature highlights several risk assessment tools designed specifically for pediatric patients, such as the Humpty Dumpty Fall Risk Scale and the I'M SAFE Fall Risk Scale. However, none of these tools has yet been accepted as the gold standard for assessing fall risk in pediatric patients (Cetintas and Gurkan, 2019; Sarik et al., 2022; McNeely et al., 2018).

Like much of the world, preventing falls among pediatric patients is a top patient safety priority in healthcare services across our country. The Ministry of Health promotes this goal in its hospitals by tracking patient falls as a quality indicator and setting a quality standard that requires assessing pediatric fall risk with a reliable tool (Ministry of Health, 2020). However, research by Intepeler Seren and colleagues revealed that the HARIZMI Fall Risk Scale—widely used in our country—struggles to accurately identify pediatric patients at high risk of falling (Intepeler Seren et al., 2020). This shortfall poses a major challenge to efforts aimed at preventing pediatric falls nationwide.

Pediatric patient fall risks are often categorized using frameworks like "intrinsic and extrinsic factors" or "patient-related and hospital-related factors." Yet, despite these efforts, the international community has not agreed on a standardized classification system for risk factors (Kim et al., 2019). This lack of uniformity complicates the comparison of research findings and prevents the creation of a cohesive fall prevention strategy addressing these factors. Here, the International Classification of Functioning, Disability and Health (ICF) model—developed by the World Health Organization (WHO) with global input—emerges as a promising solution (De Clercq et al., 2021; Soh et al., 2020; Baris & Seren Intepeler, 2019).

This research aimed to update the HARIZM Fall Risk Scale to develop an assessment tool capable of more effectively identifying pediatric patients at high risk of falling, as well as to examine the tool's validity, reliability, and ability to distinguish high-risk pediatric patients. Beyond that, by aligning the risk factors in this new tool with the WHO's ICF model, the research aimed to support the broader goal of developing a unified, international framework for defining fall risk factors.

Research Question(s)

Research Question 1: What are the key fall risk factors for hospitalized pediatric patients, and how can they be effectively classified using the ICF model?

Research Question 2: Is the newly developed fall risk assessment tool valid and reliable for identifying hospitalized pediatric patients at high risk of falling?

Research Question 3: What is the discriminative performance of the newly developed fall risk assessment tool in identifying high fall risk among pediatric patients?

METHOD

The Type of the Research

The study employs a methodological, cross-sectional descriptive design.

The Place of the Research

To ensure sample diversity and make the fall risk assessment tool broadly applicable to

Türkiye's pediatric patient population, the study was conducted across 10 hospitals in seven major cities, representing each region of the country. These included 5 university hospitals, 1 city hospital, and 4 training and research hospitals, located in Istanbul (1 university hospital, 1 training and research hospital), Izmir (1 university hospital), Konya (1 city hospital), Antalya (1 training and research hospital), Erzurum (1 training and research hospital, 1 university hospital), Diyarbaki r (1 university hospital), and Samsun (1 university hospital, 1 training and research hospital).

Since including every pediatric unit in these hospitals wasn't feasible, the study focused on specific units selected with input from each hospital's quality director: one pediatric internal medicine unit, one pediatric surgery unit, one pediatric intensive care unit, and one pediatric emergency unit.

The Universe/Sample of the Research

The tool being developed targets pediatric patients aged 18 and under.

The study involved creating a diagnostic tool, and its sample size was determined using key parameters: a fall prevalence of 5 among pediatric patients [literature reports a range of 0.5 to 5.4 in Türkiye (Demir et al., 2013; Camurcu et al., 2020)], a target sensitivity of 70% to 90%, a statistical power of 80%, and a significance level of 0.05. This yielded a minimum sample size of 620 patients, including at least 31 who had experienced a fall. To buffer against potential data loss, however, the validity study aimed to include 1000 patients, with at least 40 having a history of falling. Participants in the faller group were considered cases, while those in the non-faller group served as controls.

Data Collection Instrument-Validity and Reliability Information

The research proceeded in stages: first, a fall risk assessment scale for pediatric patients was developed; then, its inter-rater reliability was assessed; and finally, it was tested on a broader population to determine its effectiveness in identifying pediatric patients at high fall risk.

Development of the Pediatric Fall Risk Assessment Toll

Selection of Items/Risk Factors

The success of the risk assessment tool hinges on its ability to capture fall risk factors relevant to pediatric patients. To achieve this, the research team drew on their expertise while also reviewing fall risk factors for pediatric patients documented in the literature at the outset of the development process (Sheppard-Law et al., 2022; Wang et al., 2022; Altın et al., 2020; Parker et al., 2020; Kim et al., 2019; Al-Sowailmi et al., 2018; Camurcu et al., 2020, Cetintas and Gurkan, 2018, Seren Intepeler et al., 2020). After this review, the identified risk factors were compiled into a draft list.

Beyond content, the usability of the risk assessment tool is critical. This made it essential to involve end-users in the development phase and gather their input. To that end, the study collected feedback from 10 nurses—one each from the internal medicine, surgical, intensive care, emergency, and quality units of both a university hospital and a training and research pediatric hospital. Nurses were required to have at least five years of experience in pediatric care to participate.

The panel was held online due to the geographical distribution of participants and their schedules. During the session, the tool's content was evaluated in detail based on four key usability criteria:

- **Clarity of Items** (whether each item was clearly worded and understandable in clinical context),
- **Ease of Application** (time required to complete the tool and its feasibility during busy shifts),
- **Interpretability of Results** (whether scoring and results could guide interventions clearly), and
- **Integration into Workflow** (compatibility with routine patient assessment processes).

In addition to usability, "clinical realities" referred to the panelists' shared observations from daily practice. These included common patient conditions, caregiver behaviors, documentation patterns, and staffing limitations that could influence fall risk or affect tool usage.

Assessing Content Validity

The study assessed the content validity of the draft pediatric fall risk assessment scale (18 items) using the Item Content Validity Index (I-CVI) and Scale Content Validity Index (S-CVI) methods outlined by Polit and Beck (2006). Ten experts, each holding at least a doctoral degree and knowledgeable about pediatric falls, were chosen to evaluate the relevance of each risk factor on a four-point Likert scale (1: Not suitable, 2: Somewhat suitable, 3: Quite suitable, 4: Highly suitable). The I-CVI was calculated as the proportion of experts assigning a score of 3 or 4 to an item, while the S-CVI was determined as the proportion of all items rated 3 or 4 (Polit & Beck, 2006). Results showed I-CVI values ranging from 0.83 to 1.00 and an S-CVI of 0.921 for the tool.

Classifying Risk Factors Using the International Classification of Functioning, Disability and Health (ICF) Model

To establish a shared language for classifying fall risk factors both nationally and globally, the risk factors in the new assessment tool were organized under the key domains of the WHO's International Classification of Functioning, Disability and Health (ICF) model (Personal factors, Body function and structure, Activity and participation, Environmental factors) (WHO, 2013; Soh et al., 2020; de Clercq et al., 2021).

Introduced by the WHO in 2001 with input from over 60 countries, the ICF provides a framework that examines interactions among body functions, body structures, activity and participation, environmental factors, and personal factors. The WHO strongly endorses its use for classifying qualitative and quantitative data (WHO, 2013).

ICF Domains

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

Activity and Participation: An individual's ability to perform tasks and engage in daily activities,

Environmental Factors: Impacts of physical and organizational settings and the individual's surroundings,

Personal Factors: Personal traits that shape an individual's performance and behavior.

Team members experienced with the ICF, guided by WHO standards, categorized the risk factors into these domains (WHO, 2013).

Establishing Inter- Rater Reliability

Since risk assessment tools are used by va-

rious evaluators in real-world settings, consistency across evaluators—indicating high reliability—is vital for the tool's general applicability (Belur et al., 2021). To test this, the inter-rater reliability of the developed tool was evaluated. Two evaluators, each with five years of clinical experience, were selected and briefed on the study's objectives and methods. The reliability study took place in the pediatric internal medicine and surgical units of a university hospital in Izmir. The evaluators independently assessed 30 inpatients aged 18 and under using the tool, with both evaluations for each patient occurring on the same day.

Afterward, the evaluators' results were analyzed, and their feedback on the items and the tool's usability was gathered. The Cohen's Kappa statistic for inter-rater reliability was calculated at 0.87, indicating strong consistency between evaluators (Tabachnick et al., 2013).

Assessing Validity and Reliability

At this stage, the scale—confirmed to have strong content validity and inter-rater reliability—was rolled out in the designated units of the participating hospitals. The resulting data were analyzed to evaluate the scale's validity and its effectiveness in pinpointing pediatric patients at high risk of falling.

The risk assessment tool was applied by nurses working in the study units. To support this, an online training session was organized in partnership with the hospitals' quality coordinators and unit head nurses. The training introduced the new scale and provided guidance on its use, while also sharing up-to-date literature on the significance, causes, and prevention of patient falls. Given the nurses' varied schedules, the sessions were recorded for those unable to attend live, and head nurses collaborated to ensure all staff had access. Post-training, the tool was deployed in the selected units. Beyond validity and reliability, the tool's clarity and usability were key priorities. A two-week pilot phase followed the training, during which nurses' feedback was gathered via an online form distributed by head nurses. Thirty-eight nurses responded, affirming the scale's clarity and practicality without suggesting major revisions. The scale was then implemented in the units from December 2022 to April 2023, with ongoing collaboration from quality coordinators and head nurses. Head nurses archived completed forms in the clinics and forwarded them to quality directors, who shared monthly updates with the research team. Falls experienced by patients during this period were recorded on the tool.

Evaluation of the Data

Descriptive data were summarized using counts, percentages, means, and standard deviations. Simple and multiple binary logistic regression analyses identified risk factors linked to falls, with the dependent variable defined as fall occurrence (0 = No fall, 1 = Fall occurred). Simple logistic regression examined each risk factor's relationship with falls, holding other variables constant. Multiple binary logistic regression then incorporated risk factors selected from the simple analysis and expert input as independent variables, finalizing which factors to include in the tool. Odds ratios from this analysis determined the weight scores for each risk factor.

Using the total scale score, a Receiver Operating Characteristic (ROC) analysis established the optimal cutoff point, splitting patients into high- and low-risk groups. The tool's ability to

ve (AUC) providing an additional measure of success.As all risk factors were dichotomous, reliability was evaluated via inter-rater reliability (using the Kappa statistic) and internal consistency (using Kuder-Richardson 20, or KR-20).

Variables of the Research

In this methodological study, the dependent variable was whether a fall occurred, and the independent variables were the risk factors proposed for inclusion in the tool.

Ethical Aspect of the Research

The study adhered to publication ethics and the Helsinki Declaration. Ethical approval was secured from a university's non-invasive research ethics committee (2021/19-16, 23.06.2021), and permission to conduct the study in the selected hospitals was granted by the General Directorate of Health Services, Ministry of Health of Türkiye.

RESULTS

Among the 1,056 patients in the study, 54 had experienced a fall. The patients' average age was 5.95 ± 5.07 years, with 61.9% being male. Simple binary logistic regression analyses showed that the following factors were linked to pediatric falls: "Age 0-3 (p = .001)", "Age 4-7 (p = .043)", "Age 8 and older (p = .004)", "Hospital stay of 5 days or more (p = .001)", "Hyperactivity (p = .001)", "Need for physical support while standing (p = .004)", "Medication use (p = .022)", and "Inappropriate bed (p = .003)". These findings are summarized in Table 1.

Table 1. *Predictors of Pediatrik Falls*

Risk Factor	Simple Models		Multiple Model	
	OR (95% CI)	*p*	*OR (95% CI)*	*p*
Age 0-3	3.948 (2.146-7.262)	.001	2.445 (0.046-128.882)	.659
Age 4-7	0.435 (0.194-0.974)	.043	0.821 (0.015-45.203)	.923
Age 8 and above	0.329 (0.154-0.706)	.004	0.852 (0.016-46.092)	.937
Gender (Male)	0.820 (0.470-1.428)	.482	0.878 (0.485-1.588)	.666
History of Fall	1.880 (0.717-4.931)	.199	1.835 (0.635-5.298)	.262
Having one or two diseases*	1.794 (0.978-3.288)	.059		
Having three or more diseases*	1.275 (0.382-4.252)	.693	1.120 (0.285-4.405)	.871
Hospitalization of 5 days or more	4.601 (2.613-8.102)	.001	3.782 (2.017-7.091)	.000
Inadequate sleep	1.804 (0.855-3.806)	.121		
Hyperactive	2.778 (1.342-5.749)	.006	1.866 (0.810-4.298)	.143
Vision	1.734 (0.715-4.206)	.223	1.006 (0.318-3.179)	.992
Impaired consciousness	1.140 (0.503-2.585)	.754	0.890 (0.252-3.138)	.856
Vital signs	1.387 (0.661-2.909)	.387	1.159 (0.439-3.064)	.766
Need for physical support when walking	2.259 (1.295-3.938)	.004	1.443 (0.710-2.932)	.311
Use of medication	1.966 (1.101-3.509)	.022	1.669 (0.771-3.612)	.193
Use of equipment	0.827 (0.419-1.630)	.582	0.304 (0.123-0.751)	.010
Unsuitable bed	2.476 (1.359-4.513)	.003	1.923 (0.985-3.754)	.056
Parental need for information	1.141 (0.638-2.043)	.656		
Constant			.021	.057

* **Diseases =** *Epilepsy, Asthma, Mental Retardation, Convulsion, Balance/gait disorder, Syncope/dizziness, Vertigo, Agitation, Orthopedic diagnosis*

****Medications =** *Seizure-preventing drugs, Narcotics, Chemotherapy drugs, Antipsychotics, Neuroleptics, Antidepressants, Sedatives, Anesthetic drugs, Antihypertensives, Opioids*

Following simple logistic regression analyses, the risk factors "Need for parental education," "Inadequate sleep," and "Having one or two diseases" were excluded from the multiple binary logistic regression analysis. Although the remaining risk factors did not demonstrate statistically significant differences, the researchers decided they could be clinically meaningful and opted to include them in the multiple logistic regression analysis. The results of this analysis are summarized in Table 1.

The research team primarily relied on the results of the multivariate logistic regression analysis to determine the weight of each risk factor in the final scoring system. However, the inclusion or exclusion of certain variables was not based solely on statistical significance. For example, the variables "Need for parental education," "Inadequate sleep," and "Having one or two diseases" were excluded from the final version of the tool due to their weak performance in the regression model and after thorough team discussions regarding their clinical relevance and clarity.

On the other hand, some variables that did not show statistically significant associations—such as use of medication, impaired vision, or impaired consciousness—were retained because they were consistently emphasized in the literature as potential contributors to fall risk (Kim et al., 2019; Wang et al., 2022), and their importance was strongly supported by expert opinions during the panel discussions. These decisions were made to preserve the clinical utility and comprehensiveness of the tool, acknowledging that risk assessment tools require both statistical rigor and practical relevance for real-world application.

The score weights for the retained variables were assigned based on their odds ratios from the logistic regression analysis. The variables included in the finalized risk assessment tool for pediatric patients, along with their updated weights, are detailed in Table 2.

Using these weights, the total scale score was calculated, and a ROC analysis was performed. The analysis showed that the area under the ROC curve (AUC) for the pediatric fall risk assessment tool was 0.758 (95% CI: 0.696–0.820, p = .001). The ROC curve for the tool is presented in Figure 1.

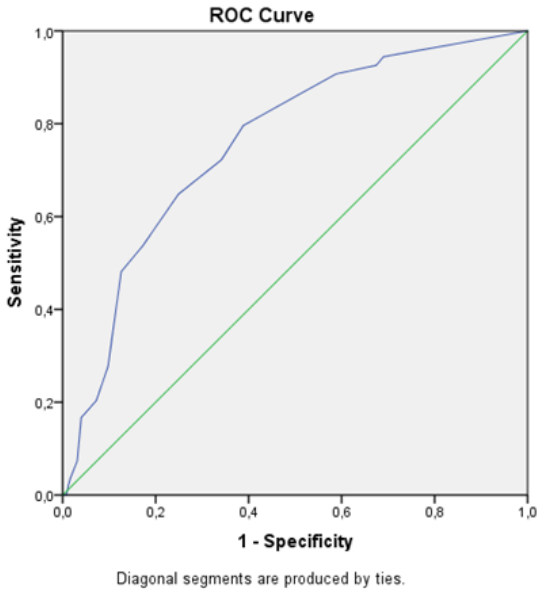

Figure 1. ROC Curve

Table 2. Pediatrik Fall Risk Scale

ICF DOMAIN	PARAMETERS	RISK FACTORS	SCORE
PERSONAL FACTORS	AGE	0-3 Age	3
	HISTORY OF FALL	History of a fall in the past 6 months	2
	DISEASES/ KOMORBIDITIES	Having three or more of the listed diseases*	1
	LENGTH OF STAY	Hospitalized for 5 days or longer	3
BODY FUNCTION AND STRUCTURE	HIPERACTIVITY	Hyperactivity (excessive movement)	2
	VISION	Impaired vision (cannot perform daily activities without glasses or lenses)	1
	CONSCİOUSNESS STATUS	Impaired consciousness (e.g., confusion, dementia, delirium, agitation, lethargy)	1
	VITAL SIGNS	Unstable vital signs (any vital sign unstable within the last 24 hours)	1
ACTIVITY AND PARTICIPATION	WALKING AND BALANCE	Needs physical support for standing or walking (e.g., walker, crutches, or assistance)	2
ENVIRONMENTAL FACTORS	USE OF MEDICATION	Using one or more medications** that elevate fall risk	1
	OTHERS	Not in a suitable bed	2

* **Diseases** = *Epilepsy, Asthma, Mental Retardation, Convulsion, Balance/gait disorder, Syncope/dizziness, Vertigo, Agitation, Orthopedic diagnosis*

****Medications** = *Seizure-preventing drugs, Narcotics, Chemotherapy drugs, Antipsychotics, Neuroleptics, Antidepressants, Sedatives, Anesthetic drugs, Antihypertensives, Opioids*

The goal was to optimize the sensitivity and specificity values at the cutoff point determined for the scale. Accordingly, following the ROC analysis, sensitivity and specificity values were examined for different cutoff points, and the optimal cutoff value was determined to be 4.5 points. At this cutoff, the sensitivity was 0.722, and the specificity was 0.669. Sensitivity and specificity values for various cutoff points are presented in Table 3.

Table 3.Sensitivity and Specificity Values

Cut off score	Sensitivity	1 - Specificity
-1.0000	1.000	1.000
.5000	.944	.690
1.5000	.926	.674
2.5000	.907	.588
3.5000	.796	.389
4.5000	**.722**	**.341**
5.5000	.648	.249
6.5000	.537	.172
7.5000	.481	.126
8.5000	.278	.098
9.5000	.204	.072
10.5000	.167	.040
11.5000	.074	.032
12.5000	.037	.017
13.5000	.019	.012
14.5000	.000	.008
16.5000	.000	.001
19.0000	.000	.000

Using the determined cutoff value, pediatric patients in the study sample were divided into two groups based on their fall risk. Patients with a total score below 4.5 were classified as having a "Low Fall Risk," while those with a score above 4.5 were classified as having a "High Fall Risk."

Accordingly, among the 54 patients who experienced a fall, 39 were categorized as high risk, and 15 were classified as low risk. Among the 952 patients who did not experience a fall, 325 were categorized as high risk, and 627 were classified as low risk. The classification results are presented in Figure 2.

Based on the cutoff value, the sensitivity of the scale was calculated as 0.722, specificity as 0.669, Positive Predictive Value (PPV) as 0.11, Negative Predictive Value (NPV) as 0.98, and overall accuracy as 0.66.

	PREDICTIONS USING FALL RISK SCALE		
		High Risk ***(364 Patients)***	***Low Risk*** ***(647 Patients)***
REAL WORLD DATA	***Fall*** ***(54 Patients)***	True Postive *(39 Patients)*	False Negative *(15 Patients)*
	No Fall ***(952 Patients)***	False Postive *(325 Patients)*	True Negative *(627 Patients)*

Figure 2. Comparison of Actual Falls and Risk Assessment Tool Classification

As part of the reliability analyses, inter-rater reliability was assessed using the kappa statistic, which was calculated as 0.87. Additionally, the Kuder-Richardson 20 (KR-20) coefficient was determined to be 0.651.

DISCUSSION

In this study, a risk assessment tool was developed to evaluate fall risk in pediatric patients. The risk factors included in the tool were classified according to the International Classification of Functioning, Disability, and Health (ICF) model developed by the World Health Organization (WHO). The effectiveness of the newly developed tool in identifying pediatric patients at high risk of falls was also assessed.

The content validity of the risk assessment tool was found to be high based on the criteria defined by Polit and Beck (2006). The fact that both existing literature and expert opinions were considered during the development process likely contributed to ensuring that the tool accurately captures the concept it aims to measure.

The study findings indicate that the pediatric fall risk assessment tool demonstrated high inter-rater reliability. Despite its dichotomous structure, the KR-20 value fell within an acceptable range (Tabachnick et al., 2013), further supporting the reliability of the tool. This suggests that researchers and healthcare professionals using the tool are likely to obtain consistent results.

In addition to providing consistent results across different evaluators, it is also crucial that the risk assessment tool accurately distinguishes between high- and low-risk patients. This capability not only aids in fall prevention but also enhances healthcare professionals' confidence in the tool. In this regard, the area under the ROC curve (AUC) indicates that the tool performs at an acceptable level in identifying patients at high risk of falling. According to the literature, an AUC value below 0.70 suggests "insufficient" discriminatory power, a value between 0.70 and 0.80 is

considered "acceptable," a value between 0.80 and 0.90 is classified as "very good," and a value between 0.90 and 1.0 is deemed "excellent" (Nahm, 2022).

Seren Intepeler et al. (2020) calculated the area under the ROC curve (AUC) for the HARIZMI Fall Risk Scale, which is widely used in our country for assessing pediatric fall risk, as 0.61, with a sensitivity of 0.43, specificity of 0.62, a positive predictive value (PPV) of 0.37, and a negative predictive value (NPV) of 0.68. Demir et al. (2013) reported an AUC of 0.75 for the Behcet Uz Children's Hospital (BUCH) Fall Risk Scale, with a sensitivity of 0.83 and a specificity of 0.50. Cetintas and Gurkan (2019) found an AUC of 0.66 for the BUCH Fall Risk Scale, with a sensitivity of 0.88, specificity of 0.41, PPV of 0.11, and NPV of 0.98. For the Humpty Dumpty Scale, they calculated an AUC of 0.74, sensitivity of 0.88, specificity of 0.60, PPV of 0.15, and NPV of 0.98. Yontem et al. (2017) reported AUC values for the HARIZMI, BUCH, and BUCII pediatric fall risk scales as 0.53, 0.60, and 0.79, respectively. When compared to these values in the literature, the pediatric fall risk assessment tool developed in this study demonstrates comparable or superior performance in identifying patients at high risk of falling.

Limitations

While this study represents a significant step toward assessing fall risk in pediatric patients, certain limitations must be considered. These limitations may affect the study's scope, generalizability, and interpretation of results:

- The study included only pediatric internal medicine, surgery, intensive care, and emergency department units. Due to the study design, not all pediatric units could be included, which may have led to the exclusion of factors that influence fall risk. However, an extensive literature review and expert consultations were conducted, which likely mitigates the impact of this limitation.
- Nurse training was conducted online, and some nurses only accessed recorded video content rather than participating in live interactive sessions. This may have limited opportunities for active engagement and experience sharing, potentially leading to variations in how the tool was applied and inconsistencies in assessments. However, the inter-rater reliability study conducted in the research demonstrated excellent agreement among evaluators, indicating that this risk was minimal.

IMPLICATIONS FOR PRACTICE

The findings of this study support the Pediatric Fall Risk Assessment Tool as a valid and reliable instrument for identifying pediatric patients at high risk of falling. The tool has significant potential to enhance patient safety and contribute to fall prevention efforts in clinical settings.

By integrating this assessment tool into routine hospital admissions and clinical follow-ups, healthcare professionals can systematically evaluate risk factors, allowing for the early identification of high-risk children. This, in turn, enables the development of individualized care plans tailored to each patient's needs. Additionally, the classification of risk factors within the subdomains of the International Classification of Functioning, Disability, and Health (ICF) model, developed by the World Health Organization (WHO), facilitates the creation of personalized care plans. This feature enhances the tool's applicability at an international level, making it valuable for global use. The ICF-based classification also improves the comparability of collected data across national and international studies, laying the foundation for future research on different patient populations, such as those with chronic illnesses or receiving outpatient care.

Acknowledgment

We sincerely appreciate the support of the Republic of Türkiye Ministry of Health, General Directorate of Health Services, and the Department of Health Quality, Accreditation, and Employee Rights. Our gratitude also extends to the administrators, quality coordinators, and nurses at the institutions where this study was conducted. Ethical approval was secured from a university's non-invasive research ethics committee (2021/19-16, 23.06.2021),

The authors declare no conflicts of interest. All authors have reviewed and approved the final manuscript.

Author Contributions

Study Conception and Design was performed by VKB, IC, SSI, and MB. Data Analysis was conducted by VKB and IC. The manuscript was written by VKB, SSI, IC, MB, SE, and DK, and it was critically reviewed by VKB.

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