E-ISSN: 2822-4078

Turkish EMERGENCY MEDICINE Foundation

GLOBAL EMERGENCY AND CRITICAL CARE

OFFICIAL JOURNAL OF THE TURKISH EMERGENCY MEDICINE FOUNDATION

Volume: 5 Issue: 4 December '26

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GLOBAL EMERGENCY AND CRITICAL CARE

Volume: 5 | Issue: 4 | December 2026

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ORCID ID: orcid.org/0000-0003-3183-3438

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Online Publishing Date: December 2026
E-ISSN: 2822-4078
International periodical journal published four times in a year (March, June, September, December).

Volume: 5 | Issue: 4 | December 2026

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The editorial and publication processes of the journal are shaped in accordance with the guidelines of ICMJE, COPE, WAME, CSE and EASE.
The Global Emergency and Critical Care is indexed in **TRDizin**, **Ebsco**, **Gale** and **J-Gate**.

The journal is published online.

Owner: The Turkish Emergency Medicine Foundation

Responsible Manager: Şahin Çolak

Volume: 5 | Issue: 4 | December 2026

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ORIGINAL RESEARCH

DOI: 10.14744/globecc.2025.27676
Glob Emerg Crit Care 2026;5(4):195-201

Analysis of Adult Patients Admitted to the Emergency Department Due to Home Accidents: a Retrospective Study

Merve Demireller[1], Nefise Büşra Çelik[1], Görkem Şekerci[1], Pınar Sarıcı[2], Oya Güven[1]

[1]*Kırklareli University Faculty of Medicine, Department of Emergency Medicine, Kırklareli, Türkiye*
[2]*Kırklareli 112 City Ambulance Service Command Control Centre, Kırklareli, Türkiye*

Abstract

Objective: Trauma patients constitute one of the predominant groups presenting to emergency departments. Although the home environment is regarded as safe, it contains numerous factors that may cause trauma and is identified as the leading source of injury after traffic accidents. The objective of this study was to emphasize home accidents and their associated problems and to propose solutions by highlighting emerging injury data.

Materials and Methods: This study retrospectively examined the files of patients aged over 18 years who presented to the Emergency Department in 2024 with diagnoses related to "trauma," "accident," or "injury" and whose epicrisis indicated trauma sustained at home. Patients' demographic data, the location of the accident within the home, the type of injury, the affected anatomical site, the causative factor, the diagnostic tests ordered, and the prognosis were documented.

Results: Among the 320 patient files accessed, the most common home accidents occurred in rooms (39.6%, n=127). It was determined that 34.4% of the injuries resulted from physical trauma, with crushing being the predominant injury type (43.4%, n=139). The most frequently affected anatomical region was the lower extremity (27.2%, n=87). Gender classification revealed that women were significantly more likely to sustain injuries on slippery surfaces, whereas men were injured due to incorrect tool use.

Conclusion: Through more extensive initiatives, strategies can be formulated during the construction and furniture selection phases, with designs tailored according to age and gender. Identifying human or environmental factors that cause accidents enables the implementation of strategies to prevent home accidents.

Keywords: Emergency department, home accidents, trauma

Introduction

Trauma patients constitute one of the predominant groups presenting to emergency departments. Although the home environment is regarded as safe, it contains numerous elements that may induce trauma and is identified as the leading source of injury after traffic accidents [1]. Patients frequently forgo hospital care because the trauma is minor [2]. Consequently, comprehensive information regarding the causes and consequences of home accidents remains unavailable.

Risks can arise from household items, such as slippery floors, restricted movement in confined areas, misplaced objects, and insufficient lighting. Human-induced factors include inadequate visual or auditory acuity, the incorrect or inexperienced use of sharp tools, neglecting safety procedures in daily routine tasks, carelessness, and distraction.

Home accidents include any incidents that transpire within indoor areas, such as rooms, kitchens, and bathrooms, or external areas, such as gardens, garages, and storage rooms. Studies indicate that injuries predominantly occur in rooms and kitchens [3]. Although accidents are characterized as unforeseen traumas, home accidents are predictable and preventable [4].

Research indicates that elderly individuals are predominantly

Address for Correspondence: Merve Demireller, Kırklareli University Faculty of Medicine, Department of Emergency Medicine, Kırklareli, Türkiye
E-mail: mervedemireller86@gmail.com **ORCID-ID:** 0000-0002-5580-6015

Received: 03.09.2025 **Revised Date:** 20.02.2026 **Accepted:** 15.04.2026

Cite this article as: Demireller M, Çelik NB, Şekerci G, Sarıcı P, Güven O. Analysis of adult patients admitted to the emergency department due to home accidents: a retrospective study. Glob Emerg Crit Care 2026;5(4):195-201.

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injured by falls, attributable to pathophysiological alterations associated with chronic illnesses, their prescribed medications, and advanced age. The risk of falling was shown to increase during the mandatory stay-at-home phase of the COVID-19 pandemic [5]. A separate study in the United States revealed that falls, poisonings, and burns occurring within the home resulted in fatal outcomes and found the mortality rate from home accidents to be 6.83 per 100,000, in contrast to the overall accident rate [6]. A study in Iran revealed that 0.4% of patients who experienced a home accident died, whereas 13% required long-term treatment for survival [7]. These studies provided overarching categories but failed to specify the precise factors contributing to the accidents, such as human, environmental, or object-related factors.

Previous studies investigating home accident–related emergency department presentations in our country have largely focused on the pediatric population or relied on questionnaire-based methodologies. In contrast, the present study evaluated adult patients presenting to the emergency department and aimed to contribute to the literature by systematically categorizing injury patterns and clinical outcomes in this population. The research was conducted in the only emergency department serving the city center and the largest healthcare facility in the province, thereby providing a comprehensive representation of regional cases. By highlighting the epidemiological characteristics and emerging injury trends associated with home accidents, this study seeks to raise awareness and propose evidence-based preventive strategies.

This study assessed home accidents in the adult population based on actual injury data and outcomes from emergency department visits, in contrast to the existing literature. The objective was to highlight home accidents and their resultant issues while providing solutions derived from the collected data. Although accidents are characterized as unforeseen events, home accidents are foreseeable and preventable [8].

Materials and Methods

This study was structured as retrospective, cross-sectional, and descriptive. The files of patients aged over 18 years who presented to the Emergency Department of Kırklareli Training and Research Hospital from January 1 to December 31, 2024, with diagnoses related to "trauma," "accident," or "injury" and whose epicrisis indicated trauma sustained at home were retrieved from the archive and analyzed.

Patients' demographic data, the location within the home where the accident occurred, the type of injury, the affected anatomical site, the causative factor of the injury, the diagnostic tests ordered in the emergency department, and the patient's prognosis were documented, followed by statistical analysis.

Within the injury mechanisms, tools and objects were classified into three categories: cutting, penetrating, and crushing. Cutting tools included knives, peelers, can openers, blenders, and saws; penetrating tools comprised knitting needles, screwdrivers, drills, and screws; and crushing tools included hammers and vegetable mashers. Similarly, objects were categorized as cutting, such as glassware and metal items; penetrating, such as screws embedded in furniture, pens, and clothes hangers; and crushing, such as furniture, cabinets, and drawers as heavy objects.

The primary outcome pertained to prognosis in the emergency department, whereas the secondary outcome related to prognosis in the ward after patient admission.

Patients under 18 years of age, those transferred to another hospital with indeterminate outcomes, and patients whose records were inaccessible were excluded from the study.

Age classification was established by analyzing patterns in age distribution and societal age groups. Descriptive statistics revealed that the young and middle-aged groups dominated the age distribution. Consequently, these intervals were maintained at a reduced width. The age interval of 18 to 35 years was regarded as the young adulthood period. The 36–50 age group was regarded as the stage of maturity in adulthood; thus, it was termed middle age. The age range of 51–65 years was classified as the adult group, as it marks the preliminary phase of transition from employment to retirement. The age group of 66 years and over was designated as the post-retirement old period [9].

The study was approved by the Scientific Research Ethics Committee of Kırklareli University Faculty of Medicine (P20250018-06/14.04.2025).

Statistical Analysis

The analyses were performed using SPSS 27.0 software. Mean, standard deviation, median, minimum, maximum, frequency, and percentage values were used for the descriptive statistics of the data. The distribution of variables was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. The Mann–Whitney U test was used to analyze non-normally distributed quantitative independent data, whereas the chi-square test was used to analyze qualitative independent data.

Results

A total of 320 patient files that met the study criteria were accessed. Of the patients, 53.1% (n=170) were female, whereas

46.9% (n=150) were male. The mean age was 45.43±18.49 years (median: 43), with the highest proportion of presentations from patients aged 18–35 years (36.8%, n=118). The most prevalent home accidents occurred in the rooms of the house (39.6%, n=127). It was determined that 34.4% of the injuries resulted from physical trauma, with crushing being the predominant injury type (43.4%, n=139). The predominant cause of injury was identified as slippery surfaces (33.1%) (Table 1). The most frequently affected anatomical region, considering multiple injuries, was the lower extremity (27.2%, n=87). X-rays were identified as the most commonly requested diagnostic test in emergency department evaluations, accounting for 67.5% of requests. The predominant pathology identified was soft tissue injury, observed in 62.2% of all age groups, whereas the least common pathologies were finger amputation (0.3%, n=1) and the concurrent occurrence of femur fracture, scalp laceration, and intracranial hemorrhage in a single patient (0.3%, n=1). Although multiple procedures were performed in some cases, prescriptions (81.5%) and wound dressings (23.5%) were the most frequently administered interventions in the emergency department (Table 2).

To evaluate the effects of age and sex on the factors contributing to home accidents, multinomial logistic regression analysis was performed. The dependent variable, "cause of injury," was categorized into three groups: environmental factors, such as slippery surfaces and falls; human error, such as carelessness, improper use of tools, and inadequate protective measures; and household arrangement, such as misplaced furniture or objects. "Environmental factors" were designated as the reference category.

The independent variables included age as a continuous variable and sex as male and were entered into the model. The analysis was conducted using a multinomial logistic regression approach, and model parameters were estimated using the Newton method implemented in the statsmodels library. The multinomial logistic regression model demonstrated a statistically significant overall fit (likelihood ratio χ^2=24.71, p<0.001). The model explained 3.6% of the variance according to McFadden's pseudo R^2. Increasing age was associated with lower odds of both human error-related injuries (OR=0.97, 95% CI: 0.96–0.99) and household arrangement-related injuries (OR=0.98, 95% CI: 0.96–0.99) compared with environmental causes. Male sex was significantly associated with human error-related injuries (OR=1.90, 95% CI: 1.11–3.25). Logistic regression analysis, using environmental factors as the reference category and stratified by age and sex, revealed a significant decrease in human error-related accidents with advancing age (p<0.05); however, no significant correlation was observed between age and accidents associated with home configuration (p>0.05). A significant sex disparity was observed in accidents

Table 1. General characteristics of patients

Variables	Mean±SD/n(%)
Gender	
Female	170 (53.1)
Male	150 (46.9)
Mean age	45.43±18.49
Age	
18-35	118 (36.8)
36-50	78 (24.4)
51-65	67 (21)
66 over	57 (17.8)
In which part of the house?	
Room	127 (39.6)
Living room	118 (36.8)
Bed room	7 (2.2)
Dining room	2 (0.6)
Corridor	58 (18.1)
Garden	58 (18.1)
Kitchen	52 (16.3)
Bathroom	23 (7.2)
Stairs	1 (0.3)
Entree	1 (0.3)
Mechanism of Injury	
Caused by a tool	
Penetrating	8 (2.5)
Crushing	4 (1.25)
Blunt	31 (9.7)
Caused by an object	
Penetrating	22 (6.9)
Crushing	13 (4.1)
Blunt	81 (25.3)
Sharp	33 (10.3)
With chemical substance	2 (0.6)
[a]Physical	110 (34.4)
Heat	16 (5.0)
*Type of Injury	
Burn	
First degree	13 (4.1)
Second degree	5 (1.6)
Third degree	1 (0.3)
Soft tissue injury	
Abrasion	93 (29.0)
Laceration	63 (19.7)
Crush	155 (48.4)
Perforation	6 (1.9)
Cause of Injury	
Improper use of tools	47 (14.7)
Carelessness	84 (26.3)
Fall	1 (0.3)
Misplaced objects	79 (24.7)
Slippery surface	106 (33.1)
Inadequate protection	3 (0.9)

[a]Physical trauma: fall, sprain, hit etc., * Patients have multiple findings

Table 2. Findings from pyhsical examination, evaluation, and intervention in the emergency department

*Pathology	
Soft tissue trauma	
Soft tissue injury	199 (62.2)
Laceration	53 (16.5)
Burn	16 (5.0)
Amputation	1 (0.3)
Fracture	50 (15.6)
Other	6 (1.8)
*Diagnostic tool	
X-Ray	216 (67.5)
Computed tomography	38 (11.8)
Ultrasound	1 (0.3)
*Primary intervention	
Prescription	261 (81.5)
Dressing	75 (23.5)
Suture	37 (11.5)
Splint	55 (17.2)
Hospitalization (Operation)	6 (1.8)
Analgesia	42 (13.1)
Eye irrigation	5 (1.5)
Removal of a foreign object from the eye	1 (0.3)

* Patients have multiple findings, other: Conjunctivitis, intracranial hemorrhage

attributable to household organization (p<0.05). The prevalence of incidents attributed to home configuration was higher among males (Table 3).

Gender classification revealed that women sustained significantly more injuries on slippery surfaces, whereas males were injured due to improper tool use (p<0.05). A statistically significant association was found between sex and cause of injury, with a small-to-moderate effect size (Cramer's V=0.21) (Table 4).

The lower extremities were identified as the most frequently injured anatomical region, whereas the lip was the least affected (Fig. 1).

Table 3. Correlation between environmentally induced injuries and other categories (p)

Variable	OR	%95 CI	p
Human error and. environmental factors			
Age	0.97	0.96-0.99	**p<0.001**
Gender (male)	1.90	1.11-3.25	**p=0.019**
Household arrangement and environmental factors			
Age	0.98	0.96-0.99	**p=0.008**
Gender (male)	1.56	0.85-2.86	p=0.148

OR: Odds ratio; CI: Confidence interval

Table 4. Predominant injury causes by gender

Cause of injury	Male (n)	Female (n)	p
Improper tool use	31	15	**0.0037**
Fall	0	1	1.000
Carelessness	40	44	0.918
Misplaced objects	38	40	0.754
Slippery surface	38	68	**0.0098**
Inadequate protection	1	2	1.000

Chi-square test: χ^2=14.18, df=5, p=0.014, Cramer's V=0.21

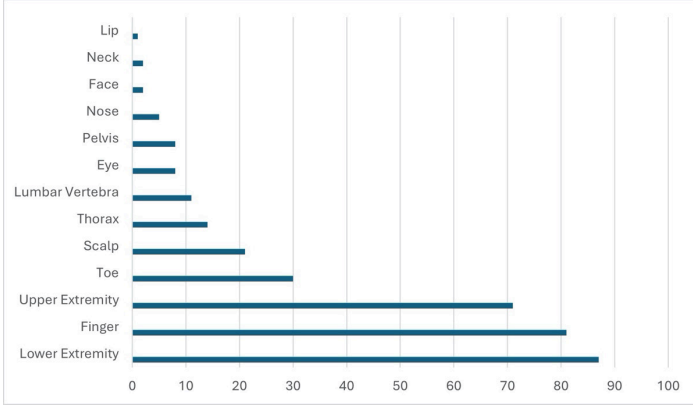


Figure 1. Distribution of anatomical regions of injury

Analysis of age categories revealed that the younger population sustained injuries more frequently. Carelessness was established as the predominant cause of injury in the 18–35 age group, whereas slippery surfaces were responsible for injuries in the other age categories (Table 5).

Discussion

This study revealed that female patients experienced physical trauma from falls on slippery surfaces, whereas male patients sustained injuries while using tools. Younger patients exhibited a higher susceptibility to home accidents attributable to carelessness, whereas older patients showed increased vulnerability to home accidents resulting from falls on slippery surfaces. Furthermore, it was ascertained that accidents attributable to human factors, including carelessness, improper tool use, and inadequate protection, diminished with age, while accidents associated with home configuration were more prevalent among males. This study indicates that the older population exhibits greater caution than younger individuals; nonetheless, they are more susceptible to accidents resulting from environmental variables, such as slippery floors. Although the statistical model used in this study was statistically significant, its explanatory power was

Table 5. Distribution of injury causes by age group

Age Group	Incorrect use of tools	Fall	Carelessness	Misplaced objects	Slippery surface	Inadequate protection	Total
18-35 (Young)	19	0	42	32	24	1	118
36-50 (middle age)	11	1	20	19	26	1	78
51-65 (Adult)	7	0	16	17	27	0	67
66+ (elderly)	10	0	6	11	19	1	57
Total	47	1	84	79	106	3	320

modest, suggesting that additional environmental or behavioral variables may contribute to injury mechanisms. Consequently, age-sensitive interventions, such as automated lighting, fall detection sensors, or auditory alert systems, are advisable for elderly adults. Contemporary safe residences can be tailored to an individual's sex and age. These findings can be considered when implementing preventive measures against home accidents.

The literature indicates that female patients experience a higher incidence of home accidents [10]. This study revealed similar results. Moreover, the observation that female patients sustained trauma from falling on slippery surfaces may stem from the perception of cleaning activities as women's responsibilities and the increased time women spend at home. Male patients' involvement in repair activities may account for the elevated incidence of tool-related injuries [11]. This circumstance also suggests that user guidelines are not being followed when professional tools are used. Cultural disparities and the distribution of home responsibilities may have influenced these outcomes.

The study indicated that injuries were more prevalent in the rooms of the home. The risk of accidents is likely to increase in environments where individuals spend prolonged periods of time. Upon examination of the files, it was noted that these individuals sustained physical trauma, including falls and sprains in the extremities, which were attributed to carelessness and misplaced objects, resulting in lacerations, abrasions, and crush injuries. The high incidence of extremity injuries relative to other anatomical regions substantiates our perspective [12]. To prevent such injuries, furniture dimensions should be selected in accordance with the architectural characteristics of the home. Items should not be placed in confined or hazardous areas, and objects that obstruct movement or pose a risk of injury should not be left on the floor [13].

A survey released in the United States indicated that the incidence of home accidents has diminished over the years, albeit at a slower rate compared with other categories of accidents [14]. A separate study estimated the annual expenditure to be $217 billion. Despite being preventable, home accidents pose a considerable public health concern due to the risks of injury, diminished quality of life, and associated costs [15]. This study found that most patients sustained soft tissue injuries and were discharged with a prescription. All patients survived. This circumstance may generate the false impression that home accidents do not result in significant problems; however, the presence of patients with third-degree burns, fractures, and amputations who underwent surgery indicates a need for increased attention and care. It indicates that home accidents should not be underestimated [16].

Conclusion

This study provides a comprehensive analysis of adult home accident–related emergency department presentations and demonstrates that such injuries are predominantly associated with environmental factors, particularly slippery surfaces. The lower extremities were the most frequently affected anatomical region, and soft tissue injuries constituted the majority of pathologies. Although severe injuries were rare, the high frequency of emergency department utilization and diagnostic imaging highlights the clinical burden of home accidents. The results of this study indicate that home accidents in adults are not random events but follow identifiable demographic patterns.

The establishment of safer home environments is achievable through practical and low-cost measures that consider structural, human, and environmental factors. Preventive strategies include the use of non-slip rugs, the installation of additional handrails in staircases and bathrooms, the placement of frequently used items within easy reach, the avoidance of clutter and unstable stacking, adequate lighting, the proper use of household appliances according to instructions, and refraining from using professional tools without appropriate experience.

Beyond individual-level precautions, broader preventive strategies may be integrated into the construction and furniture selection phases, with designs adapted to age- and sex-specific needs. Identifying the human and environmental determinants of home

accidents is essential for developing targeted interventions and reducing the overall burden of home-related injuries.

The classification of injury mechanisms and their demographic associations provides valuable insight into targeted prevention strategies. Emergency department data can serve as an important source for identifying modifiable risk factors and developing age- and sex-specific safety interventions in home environments.

Limitations Study

The study has specific limitations attributable to its retrospective design. The patients' educational level, presence of comorbidities, including mental health disorders or conditions affecting vision or hearing, living arrangements, home design features, such as wet floor protection and adequate lighting, household occupancy, and the time of day, day or night, of the incident could not be ascertained. Therefore, interpretations related to gender roles or behavioral characteristics should be made cautiously. Although lower rates of human error–related injuries were observed among older adults, the dataset did not include detailed information on activity patterns, mobility status, or exposure to high-risk domestic tasks. Consequently, alternative explanations, such as differences in exposure or functional capacity, cannot be excluded. Moreover, all participants included in the study were managed as outpatients. Therefore, individuals transported by ambulance or presenting with impaired consciousness and a diagnosis of trauma may not have had the exact mechanism or location of injury clearly documented. As a result, some home accident cases may have been misclassified or underrepresented in the dataset.

Furthermore, as this study was performed at a single center, the results cannot be generalized. However, as the largest emergency department in the province was assessed, the findings may be indicative. Future prospective investigations will yield more accurate information. Consequently, the severity of home accidents can be assessed, allowing for the implementation of preventive strategies.

Ethics

Ethics Committee Approval: The study was approved by the Scientific Research Ethics Committee of Kırklareli University Faculty of Medicine. (P20250018-06/14.04.2025).

Informed Consent: Retrospective study.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

Use of AI for Writing Assistance: None declared.

Acknowledgement: We extend our gratitude to Dr. Efehan Ulaş for his assistance informed by his expertise.

Authorship Contributions: Concept: M.D., N.B.Ç., G.Ş., P.S., O.G.; Design: M.D., N.B.Ç., G.Ş., P.S., O.G.; Supervision: M.D., N.B.Ç., G.Ş., P.S., O.G.; Resource: M.D., N.B.Ç., G.Ş., P.S., O.G.; Materials: M.D., N.B.Ç., G.Ş., P.S., O.G.; Data collection and/or processing: M.D., N.B.Ç., G.Ş., P.S., O.G.; Analysis and/or interpretation: M.D., N.B.Ç., G.Ş., P.S., O.G.; Literature review: M.D., N.B.Ç., G.Ş., P.S., O.G.; Writing: M.D., N.B.Ç., G.Ş., P.S., O.G.; Critical review: M.D., N.B.Ç., G.Ş., P.S., O.G.

Peer-review: Externally peer-reviewed.

References

1. Hsia RY, Ozgediz D, Mutto M, Jayaraman S, Kyamanywa P, Kobusingye OC. Epidemiology of injuries presenting to the national hospital in Kampala, Uganda: implications for research and policy. Int J Emerg Med. 2010;3(3):165-72.
2. Keskinoglu P, Giray H, Pıçakçıefe M, Bilgiç N, Uçku R. Home accidents in elderly living in region of Inonu Health Center. Turk J Geriatr. 2004;7:89-94.
3. Bucaktepe GE, Kara IH, Özdemir Ö. Evaluation of home accident cases admitted to the emergency department of Dicle University Faculty of Medicine. Turk J Fam Pract. 2004;8:75-9.
4. Shao L, Shi Y, Xie XY, Wang Z, Wang ZA, Zhang JE. Incidence and risk factors of falls among older people in nursing homes: systematic review and meta-analysis. J Am Med Dir Assoc. 2023;24:1708-17.
5. Santos JC, Arreguy-Senna C, Pinto PF, Paiva EP, Parreira PMSD, Brandão MAG. Home fall of elderly people: implications of stressors and representations in the COVID-19 context. Rev Gaúcha Enferm. 2021;42(spe):e20200221.
6. Runyan CW, Casteel C, Perkis D, Black C, Marshall SW, Johnson RM, et al. Unintentional injuries in the home in the United States Part I: mortality. Am J Prev Med 2005;28:73-9.
7. Fazel MR, Fakharian E, Razi E, Abedzadeh-Kalahroudi M, Mahdian M, Mohammadzadeh M, et al. Epidemiology of home-related injuries during a six-year period in kashan, iran. Arch Trauma Res. 2012;1:118-22.
8. Özcebe H, Aslan D, Aslan B, et al. Frequency of accidents among first-grade students of Sincan Imam Hatip High School. Cocuk Forumu Derg. 2001;4:13-9.
9. National Center for Health Statistics (US). Age adjustment. Atlanta (GA): Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/nchs/hus/sources-definitions/age-adjustment.htm Accessed 10 Nov, 2025.
10. Gielen AC, Bachman G, Badaki-Makun O, Johnson RM, McDonald E, Omaki E, et al. National survey of home injuries during the time of COVID-19: who is at risk? Inj Epidemiol. 2020;7:63.
11. Tekkas Kerman K, Betrus P. What makes a man a "real man"?: perspectives regarding masculinities and gender roles among young men in Turkey. Asian J Womens Stud. 2019;25:491-514.
12. Hamzaoglu O, Özkan Ö, Janson S. Incidence and causes of home accidents at Ankara Çigiltepe apartments in Turkey. Accid Anal Prev. 2002;34:123-8.

13. Ferrante P, Marinaccio A, Iavicoli S. Home injuries in Italy: patterns of injury and the most exposed people. Int J Inj Contr Saf Promot. 2013;20:36-41.
14. Runyan CW, Casteel C. The state of home safety in America: facts about unintentional injuries in the home. 2nd ed. Washington (DC): Home Safety Council; 2004.
15. Zaloshnja E, Miller TR, Lawrence BA, et al. The costs of unintentional home injuries. Am J Prev Med. 2005;28:88-94.
16. Neghab M, Rajaeefard A, Choobineh A. Home accidents in Shiraz during a 3-year period (2000–2002). J Kermanshah Univ Med Sci. 2008;11:e80470

ORIGINAL RESEARCH

DOI: 10.14744/globecc.2026.02886
Glob Emerg Crit Care 2026;5(4):202-208

Analysis of Workforce Productivity After Changeover of Rotational Doctors in a UK Emergency Department: Can we Predict the "August Effect"?

Robert Conway[1,2], Oliver Meek[2], Emma Maxwell[2]

[1]*Green Templeton College, University of Oxford, Oxford, UK*
[2]*Department of Emergency Medicine, Oxford University Hospitals NHS Foundation Trust, Oxford, UK*

Abstract

Objective: There is limited literature examining the impact of changeover on workforce productivity and the number of patients seen per hour by doctors in UK emergency departments. Given the emphasis on key performance indicators, e.g., 4-hour and 12-hour breach targets, trusts may benefit from minimising the impact of predictable decreases in performance metrics, such as those occurring when new doctors rotate.

Materials and Methods: The mean number of patients seen per hour was calculated for 49 doctors in training in a UK emergency department over a 4–6-month period. Trends were analysed to predict the impact of changeover on productivity for each group of trainees.

Results: When averaged across all trainees, there was an increase of 0.011 patients seen per hour per week. Over the course of an 18-week rotation, this would equate to approximately 1.6 additional patients seen per doctor per shift. When analysed individually, there was a statistically significant increase in the number of patients seen per hour among FY2, GP, and ACCS trainees, although only GP trainees remained statistically significant after correction for multiple comparisons.

Conclusion: Doctors in a UK emergency department appear to increase the number of patients seen per hour during their rotation. This suggests that decreases in departmental performance at changeover may follow a predictable pattern, although conclusions should be drawn with caution due to multiple limitations, including the single-centre nature of the study.

Keywords: Emergency Department Performance Metrics, Impact of Doctors' Rotations, Workforce Productivity

Introduction

In the United Kingdom, doctors routinely move between different specialties, departments, and hospitals during their training. All Foundation Year (FY) 1 and 2 doctors (postgraduate years [PGY] 1 and 2) rotate between specialties every 3–4 months, typically in August, December, and April. Additionally, in the Emergency Department (ED), general practitioner (GP) trainees (PGY 3–5), Acute Care Common Stem (ACCS) trainees (PGY 3–5), and specialty registrars (PGY 5+) rotate every 6 months (August and February). With large proportions of the workforce moving into and out of the department simultaneously, it is assumed that there is some disruption to departmental productivity. UK studies investigating the impact of changeover on productivity are lacking, with the few studies in this field focusing on the US healthcare system. Given that there are major emergency medicine performance targets in the UK, including the 4- and 12-hour targets, hospitals may benefit from implementing measures to mitigate the impact of changeover on performance if productivity is predictably disrupted during this period.

It is intuitive that the productivity of new doctors improves over time as they adjust to the department. Studies have shown that, in US emergency departments, resident doctors are more productive in terms of the number of patients seen toward the end of their rotation than shortly after changeover [1] and that productivity, as measured by patient complexity, increases with each stage of training [2]. The July changeover in the US may also lead to reduced patient care and longer hospital stays, with some evidence suggesting that this impact may be mitigated by higher levels of

Address for Correspondence: Robert Conway, Department of Emergency Medicine, Green Templeton College, University of Oxford, Oxford, UK
E-mail: Robert.Conway@univ.ox.ac.uk **ORCID-ID:** 0009-0004-5090-2093

Received: 12.02.2026 **Revised Date:** 27.05.2026 **Accepted:** 05.06.2026

Cite this article as: Conway R, Meek O, Maxwell E. Analysis of Workforce Productivity After Changeover of Rotational Doctors in a UK Emergency Department: Can we Predict the "August Effect"?. Glob Emerg Crit Care 2026;5(4):202-208.

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senior supervision [3]. Reducing the proportion of staff changing over from 40% to 20% can reduce this impact on length of stay [4]. The UK's equivalent "August effect" has not been investigated in as much detail, particularly in relation to emergency medicine. One UK study showed that the speed at which doctors performed routine tasks improved over the course of their rotation, but there were minimal differences for complex tasks [5]. Other studies have helped quantify the number of patients reviewed during a shift at various career stages, indicating that PGY 2–4 clinicians review approximately 0.8–1.2 patients per hour [6–8]. However, some of these data are not contemporary, and the demographics of emergency department attendances appear to be changing, with a higher volume of attendances involving patients with multimorbidity requiring complex care [9].

The hospital examined in this study is a UK Major Trauma Centre that employs many rotational doctors in training and locally employed doctors. There were approximately 140,000 presentations to the ED between April 2024 and March 2025, comprising both pediatric and adult patients with a full spectrum of medical, surgical, trauma, and psychiatric presentations. Doctors usually spend an entire shift in a specific area, such as Pediatrics, Resuscitation (Resus), Majors, or Ambulatory Care, but move between areas as required based on clinical acuity and patient volume. Doctors generally rotate between these areas, although some FY1 doctors and senior house officers (PGY 2–4) often spend little time in Pediatrics or Resus.

To the best of our knowledge, this is the first study to investigate the impact of doctor changeover on the productivity of a UK emergency department. This study explores trends in the number of patients seen per hour by doctors over the duration of their rotation in the emergency department of a large teaching hospital in England.

Materials and Methods

A retrospective analysis was conducted of the number of patients seen per shift by doctors in training who began working in the department between April 2024 and April 2025, inclusive. Training grades were recorded, and the rota was analyzed to identify shifts worked in patient-facing areas of the department. Shifts missed due to sickness and those assigned to receiving handovers from the previous shift were excluded.

Shifts were classified as either "day" shifts, lasting 9 hours, or "night" shifts, lasting 10.5 hours. An equal distribution of different daytime shift patterns (08:00–17:00, 10:00–19:00, 12:00–21:00, and 16:00–01:00) was assumed. Across these four shift patterns, doctors attend five handovers, each assumed to last 15 minutes. During daytime shifts, doctors are advised to take a 30-minute break, while during night shifts, they are entitled to a total break of 1 hour and are not expected to see new patients after handover. Based on these assumptions, doctors were estimated to spend 8 hours and 11 minutes seeing new patients during a 9-hour shift and 9 hours during a night shift.

Using the Electronic Patient Record (EPR) system, clinicians assign themselves to patients when responsible for their care. This information is stored in the EPR system and can be accessed to identify the number of patients for whom a clinician was the primary care provider over a specified date range. However, if a clinician assigns themselves to a patient and is subsequently required elsewhere, the patient will still be included in the final count, even if the clinician removes their assignment. Although this occurs rarely, it is a potential source of error, and patients were included only if the clinician was recorded as the primary clinician reviewing the patient. The weekly number of patients seen by each doctor was recorded. The rota was reviewed, and the weekly numbers of day and night shifts were calculated. Using the estimates described above, the number of patients reviewed per hour was calculated for each week spent working in the Emergency Department by individual clinicians. Days of sickness were excluded from the analysis.

Clinicians were grouped according to training specialty and grade: Foundation Year (FY) 1, FY2, general practitioner (GP) trainees, Acute Care Common Stem (ACCS) trainees (postgraduate years [PGY] 3–4), Specialty Trainee (ST) 3 (PGY 5), and ST4+ (PGY 6+). In total, the activity of 49 doctors was analyzed, with the breakdown presented in Table 1. The number of patients seen per hour was calculated for each week spent working in the Emergency Department using Microsoft Excel. Mean values for each grade were calculated, and the results were reviewed to identify changes over time. It is acknowledged that the number of patients reviewed per hour is one potential indicator of resident doctor productivity but does not provide insight into the multitude of other functions that resident doctors perform in the Emergency Department, including but not limited to rapid assessment, procedures, interpretation of investigations, and supervision of more junior colleagues.

Statistical analyses were performed using linear regression, and R^2 was calculated to assess the goodness of fit of the data. There are limited data regarding learning curves specifically in emergency medicine and the patterns they follow [10]. This is a complex area distinct from the primary outcome of this retrospective study, which included doctors of various grades at different chronological stages of the learning curve. Given the range of presentations and

Table 1. Grades of doctors included in analysis

	April 2024	August 2024	December 2024	February 2025	April 2025	Total
FY1	1	2	2		1	6
FY2	6	6	5		5	22
GP trainee		2		2		4
ACCS trainee		2		2		4
ST3		4				4
ST4+		4		5		9
Total	7	20	7	9	6	49

FY1: Foundation Year 1, FY2: Foundation Year 2, GP: General Practice, ACCS: Acute Care Common Stem, ST3: Specialty Trainee 3, ST4+: Specialty Trainee 4 and above

pathways involved in managing Emergency Department patients, linear regression was assumed for simplicity during the analysis but was compared with other models to identify any significant differences.

This project was registered as a retrospective service evaluation using routinely collected Emergency Department data and therefore did not require National Health Service (NHS) Research Ethics Committee approval. No identifiable patient information was used, and individual participant data were anonymized. All data were stored and processed in compliance with local data governance requirements. The project was registered locally as a service evaluation and was deemed not to require participant consent for the reasons stated above.

Results

A total of 49 doctors were included in the analysis over a period of either 18 or 26 weeks, depending on the length of their rotation in Emergency Medicine. The weekly average number of patients seen per hour across the entire cohort ranged from 0.35 (week 1, FY1) to 1.70 (week 22, ST4+).

FY1

Figure 1 shows the results for four distinct groups of FY1 (PGY 1) doctors rotating through the department. There was a very small but statistically nonsignificant increase in the number of patients seen per hour during their time working in the ED, with an increase of 0.00383 per week (95% CI: −0.0052 to 0.0128, p=0.38).

FY2

Figure 2 shows the data for FY2 doctors. There was a statistically significant increase of 0.0136 patients seen per hour per week (95% CI: 0.0008 to 0.0264, p=0.038); however, after adjustment for multiple comparisons, this difference was no longer significant. The R^2 value suggested a moderate fit. Assuming a linear regression

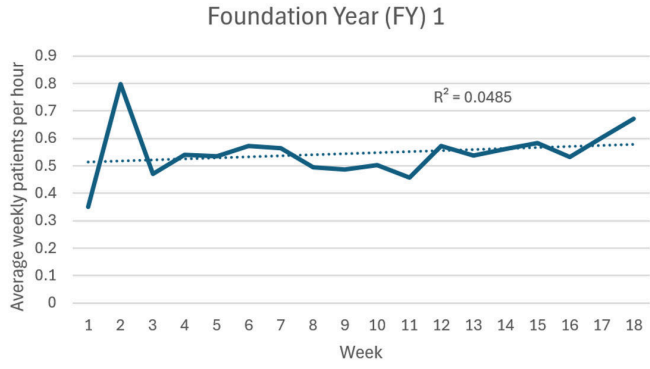


Figure 1. Average patients seen per hour by Foundation Year (FY) 1 doctors during Emergency Medicine placement

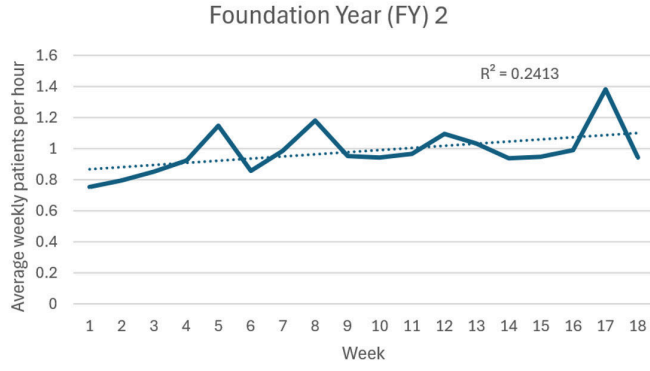


Figure 2. Average patients seen per hour by Foundation Year (FY) 2 doctors during Emergency Medicine placement

model, this would equate to each FY2 doctor seeing 2.00 more patients during day shifts and 2.20 more patients during night shifts at the end of their rotation compared with the beginning.

GP Trainee

Figure 3 shows the data for GP trainees. There was a statistically significant increase of 0.0160 patients seen per hour per week (95% CI: 0.006 to 0.026, p=0.003), with the model demonstrating

a moderate fit (R^2=0.031). Based on this model, GP trainees would see an additional 3.4 patients during a day shift and 3.7 patients during a night shift at the end of their rotation compared with the beginning. After adjustment for multiple comparisons using the Holm–Bonferroni method, this was the only group in which the difference remained statistically significant.

ACCS Trainee

Figure 4 presents the data collected for ACCS trainees. There was a statistically significant increase of 0.00715 patients seen per hour per week (95% CI: 0.0013 to 0.013, p=0.019). Based on the assumptions, this would equate to an additional 1.52 and 1.67 patients seen during each day and night shift, respectively, when comparing the end of the placement with the beginning. However, after correction for multiple comparisons, this difference was no longer statistically significant.

ST3

Among ST3 doctors (Fig. 5), there was a statistically nonsignificant increase of 0.00275 patients seen per hour per week (95% CI: −0.0023 to 0.0078, p=0.27).

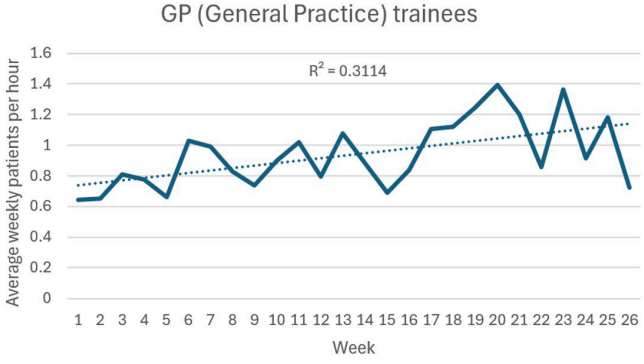


Figure 3. Average patients seen per hour by General Practice (GP) trainee doctors during Emergency Medicine placement

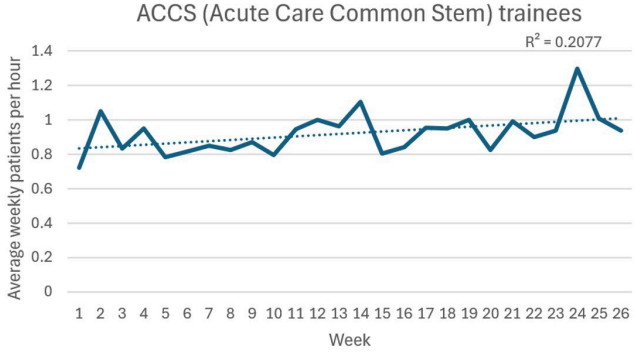


Figure 4. Average patients seen per hour by Acute Care Common Stem (ACCS) doctors during Emergency Medicine placement

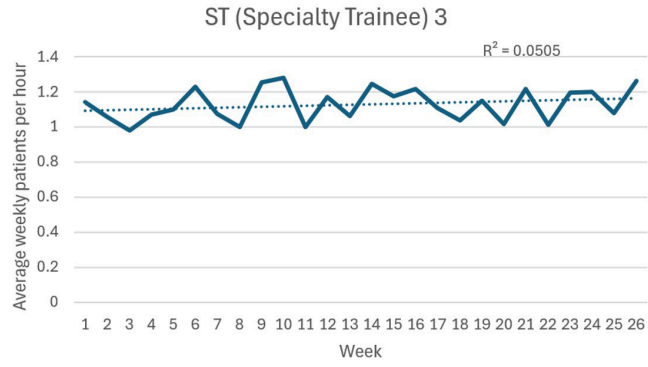


Figure 5. Average patients seen per hour by Specialty Trainee (ST) 3 doctors during Emergency Medicine placement

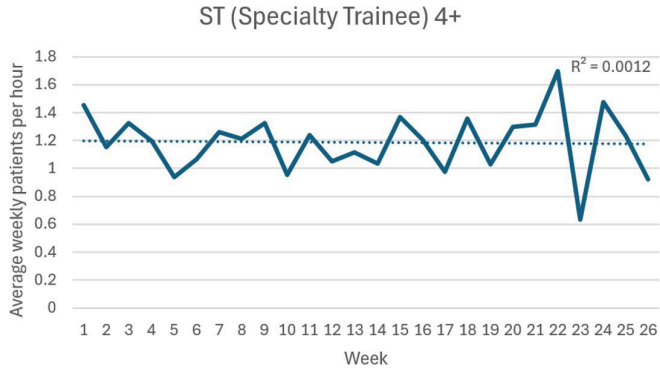


Figure 6. Average patients seen per hour by Specialty Trainee (ST) 4 doctors during Emergency Medicine placement

ST4+

There was a statistically nonsignificant decrease of 0.00097 patients seen per hour per week (Fig. 6; 95% CI: −0.0129 to 0.011, p=0.869).

After applying the Holm–Bonferroni correction for multiple comparisons, only GP trainees continued to demonstrate a statistically significant difference in the number of patients seen over time (Appendix 1).

Average of All Grades Combined

When averaging the data across all grades working in the department (Fig. 7), there was a statistically significant increase of 0.011 patients seen per hour per week (95% CI: 0.0073 to 0.014, $p=8.05\times10^{-7}$). The R^2 value was 0.6224, demonstrating a very good fit to the complex data. This increase would equate to an additional 1.62 and 1.78 patients seen per clinician during day and night shifts, respectively, by week 19. Assuming that 20 resident doctors staff an Emergency Department over a 24-hour period, this would equate to >30 additional patients seen per day. Averages across all grades could only be calculated up to week 18 because FY1 and FY2 doctors rotated out after this period. If

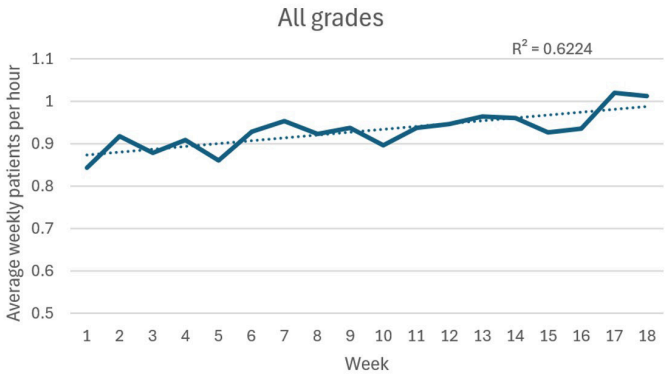


Figure 7. Average patients seen per hour across all grades of doctors during Emergency Medicine placement

extrapolated to doctors spending 6 months in the ED (PGY 3 and above), this would equate to an additional 2.34 and 2.57 patients seen per doctor per day and night shift, respectively.

Limitations

There are several limitations to this study. First, the sample size was small, particularly when considering individual grades, and the study was limited to a single center in the UK. Patient-facing time was estimated rather than directly measured. Some clinicians may have taken longer breaks, while others may not have taken their full allocated break time, as reported in previous literature [11], which could affect the number of patients seen per hour. Similarly, handover durations may vary. Although 15 minutes was assumed to represent the average handover duration, some handovers may have been longer or shorter.

Although the electronic patient record provides an accurate count of the number of patients "clicked on" by a clinician, this may not accurately represent the number of patients fully reviewed by that clinician. For example, if a clinician selected a patient for review but another patient required urgent attention, resulting in the original patient being reviewed primarily by someone else, the original patient would still be included in the clinician's total. Fortunately, this situation is rare, and patients were included only if the clinician was recorded as the primary clinician in the EPR. Nevertheless, this may have slightly inflated the number of patients seen per hour. Likewise, some clinicians may assign themselves to patients referred directly to a specialty. These patients require significantly less workup by the Emergency Medicine clinician, and practices vary regarding the time spent with these patients. Therefore, including these patients may also artificially increase the number of patients seen per hour. Observations from the same doctors represent repeated measures; therefore, the weekly numbers of patients reviewed are not fully independent. However, multiple training cohorts were included to minimize the impact of this limitation on the data obtained.

When comparing the number of patients seen per hour between grades, it should be noted that increasing seniority is often accompanied by numerous additional responsibilities, including but not limited to reviewing electrocardiograms (ECGs) or bloodwork, discussing or reviewing patients managed by more junior colleagues, prescribing medications, and rapidly assessing patients escalated by nursing staff. This study does not account for the supervisory and coordination roles undertaken by senior residents, particularly during night shifts. These roles were not considered in this analysis and may contribute to the differences observed between cohorts of varying seniority.

The number of patients reviewed per hour is one metric used to evaluate medical practitioner and Emergency Department productivity. However, many other system-level operational indicators of departmental performance were not included in this study. These include, but are not limited to, waiting times, average length of stay, and mortality. In the UK, key performance indicators, such as 4-hour and 12-hour breach statistics, were also not included in this study. Therefore, extrapolation of these results to broader departmental performance metrics is not recommended, although further evaluation may be warranted.

Discussion

These data suggest that there is an overall increase in the number of patients seen per hour by clinicians in the Emergency Department over time. This increase is most notable among senior house officers (SHOs; FY2, GP, and ACCS trainees), although after correction for multiple comparisons, it remains statistically significant only for GP trainees. There appears to be no change in the number of patients seen by more senior trainees (ST3 and ST4+), although these individuals have a wide range of other responsibilities during clinical shifts, as previously discussed. Overall, these findings suggest that when large numbers of resident doctors rotate, particularly SHOs, there may be a decrease in performance. This would most likely occur in August, when FY2, GP, and ACCS trainees all rotate simultaneously, along with ST3 and ST4+ doctors. The absolute number of patients reviewed per hour appears consistent with previously published literature [6–8].

Although the number of patients reviewed per hour is a pragmatic measure for evaluating resident doctor productivity in a complex setting, this measure does not account for other significant factors affecting Emergency Department performance. The measures used in this study do not account for other roles undertaken by resident doctors, such as interpreting investigations and supervising more junior colleagues. In addition, this measure is

Table 2. R squared values for each training grade with different regression analyses

	Linear	Logarithmic	Polynomial	Power
FY1	0.0485	0.0411	0.1102	0.0404
FY2	0.2381	0.3141	0.2843	0.3079
GP	0.3114	0.3341	0.3547	0.3389
ACCS	0.2114	0.1663	0.2192	0.1703
ST3	0.0463	0.0477	0.0501	0.048
ST4+	0.0011	0.0126	0.0096	0.0139
All grades	0.6445	0.5083	0.6482	0.5283

FY1: Foundation Year 1, FY2: Foundation Year 2, GP: General Practice, ACCS: Acute Care Common Stem, ST3: Specialty Trainee 3, ST4+: Specialty Trainee 4 and above

likely to be significantly influenced by local pathways and policies, patient demographics, including the proportion of patients whose first language is English, and the roles and availability of allied healthcare professionals, such as Emergency Nurse Practitioners, who manage most minor injuries in this Trust. Due to differences between hospital trusts, the absolute figures reported here should not be applied to other Emergency Departments, although the overall patterns observed may be more generalizable.

The lack of significant changes in the number of patients seen by FY1, ST3, and ST4+ doctors is likely to be multifactorial but may suggest that further education or training to enhance efficiency could be beneficial.

In many groups, there appears to be a decrease in the number of patients seen per hour during the final weeks of a rotation. This may reflect natural variation or behavioral changes among clinicians. Anecdotally, many have reported feeling "burned out" from working unsociable hours and demanding rotas in Emergency Medicine.

When calculating R^2, a linear regression model did not always provide the best fit. Table 2 presents the R^2 values for each group according to the type of regression analysis used. These findings suggest that polynomial or logarithmic regression models often fit the data better, particularly for more junior staff members, among whom significant differences were observed. Given the complexity of Emergency Medicine and the multitude of factors that may influence the number of patients seen by a clinician, it is possible that these data do not change linearly over time. When rotating to a new specialty, doctors often need to learn new ways of working, such as referral pathways and the management of specific conditions. If these are significant factors affecting a clinician's productivity, the data would be expected to follow a pattern similar to that of their ability to learn and assimilate these new ways of working. Further investigation is required to accurately model how clinicians' productivity changes over time. Understanding these patterns would be useful for assessing their impact on Key Performance Indicators (KPIs) and identifying potential strategies to mitigate this impact.

Conclusion

This study suggests that the number of patients seen per hour by resident doctors in UK Emergency Departments increases over time. This increase is most notable among FY2, GP, and ACCS trainees. These findings suggest a predictable decrease in productivity during changeover periods, particularly when multiple training cohorts rotate simultaneously, which may affect KPIs, such as the 4-hour target. However, conclusions should be drawn with caution due to the multiple limitations of this study. With further investigation into the exact nature of these increases, Trusts may be able to introduce measures to mitigate the effects of rotation on KPIs.

Ethics

Ethics Committee Approval: This project was registered as a retrospective service evaluation using routinely collected Emergency Department data and so did not require NHS Research Ethics Committee approval.

Informed Consent: Retrospective study.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

Use of AI for Writing Assistance: None declared.

Authorship Contributions: Concept: R.C., E.M.; Design: R.C., E.M.; Supervision: R.C.; Data collection and/or processing: R.C., O.M., E.M.; Analysis and/or interpretation: R.C.; Literature review: R.C., O.M.; Writing: R.C., O.M.; Critical review: R.C., O.M., E.M.

Peer-review: Externally peer-reviewed.

References

1. Bahl A, Hixson CC. July phenomenon impacts efficiency of emergency care. West J Emerg Med. 2019;20:157-62.
2. Brennan DF, Silvestri S, Sun JY, Papa L. Progression of emergency medicine resident productivity. Acad Emerg Med. 2007;14:790-4
3. Huckman RS, Barro JR. Cohort turnover and productivity: the July phenomenon in teaching hospitals. Cambridge (MA): National Bureau of Economic Research; 2005 Mar. (NBER Working Paper; No. 11182). Available at: https://www.nber.org/papers/w11182 Accesed October 15, 2026.
4. Mongelli F, Fischer H, Stickel M, Patella M, Heeren N, Christ M et al. Surgical residents' proficiency and turnover may affect the overall efficiency in an emergency department. World J Surg. 2019;43:2365-70

5. Blakey JD, Fearn A, Shaw DE. What drives the 'August effect'? A observational study of the effect of junior doctor changeover on out of hours work. JRSM Short Rep. 2013;4:2042533313489823.
6. Langdorf MI, Strange G, Macneil P. Computerized tracking of emergency medicine resident clinical experience. Ann Emerg Med. 1990;19:764-73.
7. Hamden K, Jeanmonod D, Gualtieri D*, Jeanmonod R*. Comparison of resident and mid-level provider productivity in a high-acuity emergency department setting. *Emergency Medicine Journal*. 2014;31**:**216-9.
8. DeBehnke D, O'Brien S, Leschke R. Emergency medicine resident work productivity in an academic emergency department. Academic Emergency Medicine 2000;7:90-2.
9. Alkhatib A, Aylin P, Klaber R, Woodcock T. Shifting patterns in emergency department attendance: a time series analysis Emergency Medicine Journal. 2026;43**:**223-9.
10. Preiksaitis C, Hughes J, Kabeer R, Dixon W, Rose C. Quantifying Emergency Medicine Residency Learning Curves Using Natural Language Processing: Retrospective Cohort Study. JMIR Med Educ. 2025;11: e82326.
11. Cubitt LJ, Im YR, Scott CJ, Jeynes LC, Molyneux PD. Beyond PPE: a mixed qualitative-quantitative study capturing the wider issues affecting doctors' well-being during the COVID-19 pandemic. BMJ Open 2021;11:e050223.

Group	Raw p	Holm-adjusted p
GP	0.003	**0.018**
ACCS	0.019	0.076
FY2	0.038	0.114
ST3	0.27	0.54
FY1	0.38	0.76
ST4	0.869	0.869

Appendix 1. Holm-Bonferroni correction for multiple comparisons

ORIGINAL RESEARCH

DOI: 10.14744/globecc.2026.14622
Glob Emerg Crit Care 2026;5(4):209-219

Antithrombotic Profile and Mortality Predictors of Non-Traumatic Bleeding at Emergency Department: A Prospective Observational Study

Yağız Kağan Ergün[1], Ömer Yasir Boz[2], Güçlühan Uçar[3], Recep Murat Mert[4], Emre Üstül[5], Figen Coşkun[6]

[1]*Department of Internal Medicine, Intensive Care Unit, University of Health Sciences, Kayseri City Hospital, Kayseri, Türkiye*
[2]*Emergency Medicine Service, Muğla Training and Research Hospital, Muğla, Türkiye*
[3]*Department of Princess Cruise Lines Medical, Santa Clarita, USA*
[4]*Department of Emergency Medicine, Izmir University of Economics, Medical Point Hospital, İzmir, Türkiye*
[5]*Fehime Faik Kocagöz State Hospital, Aydın, Türkiye*
[6]*Department of Emergency Medicine, Dokuz Eylül University Hospital, İzmir, Türkiye*

Abstract

Objective: This prospective observational study evaluated the clinical profile of adults presenting to the emergency department (ED) with non-traumatic bleeding and examined whether bleeding severity, antithrombotic use, and physiological/laboratory parameters were associated with in-hospital and 30-day mortality.

Materials and Methods: Demographic data, comorbidities, medication exposure, bleeding site, vital signs, laboratory variables, and clinical outcomes were recorded using a standardized data collection form. Major bleeding was defined according to the International Society on Thrombosis and Haemostasis (ISTH) criteria. Group comparisons were performed using appropriate parametric or non-parametric tests, and variables associated with mortality were evaluated using multivariable logistic regression.

Results: Among 310 patients screened, 297 adults were included after exclusion of 13 patients with cirrhosis-related complications. Gastrointestinal bleeding was the most common presentation (48.1%), and 55.9% of patients were using at least one antithrombotic agent. Major bleeding was more frequent in older patients, males, patients with comorbidities, and those with central nervous system (CNS) or gastrointestinal bleeding. In-hospital mortality was 8.1%, and 30-day mortality was 12.1%. In the final multivariable model, major bleeding (OR=7.223, 95% CI: 2.268–23.005, p=0.001) and lower oxygen saturation (OR=0.757, 95% CI: 0.665–0.860, p<0.001) were independently associated with in-hospital mortality. CNS bleeding, hypertension, higher blood urea nitrogen, higher pulse rate, and lower oxygen saturation were independently associated with 30-day mortality.

Conclusion: In adults presenting to the ED with non-traumatic bleeding, mortality appeared to cluster around bleeding severity and markers of physiological compromise rather than antithrombotic exposure alone. Early risk stratification using bleeding site, ISTH major bleeding criteria, oxygen saturation, pulse rate, and renal function markers may help identify patients requiring closer monitoring and more aggressive management.

Keywords: Antithrombotic agents, emergency department, major bleeding, mortality, non-traumatic bleeding, risk stratification

Introduction

Non-traumatic bleeding is a frequent but clinically heterogeneous reason for emergency department (ED) presentation. In contemporary ED practice, the initial evaluation of these patients is increasingly complicated by population aging, multimorbidity, chronic kidney disease, cardiovascular disease, and exposure to multiple drugs that may alter hemostasis. Therefore, the clinical question is no longer limited to identifying the anatomical source of bleeding; ED physicians must also rapidly determine whether the patient has a potentially fatal bleeding phenotype, whether antithrombotic therapy contributes to bleeding severity, and which physiological markers should trigger closer monitoring or early escalation of care [1–3]. Antithrombotic therapy is central to the prevention of thromboembolic events, but it also creates a major

Address for Correspondence: Yağız Kağan Ergün, Department of Internal Medicine, Intensive Care Unit, University of Health Sciences, Kayseri City Hospital, Kayseri, Türkiye
E-mail: yke1992@gmail.com **ORCID-ID:** 0000-0001-6891-6857

Received: 09.02.2026 **Revised Date:** 08.06.2026 **Accepted:** 20.07.2026

Cite this article as: Ergün YK, Boz ÖY, Uçar G, Mert RM, Üstül E, Coşkun F. Antithrombotic Profile and Mortality Predictors of Non-Traumatic Bleeding at Emergency Department: A Prospective Observational Study. Glob Emerg Crit Care.

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challenge at the point of acute care. Antiplatelet agents, vitamin K antagonists, and direct oral anticoagulants (DOACs) are commonly prescribed in older patients who already have a high baseline risk of bleeding because of comorbidity and polypharmacy. In addition, concomitant use of antiplatelet agents, anticoagulants, or non-steroidal anti-inflammatory drugs (NSAIDs) may increase bleeding risk through different mechanisms, including impaired platelet activation, reduced coagulation factor activity, and gastrointestinal mucosal injury [4–7]. The concept of "major bleeding" is not used uniformly across the literature. Definitions vary according to study population, anatomical bleeding site, hemodynamic instability, transfusion requirement, hemoglobin decrease, need for intervention, or involvement of a critical organ or compartment. This variability limits comparison between studies and may be particularly problematic in ED cohorts, where gastrointestinal bleeding, central nervous system (CNS) bleeding, epistaxis, hematuria, hemoptysis, and gynecological bleeding are evaluated within the same clinical workflow [1]. In the present study, the International Society on Thrombosis and Haemostasis (ISTH) criteria were selected to define major bleeding because they combine clinically meaningful outcomes with objective criteria that can be applied across heterogeneous bleeding presentations. The ISTH definition captures fatal bleeding, critical-site bleeding, substantial hemoglobin decline, and transfusion requirement, thereby providing a pragmatic framework for ED risk stratification rather than a bleeding-site-specific classification alone [8]. Although previous studies have examined specific bleeding subgroups such as gastrointestinal bleeding, intracerebral hemorrhage, epistaxis, hematuria, or hemoptysis, fewer studies have evaluated the overall ED profile of non-traumatic bleeding patients while simultaneously considering antithrombotic exposure, bleeding severity, physiological compromise, and short-term mortality. This gap is clinically important because ED disposition decisions are often made before definitive source control, endoscopic intervention, surgical management, or specialist follow-up is completed [1,9–11]. We therefore hypothesized that, among adults presenting to the ED with non-traumatic bleeding, mortality would be associated more strongly with bleeding severity, bleeding site, and markers of acute physiological compromise than with antithrombotic exposure alone. The aim of this study was to describe the clinical and antithrombotic profile of ED patients with non-traumatic bleeding and to identify factors associated with in-hospital and 30-day mortality using a prospective observational cohort.

Materials and Methods

Study Design, Setting, and Population

This single-center prospective observational study was conducted in the ED after approval by the Non-Invasive Ethics Committee of Dokuz Eylul University (Protocol No: 2021/02-55). Consecutive adult patients presenting between January and June 2021 with symptoms related to non-traumatic bleeding were screened for eligibility. The study team did not interfere with diagnostic or therapeutic management, including transfusion, reversal therapy, endoscopy, surgical consultation, admission, discharge, or follow-up decisions.

Inclusion criteria were age 18 years or older, presentation to the ED with bleeding symptoms, and absence of trauma history. Exclusion criteria included end-stage cirrhotic liver disease, hemophilia A or B, von Willebrand disease, Bernard-Soulier syndrome, and Glanzmann thrombasthenia. Of 310 screened individuals, 13 were excluded because of cirrhosis-related complications, leaving 297 patients for analysis. Patients who died during ED follow-up were included in the in-hospital mortality analysis. Patients who left the ED before completing treatment were included in the outcome analyses if survival status could be verified. Survival status and, when applicable, date of death was confirmed through the hospital information management system, which is integrated with the national death notification/registry network and provides official death records regardless of the place of death (Fig. 1).

Data Collection and Medication Use Verification

Data were initially collected using a standardized study form. After written informed consent was obtained, data collection was performed by a physician member of the study team who was not the primary physician responsible for the patient's clinical care. The completed forms were subsequently transferred to a digital database and checked by another member of the study team for completeness and consistency.

Collected variables included age, sex, comorbidities, previous bleeding history, bleeding site, vital signs, physical examination findings, laboratory parameters, medication use, and clinical outcomes. Medication use included antiplatelet agents, anticoagulants, NSAIDs, drug combinations, specific drug names, and clinical indications when available.

Medication use was primarily assessed through patient or family interview and was cross-checked with previous electronic medical records and prescription information whenever available. This verification process was used to distinguish active medication use from medications that had only been prescribed previously but were not being taken at the time of ED presentation. For patients residing in nursing homes, medication information was additionally verified by contacting the nursing home staff or the responsible nurse.

Definition of Major Bleeding and Outcomes

Major bleeding was defined according to the ISTH criteria as one or more of the following: fatal bleeding; symptomatic bleeding

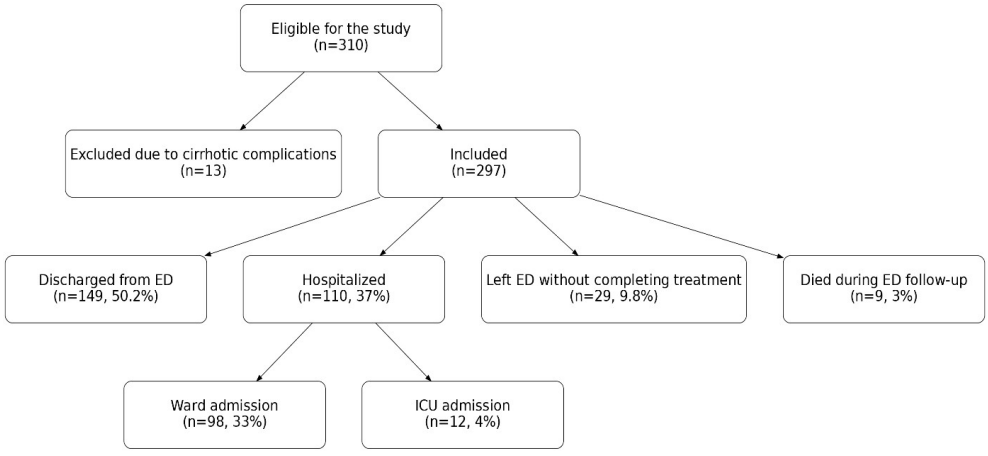


Figure 1. Flowchart of the study population.
Emergency Department (ED) Intensive Care Unit (ICU)

in a critical area or organ, including intracranial, intraspinal, retroperitoneal, intra-articular, pericardial, or intramuscular bleeding with compartment syndrome; a hemoglobin decrease of at least 2 g/dL attributable to bleeding; or transfusion of at least 2 units of blood products [8].

The primary outcomes were in-hospital mortality and 30-day mortality. In-hospital mortality was defined as death occurring during ED follow-up or subsequent hospitalization after admission from the ED. Thirty-day mortality was defined as death from any cause within 30 days after the index ED presentation. Survival status and, when applicable, date of death was verified primarily through the hospital information management system, which is integrated with the national death notification/registry network and provides official death records regardless of the place of death within Türkiye. When clarification was needed or electronic registry information was unavailable at the time of follow-up, patients or family members were contacted by telephone to confirm survival status.

Bias Reduction and Sample Size Considerations

To reduce selection bias, all eligible non-traumatic bleeding presentations during the predefined study period were screened using the same inclusion and exclusion criteria. Because this was a single-center ED cohort, the findings should be interpreted as reflecting the case-mix and clinical pathways of the study institution rather than the full national ED population.

No formal a priori sample size calculation was performed before enrollment. The final cohort size was determined by the number of eligible patients presenting during the study period. For transparency, the final analysis included 24 in-hospital deaths and 36 deaths within 30 days; therefore, the number of variables entered multivariable models was restricted to reduce overfitting risk. Model results were interpreted as exploratory and hypothesis-generating rather than as definitive causal estimates.

Statistical Analysis

Data were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY). Continuous variables are presented as mean±standard deviation or median and interquartile range according to distribution, and categorical variables are presented as number and percentage. Normality was evaluated using the Shapiro-Wilk test. Continuous variables were compared using the independent-samples t test or Mann-Whitney U test, as appropriate. Categorical variables were compared using the chi-square test, Fisher exact test, or Yates continuity correction, as appropriate.

Variables were first evaluated using univariable logistic regression analyses for each mortality outcome. Variables associated with mortality in univariable logistic regression at $p<0.20$, together with clinically important variables identified a priori, were considered candidate variables for multivariable logistic regression models. Variables that were significant in group comparisons but did not show an independent association in univariable logistic regression, or that did not contribute to the final multivariable model, were not retained. Separate multivariable logistic regression models were constructed for in-hospital mortality and 30-day mortality. Backward stepwise elimination was applied within the multivariable models, with attention to clinical plausibility and the number of outcome events to minimize overfitting. Results are reported as odds ratios (ORs), 95% confidence intervals (CIs), and p values.

Age-adjusted logistic regression models were additionally constructed by adding age as a continuous covariate to the final

multivariable models. To assess potential effect modification, an interaction term between antithrombotic use and major bleeding was added to the logistic regression models. Because menometrorrhagia represents a clinically distinct, sex-specific bleeding subgroup that may differ from other bleeding presentations in terms of age and comorbidity profile, a sensitivity analysis was performed after excluding patients with menometrorrhagia.

Overall model performance was evaluated using the model chi-square statistic and Nagelkerke R^2. Model calibration was assessed using the Hosmer-Lemeshow goodness-of-fit test. Multicollinearity was evaluated using tolerance and variance inflation factor (VIF) values. A two-sided p value<0.05 was considered statistically significant.

A post-hoc power analysis was performed to evaluate the adequacy of the sample size (n=297) for the multivariable logistic regression models. For the primary outcome of in-hospital mortality (24 events out of 297 patients), a model with two independent predictors (major bleeding and SpO2) achieved a statistical power of 93.4% (1-β=0.934) to detect a significant association with an alpha level of 0.05. For the 30-day mortality outcome (36 events out of 297 patients), the multivariable model containing five independent predictors achieved a statistical power of 89.1% (1-β=0.891). These results indicate that the study cohort provided sufficient statistical power (well above the conventional 80% threshold) to identify independent risk factors for both in-hospital and 30-day mortality.

Results

A total of 297 adult patients met the inclusion criteria and were included in the final analysis. The cohort consisted of 152 male and 145 female patients. The mean age was 62.2±18.9 years. Baseline laboratory findings reflected the heterogeneous clinical profile of the cohort. Overall, the mean hemoglobin level was 10.6±3.0 g/dL, mean hematocrit was 32.3±8.6%, mean creatinine was 1.1±1.1 mg/dL, mean BUN was 29.3±24.3 mg/dL, and mean INR was 1.4±1.2. Patients with comorbidities had lower hematocrit levels and higher BUN and INR values, while patients with GI bleeding had lower hematocrit levels than those with other common bleeding sites.

The most frequent bleeding site was the gastrointestinal system (48.1%, n=143), followed by menometrorrhagia (13.8%, n=41), CNS bleeding (10.1%, n=30), epistaxis (9.8%, n=29), and hematuria (9.1%, n=27). Less frequent presentations included hemoptysis, oral cavity bleeding, intramuscular bleeding, cutaneous bleeding, subconjunctival hemorrhage, and dialysis fistula bleeding.

Almost half of the patients (n=149, 50.2%) were discharged from the ED. Ninety-eight patients (33.0%) were admitted to the ward, 12 patients (4.0%) were admitted to the intensive care unit, 29 patients (9.8%) left the ED before completing treatment, and 9 patients (3.0%) died during ED follow-up. Among admitted patients, 15 additional deaths occurred during ward or intensive care follow-up, resulting in total in-hospital mortality of 8.1% (n=24); (Fig. 1).

A total of 166 patients (55.9%) were using at least one antithrombotic agent. Eighty-three patients (27.9%) were using a single antiplatelet agent, 21 (7.1%) were using dual antiplatelet therapy, and one patient (0.3%) was receiving triple antiplatelet therapy. NSAID use was reported in 26 patients (8.8%). A total of 131 patients (44.1%) were not using any antithrombotic medication, and 115 patients (38.7%) were not using antiplatelet, anticoagulant, or NSAID therapy (Fig. 2).

Antithrombotic use varied by bleeding site. Antiplatelet therapy was the most common medication group among patients with epistaxis, GI bleeding, hematuria, CNS bleeding, and hemoptysis (48.3%, 40.6%, 48.1%, 26.7%, and 43.8%, respectively), whereas anticoagulant use was most frequent in patients with menometrorrhagia (14.6%). Combined antiplatelet and anticoagulant therapy were observed in 9 patients (3.0%).

The frequency of major bleeding increased numerically with the number of antiplatelet agents, and an exploratory test for linear trend was statistically significant (linear-by-linear association, p=0.033). However, the overall exact association was

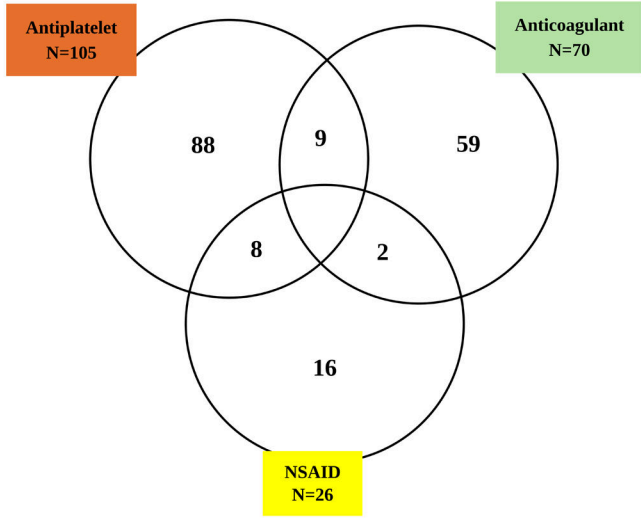


Figure 2. The distribution of antiplatelet, anticoagulant and non-steroidal anti-inflammatory drugs use according to medication combination among the study patients. Non-Steroidal Anti-Inflammatory Drugs (NSAID)

not statistically significant (p=0.064), and the finding should be interpreted cautiously because only one patient was receiving triple antiplatelet therapy.

Major bleeding was observed in 124 patients (41.8%). Patients with major bleeding were older than those without major bleeding (67.8±16.6 vs. 58.2±19.5 years, p<0.001). Male sex and comorbidity were also associated with a higher frequency of major bleeding. All 30 patients with CNS bleeding fulfilled major bleeding criteria, which is expected because CNS bleeding is included among critical-site bleeding events in the ISTH definition.

In-hospital mortality was 8.1% (n=24). In univariable comparisons, in-hospital mortality was associated with older age, higher creatinine, higher BUN, higher INR, higher pulse rate, lower oxygen saturation, and major bleeding. In the final multivariable model, major bleeding (OR=7.223, 95% CI: 2.268-23.005, p=0.001) and lower oxygen saturation (OR=0.757, 95% CI: 0.665-0.860, p<0.001) remained independently associated with in-hospital mortality. After adjustment for age, major bleeding and oxygen saturation remained statistically significant predictors of in-hospital mortality. Age itself was not independently associated with in-hospital mortality. Antithrombotic exposure did not significantly modify the association between major bleeding and mortality (Table 1-5).

The 30-day mortality rate was 12.1% (n=36). Thirty-day mortality was higher among patients with hypertension and among those with major bleeding. Patients who died within 30 days had lower hemoglobin and hematocrit values and higher BUN values. In the final multivariable model, CNS bleeding (OR=4.592, 95% CI: 1.553-13.578, p=0.006), hypertension (OR=2.239, 95% CI: 1.003-4.998, p=0.049), BUN (OR=1.024, 95% CI: 1.010-1.037, p=0.001), pulse rate (OR=1.024, 95% CI: 1.002-1.045, p=0.029), and oxygen saturation (OR=0.822, 95% CI: 0.734-0.920, p=0.001) were independently associated with 30-day mortality. After adjustment for age, the associations of CNS bleeding, BUN, pulse, and oxygen saturation with 30-day mortality remained largely unchanged. However, the association between hypertension and 30-day mortality was attenuated and no longer statistically significant. Age was not independently associated with 30-day mortality in the multivariable model (Table 4, Table 5).

In the multivariable model for in-hospital mortality, major bleeding and lower oxygen saturation remained independently associated with mortality. The model was statistically significant, χ^2 (2)=38.826, p<0.001, Nagelkerke R^2=0.285, and showed acceptable calibration, Hosmer-Lemeshow χ^2 (5)=6.384, p=0.271. Multicollinearity was not detected (VIF=1.027 for both variables). In the multivariable model for 30-day mortality, CNS bleeding, hypertension, higher BUN, higher pulse rate, and lower oxygen saturation remained independently associated with mortality. The model was statistically significant, $\chi^2(5)=46.939$, p<0.001, Nagelkerke R^2=0.280, and showed good calibration, Hosmer-Lemeshow $\chi^2(8)=2.138$, p=0.976. No problematic multicollinearity was observed (VIF range: 1.032–1.126). After excluding patients with menometrorrhagia, the results remained largely consistent with the main analyses, with no material change in the direction or interpretation of the main associations.

Table 1. Demographic and clinical characteristics according to major bleeding status

Characteristic	Major bleeding (n=124)	No major bleeding (n=173)	p
Age, years	67.8±16.6	58.2±19.5	**<0.001**
Sex			**0.007**
Female	49 (33.8)	96 (66.2)	
Male	75 (49.3)	77 (50.7)	
Previous bleeding history			**0.715**
Yes	39 (43.3)	51 (56.7)	
No	85 (41.1)	122 (58.9)	
Any comorbidity			**0.009**
Yes	97 (46.6)	111 (53.4)	
No	27 (30.3)	62 (69.7)	
Bleeding site			**<0.001**
Central nervous system	30 (100.0)	0 (0.0)	
Gastrointestinal	75 (52.4)	68 (47.6)	
Epistaxis	4 (13.8)	25 (86.2)	
Hematuria	4 (14.8)	23 (85.2)	
Hemoptysis	4 (25.0)	12 (75.0)	
Menometrorrhagia	5 (12.2)	36 (87.8)	
Other	2 (18.2)	9 (81.8)	

Continuous variables are presented as mean ± standard deviation. Categorical variables are presented as n (%); percentages are calculated across major bleeding status within each row. p values were obtained using the appropriate two-group or overall categorical comparison. CNS bleeding is classified as major bleeding under the ISTH critical-site criterion.

Discussion

The present study suggests that mortality among ED patients with non-traumatic bleeding is driven primarily by bleeding severity, critical-site involvement, and early physiological compromise rather than antithrombotic exposure alone. This distinction is clinically important. In the ED, medication exposure is often

Table 2. Antithrombotic and NSAID exposure profile and observed clinical outcomes

Panel A. Mutually exclusive medication categories

Medication category	Total, n (%)	Major bleeding, n (%)	In-hospital mortality, n (%)	30-day mortality, n (%)
No antiplatelet, anticoagulant, or NSAID use	115 (38.7)	42 (36.5)	9 (7.8)	12 (10.4)
Antiplatelet only	88 (29.6)	39 (44.3)	7 (8.0)	9 (10.2)
Anticoagulant only	59 (19.9)	27 (45.8)	5 (8.5)	10 (16.9)
NSAID only	16 (5.4)	5 (31.3)	0 (0.0)	2 (12.5)
Antiplatelet + NSAID	8 (2.7)	5 (62.5)	2 (25.0)	2 (25.0)
Anticoagulant + NSAID	2 (0.7)	1 (50.0)	0 (0.0)	0 (0.0)
Antiplatelet + anticoagulant	9 (3.0)	5 (55.6)	1 (11.1)	1 (11.1)
Total	**297 (100.0)**	**124 (41.8)**	**24 (8.1)**	**36 (12.1)**

Panel B. Major bleeding according to the number of concurrent antiplatelet agents

Number of antiplatelet agents	Total, n (%)	Major bleeding, n (%)	p
0	192 (64.6)	75 (39.1)	**0.033**
1	83 (27.9)	34 (41.0)	
2	21 (7.1)	14 (66.7)	
3	1 (0.3)	1 (100.0)	

In Panel A, percentages in the Total column were calculated using the full cohort as the denominator, whereas outcome percentages were calculated within each medication category. In Panel B, the overall association across antiplatelet-count categories was assessed using the Fisher–Freeman–Halton exact test (p=0.064), and the linear trend across the ordered categories was evaluated using the linear-by-linear association test (P for trend =0.033). The observed trend should be interpreted cautiously because only one patient was receiving three antiplatelet agents. NSAID, non-steroidal anti-inflammatory drug.

immediately visible and may dominate the initial assessment; however, our findings suggest that risk stratification should prioritize the patient's current clinical state, the anatomical consequences of bleeding, and evidence of systemic vulnerability.

The predominance of gastrointestinal bleeding in this cohort is consistent with prior ED-based reports and supports the view that gastrointestinal hemorrhage remains the most common non-traumatic bleeding phenotype encountered in acute care. However, the prognostic meaning of bleeding site was not uniform. Gastrointestinal bleeding contributed substantially to case volume and anemia burden, whereas CNS bleeding carried disproportionate prognostic weight. These findings highlight that the prevalence of a bleeding site does not necessarily reflect its prognostic impact. Critical-site bleeding may be associated with death through direct organ injury, neurological deterioration, secondary pulmonary complications, aspiration, and reduced ability to compensate for physiological stress [1,10,12].

The use of ISTH criteria helped translate this heterogeneous clinical spectrum into a severity construct that was strongly associated with in-hospital mortality. The association between major bleeding and in-hospital death is biologically plausible because the ISTH definition captures events that already indicate severe systemic or anatomical impact, including fatal bleeding, critical-site bleeding, substantial hemoglobin decrease, and transfusion requirement. The finding that all CNS bleeding events met major bleeding criteria should therefore be interpreted not as an unexpected statistical result, but as a consequence of the critical-site component of the ISTH definition [8].

A notable finding was that overall antithrombotic exposure was not independently associated with in-hospital or 30-day mortality after multivariable adjustment. This should not be interpreted as evidence that antithrombotic drugs are clinically irrelevant in bleeding presentations. Rather, several alternative explanations are possible. Antithrombotic use may increase the likelihood of bleeding presentation or major bleeding, but mortality after presentation may be driven more directly by bleeding site, physiological reserve, renal function, and early clinical deterioration. Additionally, patients known to be using anticoagulant or antiplatelet agents may be recognized earlier as high risk, monitored more closely, triaged more aggressively, or referred more rapidly for reversal, endoscopy, imaging, or specialist evaluation; this reverse surveillance bias could attenuate the independent association between medication exposure and mortality. Drug class, dosage, timing of the last dose, renal clearance, adherence, and reversal therapy could not be fully

Table 3. Demographic, clinical, and laboratory characteristics according to in-hospital mortality status

Characteristic	In-hospital death (n=24)	No in-hospital death (n=273)	p
Age, years	70.8±16.3	61.4±18.9	**0.019**
Sex			**0.171**
Female	8 (5.5)	137 (94.5)	
Male	16 (10.5)	136 (89.5)	
Previous bleeding history			**0.916**
Yes	8 (10.0)	82 (90.0)	
No	16 (7.7)	191 (92.3)	
Any comorbidity			**0.086**
Yes	21 (10.1)	187 (89.9)	
No	3 (3.4)	86 (96.6)	
Systolic blood pressure, mmHg	132.8±35.8	133.2±26.8	0.916
Diastolic blood pressure, mmHg	78.8±21.7	77.9±13.5	0.805
Pulse rate, beats/min	94.1±19.4	86.5±17.1	**0.012**
SpO_2, %	93.8±5.0	97.3±2.1	**<0.001**
Body temperature, ℃	36.3±0.5	36.2±0.2	0.733
Respiratory rate, breaths/min	18.1±3.1	17.4±5.6	0.147
Hemoglobin, g/dL	9.9±3.3	10.7±2.9	0.308
Hematocrit, %	30.2±9.8	32.4±8.4	0.334
Platelet count, /µL	288,500±116,251	269,487±194,494	0.233
Creatinine, mg/dL	1.5±1.1	1.1±1.1	**0.024**
BUN, mg/dL	45.1±34.7	27.9±22.7	**0.003**
INR	1.7±1.6	1.4±1.2	**0.044**
aPTT, s	45.0±39.9	32.8±19.8	0.120
PT, s	21.9±24.9	17.7±20.0	0.103
Major bleeding			**<0.001**
Yes	20 (16.1)	104 (83.9)	
No	4 (2.3)	169 (97.7)	

Continuous variables are presented as mean ± standard deviation. Categorical variables are presented as n (%); percentages are calculated across mortality status within each row. BUN: Blood urea nitrogen; INR: International normalized ratio; aPTT: Activated partial thromboplastin time; PT: Prothrombin time; SpO_2: Peripheral oxygen saturation.

captured by the broad medication categories used in this analysis [2,13,14].

The observed increase in major bleeding frequency with increasing number of antiplatelet agents is clinically meaningful, even though subgroup sizes were small. Combination antithrombotic therapy can impair hemostasis through multiple pathways, and previous studies have reported higher bleeding risk with dual or combined regimens [4,15]. In ED practice, these findings support careful medication reconciliation and a low threshold for identifying patients receiving dual antiplatelet therapy or combined antiplatelet-anticoagulant therapy as potentially high-risk, even when the final mortality model does not retain antithrombotic exposure as an independent predictor [4,5].

Lower oxygen saturation was independently associated with both in-hospital and 30-day mortality. This variable may function as an early global marker of physiological decompensation rather than a bleeding-specific marker [16,17]. In patients with CNS bleeding, reduced consciousness, aspiration risk, impaired airway

Table 4. Demographic, clinical, and laboratory characteristics according to 30-day mortality status

Characteristic	Death within 30 days (n=36)	Alive at 30 days (n=261)	p
Age, years	70.4±14.5	61.1±19.1	**<0.001**
Sex			0.460
Female	15 (10.3)	130 (89.7)	
Male	21 (13.8)	131 (86.2)	
Previous bleeding history			0.538
Yes	13 (14.4)	77 (85.6)	
No	23 (11.1)	184 (88.9)	
Hypertension			**0.012**
Yes	22 (18.3)	98 (81.7)	
No	14 (7.9)	163 (92.1)	
Systolic blood pressure, mmHg	127.3±31.7	133.9±26.9	0.178
Diastolic blood pressure, mmHg	77.4±19.5	78.0±13.4	0.859
Pulse rate, beats/min	95.9±22.8	85.9±16.2	**0.015**
SpO_2, %	94.8±4.6	97.3±2.1	**0.002**
Body temperature, ℃	36.2±0.4	36.2±0.2	0.394
Respiratory rate, breaths/min	18.1±3.0	17.4±5.7	0.483
Hemoglobin, g/dL	9.5±3.0	10.8±2.9	**0.018**
Hematocrit, %	29.1±8.9	32.7±8.4	**0.017**
Platelet count, /µL	271,277±120,675	270,988±103,387	0.988
Creatinine, mg/dL	1.4±1.0	1.1±1.1	0.099
BUN, mg/dL	45.9±34.1	27.0±21.7	**<0.001**
INR	1.8±1.6	1.3±1.5	0.140
aPTT, s	44.3±40.1	32.3±18.2	0.085
PT, s	23.3±27.6	17.3±19.2	0.210
Major bleeding			**<0.001**
Yes	26 (21.0)	98 (79.0)	
No	10 (5.8)	163 (94.2)	

Continuous variables are presented as mean ± standard deviation. Categorical variables are presented as n (%); percentages are calculated across mortality status within each row. BUN: Blood urea nitrogen; INR: International normalized ratio; aPTT: Activated partial thromboplastin time; PT: Prothrombin time; SpO_2: Peripheral oxygen saturation.

reflexes, and neurogenic pulmonary edema may contribute to hypoxemia [18,19]. In patients with gastrointestinal bleeding or hemoptysis, hypoxemia may reflect aspiration, underlying cardiopulmonary disease, anemia-related oxygen delivery failure, or shock physiology [20]. Therefore, SpO2 should be interpreted as an immediately available bedside warning signal that integrates respiratory, circulatory, and neurological risk.

Pulse rate and BUN were independently associated with 30-day mortality. Tachycardia may indicate sympathetic activation, blood loss, pain, hypovolemia, infection, or cardiopulmonary stress, and may remain informative even when blood pressure is not significantly different between survivors and non-survivors. BUN elevation may represent renal hypoperfusion, chronic kidney disease, dehydration, protein load from upper gastrointestinal bleeding, or overall frailty [21–23]. The persistence of BUN in the 30-day mortality model suggests that renal and metabolic vulnerability may influence outcomes beyond the immediate bleeding episode.

Table 5. Final multivariable logistic regression models for in-hospital and 30-day mortality

Outcome and variable	Primary model OR (95% CI)	p	Age-adjusted model OR (95% CI)	p
In-hospital mortality				
Major bleeding (reference: no)	7.223 (2.268–23.005)	**0.001**	6.653 (2.055–21.543)	**0.002**
SpO_2, per 1 percent increase	0.757 (0.665–0.860)	**<0.001**	0.764 (0.672–0.869)	**<0.001**
Age, per 1-year increase	—	—	1.012 (0.981–1.043)	0.460
30-day mortality				
CNS bleeding (reference: no)	4.592 (1.553–13.578)	**0.006**	4.878 (1.631–14.588)	**0.005**
Hypertension (reference: no)	2.239 (1.003–4.998)	**0.049**	1.964 (0.861–4.478)	0.109
BUN, per 1 mg/dL increase	1.024 (1.010–1.037)	**0.001**	1.023 (1.009–1.037)	**<0.001**
Pulse rate, per 1 beat/min increase	1.024 (1.002–1.045)	**0.029**	1.025 (1.004–1.046)	**0.021**
SpO_2, per 1 percent increase	0.822 (0.734–0.920)	**0.001**	0.831 (0.743–0.930)	**0.001**
Age, per 1-year increase	—	—	1.017 (0.989–1.045)	0.239

Primary models: in-hospital mortality—model $\chi^2(2) = 38.826$, $p < 0.001$; Nagelkerke $R^2 = 0.285$; Hosmer–Lemeshow $\chi^2(5) = 6.384$, $p = 0.271$; VIF = 1.027. Thirty-day mortality—model $\chi^2(5) = 46.939$, $p < 0.001$; Nagelkerke $R^2 = 0.280$; Hosmer–Lemeshow $\chi^2(8) = 2.138$, $p = 0.976$; VIF range = 1.032–1.126. Candidate variables were evaluated in univariable logistic regression; variables with $p < 0.20$ and clinically prespecified variables were considered for multivariable modelling, followed by backward elimination. Variables such as BUN and pulse rate were not retained in the final in-hospital model because they did not demonstrate an independent association after the prespecified variable-selection process. CNS, central nervous system; BUN, blood urea nitrogen; CI, confidence interval; OR, odds ratio; SpO_2, peripheral oxygen saturation; VIF, variance inflation factor.

Hypertension was associated with 30-day mortality in the main multivariable model, but its effect was attenuated after age adjustment. This suggests that hypertension may partly operate as a marker of older age and vascular comorbidity rather than as an isolated causal determinant of death in the overall cohort. Nevertheless, hypertension remains clinically relevant because of its established relationship with intracerebral hemorrhage, hematoma expansion, and other vascular bleeding phenotypes [12,24].

Limitations

Several limitations should be acknowledged. First, this was a single-center prospective observational cohort, and the findings may reflect the case-mix, referral patterns, triage thresholds, treatment pathways, and specialist availability of the study institution. Although consecutive eligible patients were screened during the predefined study period, external validity may be limited, and multicenter studies are needed before these findings can be generalized to other ED populations. Due to the observational nature of this cohort medication exposure was assessed through patient or family report and cross-checked with electronic medical records or prescription information when available. However, exact timing of the last dose, adherence, dose intensity, renal dose adjustment, over-the-counter NSAID use, and temporary discontinuation before ED presentation could not be fully verified in all patients. Therefore, misclassification of active medication exposure is possible.

Although the cohort was clinically heterogeneous, non-traumatic bleeding presentations included younger patients with menometrorrhagia, older patients with gastrointestinal bleeding, patients with CNS bleeding, and smaller subgroups such as hemoptysis, epistaxis, hematuria, and other bleeding sites. This heterogeneity reflects real ED practice, but it may also mask subgroup-specific mortality patterns. In particular, the relatively low risk menometrorrhagia subgroup may have diluted mortality estimates and attenuated associations between age, comorbidity, antithrombotic exposure, and outcomes. Although sensitivity analysis after excluding menometrorrhagia did not materially change the main interpretation, subgroup-specific estimates should still be interpreted cautiously.

Drug plasma levels, anti-factor Xa activity, thrombin time, DOAC-specific assays, platelet function tests, and other detailed hemostatic measurements were not routinely available. This limits the ability to distinguish between nominal medication exposure and clinically relevant anticoagulant or antiplatelet effect at the time of bleeding. As a result, the absence of an independent mortality association for antithrombotic exposure should not be interpreted as absence of pharmacological effect.

The analysis did not include detailed interventional variables that may influence mortality, such as timing of endoscopy, timing of surgery, timing and type of reversal therapy, use of prothrombin complex concentrate or specific antidotes, timing of transfusion,

timing of angiographic intervention, airway management, or intensive care interventions. These factors may act as mediators between bleeding severity and mortality or as confounders reflecting clinical severity. Their absence limits causal interpretation and prevents assessment of whether aggressive treatment modified mortality risk. Because of the observational design, causality cannot be established. The associations identified in this study may reflect direct effects of bleeding severity, underlying comorbidity, treatment decisions, unmeasured frailty, or residual confounding. The results should therefore be used to support ED risk stratification and future hypothesis generation rather than to infer causal relationships between antithrombotic exposure, bleeding severity, and mortality.

Conclusion

Taken together, these findings support a practical ED approach in which non-traumatic bleeding patients are not risk-stratified by antithrombotic use alone. A pragmatic first-pass assessment may include: (1) identification of critical-site bleeding, particularly CNS bleeding; (2) application of ISTH major bleeding criteria; (3) bedside assessment of oxygen saturation and pulse rate; (4) early review of renal function and BUN; and (5) structured medication reconciliation focusing on antiplatelet-anticoagulant combinations, NSAID exposure, and timing of last dose when available. Patients with critical-site bleeding, ISTH major bleeding, low SpO2, tachycardia, or elevated BUN should be considered for closer monitoring, early senior review, and earlier involvement of relevant specialties.

Ethics

Ethics Committee Approval: This study was approved by the Dokuz Eylul University (Date: 18.01.2021, Decision no: 2021/02-55).

Informed Consent: Written informed consent was obtained.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

Use of AI for Writing Assistance: ChatGPT (OpenAI, GPT-5) was used to assist with language editing and text refinement. The authors take full responsibility for the scientific content.

Authorship Contributions: Concept: Y.K.E., Ö.Y.B., G.U., R.M.M., E.Ü., F.C.; Design: Y.K.E., Ö.Y.B., G.U., R.M.M., E.Ü., F.C.; Supervision: Y.K.E., Ö.Y.B., G.U., R.M.M., E.Ü., F.C.; Resource: Y.K.E., Ö.Y.B., G.U., R.M.M., E.Ü., F.C.; Materials: Y.K.E., F.C.; Data collection and/or processing: Y.K.E., Ö.Y.B., G.U., R.M.M., E.Ü., F.C.; Analysis and/or interpretation: Y.K.E., Ö.Y.B.; Literature review: Y.K.E., R.M.M.; Writing: Y.K.E., G.U.; Critical review: Y.K.E., Ö.Y.B., G.U., R.M.M., E.Ü., F.C.

Peer-review: Externally peer-reviewed.

References

1. Conti A, Renzi N, Molesti D, et al. Short and long-term mortality of patients presenting with bleeding events to the Emergency Department. Am J Emerg Med. 2017;35:1867-72.
2. Rydberg DM, Linder M, Malmström RE, Andersen M. Risk factors for severe bleeding events during warfarin treatment: the influence of sex, age, comorbidity and co-medication. Eur J Clin Pharmacol. 2020;76:867-76.
3. Bezati S, Ventoulis I, Verras C, Boultadakis A, Bistola V, Sbyrakis N, et al. Major bleeding in the emergency department: a practical guide for optimal management. J Clin Med. 2025;14:784.
4. Bouget J, Balusson F, Viglino D, Roy PM, Lacut K, Pavageau L, et al. Major bleeding risk and mortality associated with antiplatelet drugs in real-world clinical practice. A prospective cohort study. PLoS One. 2020;15:e0237022.
5. Oldgren J, Wallentin L, Alexander JH, James S, Jönelid B, Steg G, et al. New oral anticoagulants in addition to single or dual antiplatelet therapy after an acute coronary syndrome: a systematic review and meta-analysis. Eur Heart J 2013;34:1670-80.
6. Backus B, Beyer-Westendorf J, Body R, Lindner T, Möckel M, Sehgal V, et al. Management of major bleeding for anticoagulated patients in the Emergency Department: an European experts consensus statement. Eur J Emerg Med 2023;30:315-23.
7. Kent AP, Brueckmann M, Fraessdorf M, Connolly SJ, Yusuf S, Eikelboom JW, et al. Concomitant oral anticoagulant and nonsteroidal anti-ınflammatory drug therapy in patients with atrial fibrillation. J Am Coll Cardiol 2018;72:255-67.
8. Schulman S, Kearon C; Subcommittee on Control of Anticoagulation of the Scientific and Standardization Committee of the International Society on Thrombosis and Haemostasis. Definition of major bleeding in clinical investigations of antihemostatic medicinal products in non-surgical patients. J Thromb Haemost. 2005;3:692-4.
9. Leontiadis GI, Molloy-Bland M, Moayyedi P, Howden CW. Effect of comorbidity on mortality in patients with peptic ulcer bleeding: systematic review and meta-analysis. Am J Gastroenterol. 2013;108.331-345; quiz 346.
10. Pinho J, Costa AS, Araújo JM, Amorim JM, Ferreira C. Intracerebral hemorrhage outcome: A comprehensive update. J Neurol Sci 2019;398:54-66.
11. Hirshberg B, Biran I, Glazer M, Kramer MR. Hemoptysis: etiology, evaluation, and outcome in a tertiary referral hospital. Chest. 1997;112:440-4.
12. An SJ, Kim TJ, Yoon BW. Epidemiology, risk factors, and clinical features of ıntracerebral hemorrhage: an update. J Stroke. 2017;19:3-10.
13. Davis DD, Kane SM. Muscular Hematoma. 2023. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2023.
14. Tomaselli GF, Mahaffey KW, Cuker A, Dobesh PP, Doherty JU, Eikelboom JW, et al. 2020 ACC expert consensus decision pathway on management of bleeding in patients on oral anticoagulants: a report of the american college of cardiology solution set oversight committee. J Am Coll Cardiol 2020;76:594-622.
15. Gibson CM, Mehran R, Bode C, et al. Prevention of Bleeding in Patients with Atrial Fibrillation Undergoing PCI. N Engl J Med. 2016;375:2423-34.

16. Barfod C, Lauritzen MM, Danker JK, Sölétormos G, Forberg JL, Berlac PA, et al. Abnormal vital signs are strong predictors for intensive care unit admission and in-hospital mortality in adults triaged in the emergency department - a prospective cohort study. Scand J Trauma Resusc Emerg Med. 2012;20:28.
17. Kaya E, Karaca MA, Aldemir D, Ozmen MM. Predictors of poor outcome in gastrointestinal bleeding in emergency department. World J Gastroenterol. 2016;22:4219-25.
18. Joundi RA, Martino R, Saposnik G, Giannakeas V, Fang J, Kapral MK. Dysphagia screening after intracerebral hemorrhage. Int J Stroke Off J Int Stroke Soc. 2018;13:503-10.
19. Wu MR, Chen YT, Li ZX, Gu HQ, Yang KX, Xiong YY, et al. Dysphagia screening and pneumonia after subarachnoid hemorrhage: Findings from the Chinese stroke center alliance. CNS Neurosci Ther. 2022;28:913-21.
20. Alshamsi F, Jaeschke R, Baw B, Alhazzani W. Prophylactic endotracheal ıntubation in patients with upper gastrointestinal bleeding undergoing endoscopy: a systematic review and meta-analysis. Saudi J Med Med Sci 2017;5:201-9.
21. Ben-Ari Z, Cardin F, McCormick AP, Wannamethee G, Burroughs AK. A predictive model for failure to control bleeding during acute variceal haemorrhage. J Hepatol. 1999;31:443-50.
22. Blatchford O, Murray WR, Blatchford M. A risk score to predict need for treatment for upper-gastrointestinal haemorrhage. Lancet. 2000;356:1318-21.
23. Rakotondrainibe A, Rahanitriniaina NMP, Randriamizao HMR, Raelison JG, Ramanampamonjy RM, Rajaonera AT, et al. Clinical mortality risk factors of variceal upper gastrointestinal bleeding in a Malagasy surgical intensive care unit. Afr J Emerg Med. 2020;10:188-92.
24. Falcone GJ, Biffi A, Brouwers HB, et al. Predictors of hematoma volume in deep and lobar supratentorial intracerebral hemorrhage. JAMA Neurol. 2013;70:988-94.

ORIGINAL RESEARCH

DOI: 10.14744/globecc.2026.50032
Glob Emerg Crit Care 2026;5(4):220-226

Comprehensive Assessment of Pediatric Burn Injuries in Children Aged 0–5 Years: Key Predictors of Hospitalization and Outcomes

Ömer Faruk Karakoyun[1], Halil Emre Koyuncuoğlu[1], Fulden Cantaş Türkiş[2], Yalçın Gölcük[3], Tayyibe Büşra Türkmen[3], Pınar Çay[4]

[1]*Department of Emergency Medicine, Muğla Training and Research Hospital, Muğla, Türkiye*
[2]*Department of Biostatistics, Muğla Sıtkı Koçman University Faculty of Medicine, Muğla, Türkiye*
[3]*Department of Emergency Medicine, Muğla Sıtkı Kocman University Faculty of Medicine, Muğla, Türkiye*
[4]*Department of Pediatric Emergency Medicine, Muğla Sitki Koçman University Faculty of Medicine, Muğla, Türkiye*

Abstract

Objective: To describe the epidemiology of emergency department (ED) presentations for burns among children aged 0–5 years and to identify key predictors of hospitalization using a decision tree–based prediction framework.

Materials and Methods: This retrospective, single-center observational study included children aged 0–5 years who presented to the ED with burn injuries between July 2019 and July 2024. Demographic and clinical variables, including burn etiology, depth, anatomical location, percentage of total body surface area affected, and Abbreviated Burn Severity Index (ABSI), were analyzed. A decision tree model was developed using SHapley Additive exPlanations (SHAP)–guided variable ranking and selection, and its performance was evaluated on a held-out test set.

Results: Among 329 patients, 47.7% were hospitalized (including those transferred for inpatient care). Scald burns were the predominant etiology (87.8%). Hospitalization was most strongly associated with second-degree burns, head and neck involvement, and an ABSI score ≥3. The decision tree model demonstrated good discrimination for hospitalization (area under the receiver operating characteristic curve [AUC], 0.841).

Conclusion: In early childhood burns, second-degree burn depth, head and neck involvement, and higher ABSI scores were the most influential factors associated with hospitalization decisions. This classification and regression tree (CART)–based model provides explicit decision rules derived from routinely available variables; however, its clinical utility and net benefit require external validation and prospective impact assessment.

Keywords: ABSI score, decision tree model, emergency care, hospitalization predictors, pediatric burns, scald injuries

Introduction

Burn injury remains a pervasive and largely preventable cause of pediatric morbidity, disproportionately affecting early childhood and exerting a sustained burden on emergency care systems. Globally, children continue to carry a substantial share of burn-related disability and health-care utilization, with particularly pronounced inequities in low- and middle-income settings where prevention strategies, first-aid knowledge, and access to specialized burn care may be heterogeneous [1,2]. Beyond its immediate tissue damage, burn trauma initiates a complex local and systemic inflammatory response that can rapidly evolve, especially in younger children with limited physiological reserve, thereby amplifying the clinical stakes of early assessment and timely disposition decisions [3].

Epidemiologic evidence consistently demonstrates that the highest risk concentrates in the 0–4-year age band, shaped by developmentally mediated exposure patterns and household-level hazards [4]. Although the majority of pediatric burn presentations are ultimately managed without admission, the absolute volume of emergency department (ED) encounters is considerable, and a

Address for Correspondence: Yalçın Gölcük, Department of Emergency Medicine, Muğla Sıtkı Koçman University Faculty of Medicine, Muğla, Türkiye
E-mail: dryalcingolcuk@gmail.com, yalcingolcuk@mu.edu.tr **ORCID-ID:** 0000-0002-8530-8607

Received: 15.02.2026 **Revised Date:** 09.06.2026 **Accepted:** 20.07.2026

Cite this article as: Karakoyun ÖF, Koyuncuoğlu HE, Cantaş Türkiş F, Gölcük Y, Türkmen TB, Çay P. Comprehensive assessment of pediatric burn ınjuries in children aged 0–5 years: key predictors of hospitalization and outcomes. Glob Emerg Crit Care 2026;5(4):220-226.

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clinically meaningful minority require hospitalization for analgesia, wound management, operative planning, or monitoring of complications [5]. In parallel, hospitalization patterns have evolved over time, reflecting changes in referral pathways, regionalization of burn care, and broader health-system dynamics [6]. Importantly, the downstream economic impact is non-trivial; even "small-area" burns can generate disproportionate costs at the population level when incidence is high and recurrent ED use occurs [7].

Accordingly, children aged 0–5 years were selected because early childhood consistently represents the peak-incidence period for burn-related ED presentations, largely reflecting developmentally mediated household exposures and limited self-protective capacity. In addition, disposition decisions in this age band are clinically distinct given lower physiological reserve and greater reliance on caregiver-dependent outpatient wound care and follow-up.

Disposition decisions in the ED require multidimensional risk appraisal, integrating burn depth and extent (e.g., % total body surface area [TBSA]), anatomical location, suspected inhalation injury, analgesic needs, and the feasibility of safe outpatient wound care and follow-up. Prognostic indices such as the Abbreviated Burn Severity Index (ABSI) are widely recognized and have been revalidated for severe-burn outcomes; however, many traditional tools were primarily optimized for mortality or inpatient prognostication rather than the immediate ED decision of admission versus discharge in very young children [8]. Consequently, there remains a pragmatic need for disposition-focused approaches that are clinically intelligible, explicitly reportable, and able to accommodate non-linear interactions among routinely available presentation-level features.

Therefore, using a high-volume ED cohort of children aged 0–5 years, we aimed (i) to describe the epidemiologic characteristics of burn presentations and (ii) to identify key predictors associated with hospitalization versus discharge in routine practice. To address this aim, we developed a decision-tree model based on Classification and Regression Trees (CART) methodology, with SHapley Additive exPlanations (SHAP) used to rank and prioritize candidate predictors, and evaluated its discriminative performance on a held-out test set. By formalizing commonly assessed bedside variables into explicit decision logic, this work seeks to support more consistent triage and resource planning while recognizing that external validation is necessary before broader implementation.

Materials and Methods

Study Design and Setting

This retrospective, single-center, observational cross-sectional study was conducted in the ED of a university-affiliated training and research hospital located in Muğla, Türkiye. We retrospectively reviewed consecutive pediatric patients aged 0–5 years (from neonates to preschool-aged children) who presented to the ED with burn injuries between July 1, 2019, and July 1, 2024. The institution is a tertiary referral center serving Southwest Türkiye, with a capacity exceeding 600 beds and an on-site specialized burn unit.

The study was conducted in accordance with the Declaration of Helsinki. This study was approved by the Muğla Sıtkı Koçman University (Date: 05.11.2024, Decision no: 141). Given the retrospective nature of the study, the requirement for written informed consent was waived.

Selection of Participants and Data Collection

This study included consecutive pediatric patients aged 0–5 years who presented to the ED with burn injuries during the study period (July 1, 2019–July 1, 2024), regardless of arrival mode (walk-in or ambulance). A retrospective review of electronic medical records was performed to identify all eligible cases within this age range. For consistent age stratification, the Munich Age Classification System was applied [9], categorizing patients as neonate/infant (birth–12 months), toddler (13 months–2 years), and early childhood (3–5 years).

Data were abstracted from the hospital's electronic medical records using a standardized spreadsheet to support structured and reproducible extraction. Collected variables comprised demographics (age, sex), arrival characteristics (mode of arrival), temporal variables (day of week and season), and burn-related clinical features (etiology/type of injury, burn degree, TBSA, anatomical location, and inhalation injury when present). ED disposition outcomes were recorded, including discharge, hospital admission (ward or intensive care unit), and all-cause ED mortality. For the purposes of this study, the primary endpoint was operationalized as need for inpatient care, defined as inpatient admission at our center or transfer to an advanced care facility for inpatient management. Injury severity was additionally summarized using the Abbreviated Burn Severity Index (ABSI), calculated for each patient as a standardized severity indicator incorporating age, sex, inhalation injury, TBSA, and full-thickness burn status [10]. TBSA was used as a continuous predictor in the decision-tree model, whereas it was categorized for descriptive group comparisons (0–10% vs. >10%) to align with Table 1 reporting.

Statistical Analysis

The normality of data distribution was evaluated using the Kolmogorov-Smirnov test. Comparisons of demographic, and

Table 1. Clinical and demographic characteristics of hospitalized and discharged pediatric burn patients

	Hospitalized (n=154)	Discharged from ED (n=175)	Test value (χ2/Z)	p
Age (years), median (25-75)	1 (1-2)	2 (1-3)	-2.180	**0.029**
Sex, n (%)				
Male	85 (55.2)	93 (53.1)	0.139	0.709
Female	69 (44.8)	82 (46.9)		
Burn Grade, n (%)				
First-Grade	120 (77.9)[a]	171(97.7)[b]	35.991	**<0.001**
Second-Grade	33 (21.4)[a]	3 (1.7)[b]		
Third-Grade	1 (0.6)[a]	1 (0.6)[a]		
Etiology				
Scald	145 (94.2)[a]	144 (82.3)[b]	11.030	**0.002**
Flame or fire	1 (0.6)[a]	3 (1.7)[a]		
Contact burns	8 (5.2)[a]	28 (16)[b]		
Total Body Surface Area				
0-10%	96 (62.3)	158 (90.3)	36.355	**<0.001**
>10%	58 (37.7)	17 (9.7)		
Seasons				
Autumn	32 (20.8)[a]	41 (23.4)[a]	10.740	**0.013**
Winter	31 (29.1)[a]	57 (32.6)[b]		
Spring	48 (31.2)[a]	32 (18.3)[b]		
Summer	43 (27.9)[a]	45 (25.7)[a]		
Day of The Week				
Monday	22 (14.3)	24 (13.7)	6.598	0.360
Tuesday	18 (11.7)	34 (19.4)		
Wednesday	23 (14.9)	25 (14.3)		
Thursday	31 (20.1)	28 (16)		
Friday	23 (14.9)	25 (14.3)		
Saturday	20 (13)	14 (8)		
Sunday	17 (11)	25 (14.3)		
Abbreviated Burn Severity Index Score				
ABSI, median (25-75)	3 (2-3)	2 (2-3)	-2.609	**0.009**

Data are expressed as median (25%-75% percentile) or count (%) for categorical variables unless otherwise indicated. Similar letters in the same row indicate similarity between column ratios, and different letters indicate differences between column ratios. Z: Mann Whitney U test statistics, χ^2: Chi-Square test statistics

clinical variables between hospitalized patients and those discharged from the ED were performed using the Mann-Whitney *U* test for continuous variables and the Chi-Square test for categorical variables. Continuous variables were presented as mean ± standard deviation (SD) or median (range), depending on their distribution. Categorical variables were expressed as frequencies and percentages. A p-value of <0.05 was considered statistically significant for all tests. Statistical analyses were conducted using SPSS software (IBM Corp. Released 2020. IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp). Missingness was assessed for all candidate variables. Analyses were conducted using a complete-case approach; no imputation was performed.

Decision Tree Model with SHapley Additive exPlanations for Variable Selection

Hospitalization status (need for inpatient care status vs. discharged from the ED) was the dependent variable in this study. Independent variables included key clinical and demographic factors such as burn severity, anatomical location, total body surface area, presence of inhalation injury, burn etiology, season, day of the week, month, admission pathway, age, gender, and the ABSI.

The dataset was randomly partitioned into a training set (70%) and a test set (30%). SHAP values were computed for all independent variables to determine the most influential predictors of hospitalization. The top 10 variables, whose cumulative mean absolute SHAP values accounted for 95% of total importance, were selected for model construction. A decision tree model, based on the Classification and Regression Trees methodology, was developed to predict hospitalization outcomes using these high-ranking predictors [11].

To optimize model complexity, the grid search technique was applied, testing parameters between 0.001 and 0.5 with increments of 0.01. Model performance was evaluated on the test set using multiple metrics, including the area under the receiver operating characteristic curve (AUC), sensitivity, specificity, overall accuracy, and F1 score. The 95% confidence interval (CI) for the AUC was estimated using nonparametric bootstrap resampling of the held-out test set. Statistical analyses were conducted using R software (R Foundation for Statistical Computing, Version 4.2.0, Vienna, Austria) utilizing the rpart package for decision tree modeling and the SHAPforxgboost package for SHAP value computation.

Results

During the study period, 329 consecutive pediatric patients aged 0–5 years presented to the ED with burn injuries. The median age of the cohort was 2 years, and 175 patients (54.1%) were male. Overall, 154 patients (47.7%) required hospitalization or referral to advanced care centers. Among admitted patients, the mean length of hospital stay was 4.3 ± 3.5 days.

The temporal distribution of presentations was relatively balanced across seasons and weekdays. Specifically, cases were most frequent in summer and winter (26.7% each), followed by spring (24.3%) and autumn (22.2%). With respect to weekdays, the highest frequencies were observed on Thursdays (17.9%) and Tuesdays (15.8%), whereas Saturdays had the lowest frequency (10.3%). Regarding etiology, scald injuries accounted for 87.8% of cases; in addition, contact burns comprised 10.9%, and flame/fire burns accounted for 1.2%.

Baseline characteristics stratified by ED disposition are summarized in Table 1. Compared with discharged patients, hospitalized/referred patients had a lower median age (1 [1–2] vs. 2 [1–3] years; $p = 0.029$) and a different distribution of burn depth ($p < 0.001$). Moreover, the proportion of scald injuries differed between groups ($p = 0.002$), as did the distribution of TBSA category (0–10% vs. >10%; $p < 0.001$) and season ($p = 0.013$). ABSI scores also differed between groups (3 [2–3] vs. 2 [2–3]; $p = 0.009$). In contrast, sex ($p = 0.709$) and day of the week ($p = 0.360$) did not differ significantly between disposition groups.

According to the Munich Age Classification System, patients were categorized as neonate/infant (n = 149; 45.3%), toddler (n = 100; 30.5%), and early childhood (n = 80; 24.3%). Notably, the distribution of hospitalization across these age strata differed significantly ($p = 0.012$). In absolute numbers, hospitalizations comprised 78 neonate/infant patients (50.6% of all hospitalizations), 50 toddlers (32.5%), and 26 early-childhood patients (16.9%).

The anatomical distribution of burns is presented in Figure 1 (multiple regions per patient; percentages are not mutually exclusive). The most frequently involved regions were the head and neck (35%), torso back (32.8%), and right upper extremity (28.3%). By comparison, torso front involvement was reported in 10.9% of cases. Extremity involvement included the right lower extremity (25.2%) and left upper extremity (24.9%), whereas the left lower extremity was involved in 12.5%. Inhalation injury was recorded in 0.3% of patients.

SHAP-based variable ranking identified second-degree burns as the highest-importance feature for hospitalization prediction

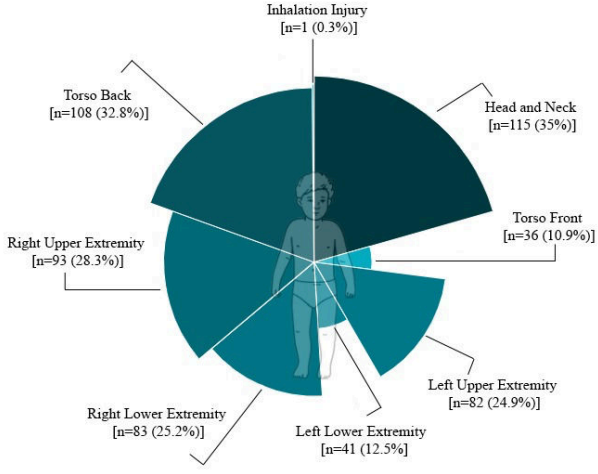


Figure 1. Distribution of Burn Injuries by Body Region (multiple regions per patient; percentages not mutually exclusive)

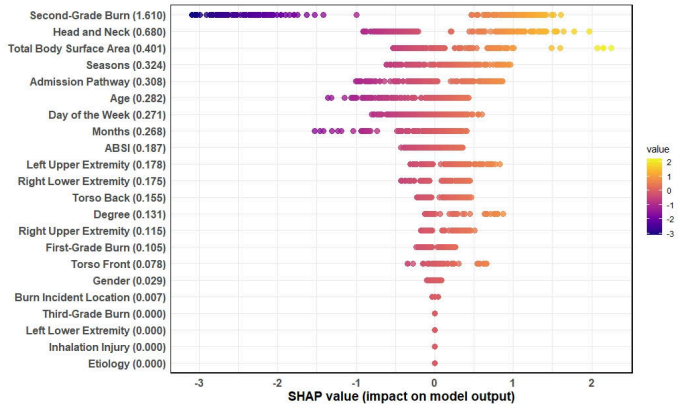


Figure 2. SHAP Summary Plot Depicting Variable Importance in Predicting Hospitalization of Pediatric Burn Patients

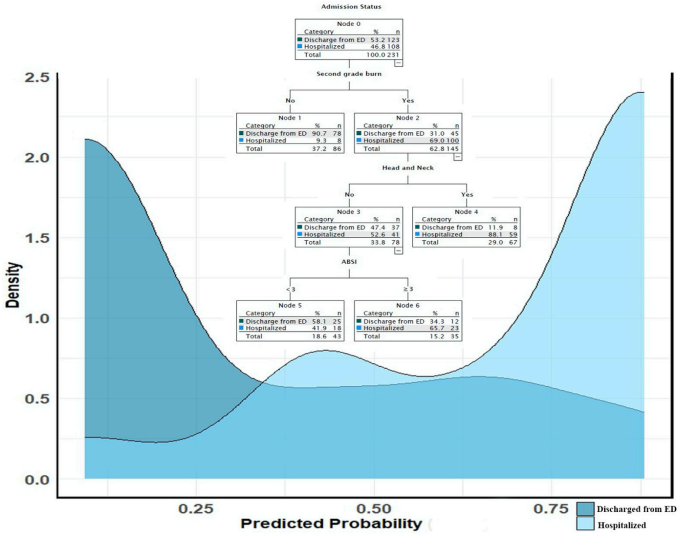


Figure 3. Decision Tree-Based Predictive Model and Probability Density Plot for Hospitalization and Discharge in Pediatric Burn Patients

(mean absolute SHAP value 1.611). Other ranked features included head and neck involvement (0.680), TBSA (0.400), season (0.324), and admission pathway (0.308). Together with age (0.282), day of week (0.271), month (0.268), and ABSI score (0.187), these variables accounted for 95% of cumulative mean absolute SHAP importance (Fig. 2).

A decision tree model was developed using the training set (n = 231), and its structure is shown in Fig. 3. Model performance on the held-out test set was as follows: sensitivity 93.5%, specificity 61.5%, and AUC 0.841 (bootstrap-derived 95% CI: 0.153–0.907; $p < 0.001$). Furthermore, overall accuracy was 76.5% (95% CI: 0.669–0.845), with a negative predictive value of 91.4%, positive predictive value of 68.3%, and F1 score of 78.9%.

Discussion

This study characterizes burn-related ED presentations among children aged 0–5 years and examines the practical disposition decision of inpatient management versus safe discharge. Here, "hospitalization" denotes either direct inpatient admission at our center or transfer to an advanced care facility for inpatient management when local capacity or logistical constraints precluded on-site admission. Using a CART-based decision-tree approach, second-degree burns, head and neck involvement, and ABSI >3 emerged as the principal factors associated with admission decisions in this cohort. These findings may inform triage standardization and resource planning by formalizing admission-associated patterns; however, given that the approach is a classical CART decision tree, it is presented as an interpretable baseline rather than a methodologically novel AI system.

A large meta-analysis of pediatric burns reported scald injuries as the predominant etiology and highlighted a disproportionate burden among children under five years of age [12]. Consistent with this literature, scalds accounted for the majority of presentations in our cohort, and the youngest age stratum constituted the largest share of cases; a modest male predominance was also observed, in line with prior pediatric series [13–16]. In our setting, scalds—most commonly involving hot beverages, cooking liquids, and bath water—reflected household exposures typical of early childhood [2], and even apparently limited injuries may still entail clinically meaningful depth and pain burden that can influence the need for inpatient monitoring and structured wound care [17].

Admission was most strongly associated with second-degree burns, a pattern consistent with the heterogeneous depth and variable healing trajectory of partial-thickness injuries and their attendant analgesic and follow-up requirements. Evidence syntheses similarly indicate that partial-thickness burns—particularly when coupled with greater TBSA or high-consequence anatomical sites—are linked to higher hospitalization likelihood [18]. Contemporary consensus guidance on second-degree burn wound care provides additional context for disposition considerations in the ED [19]. Head and neck involvement showed a strong association with admission, plausibly reflecting higher clinical stakes related to airway risk, feeding difficulties, and functional/cosmetic sequelae; craniofacial pediatric series likewise report greater morbidity and longer inpatient courses for burns affecting these regions [5,20]. Season also appeared among influential predictors in our analyses and may reflect shifting exposure and supervision patterns across the year; prior reports similarly describe temporal clustering, often with increases during warmer months, while winter mechanisms may follow distinct pathways [2,16].

ABSI contributed as a pragmatic severity summary in our cohort, particularly when combined with depth and anatomical involvement. Notably, ABSI was originally developed for broader burn prognostication—especially mortality—rather than to guide ED admission decisions in very young children [10]. Nevertheless, pediatric and contemporary evaluations suggest ABSI can function as a standardized severity anchor, and in our dataset an ABSI threshold above 3 aligned with a higher likelihood of inpatient management [21,22]. Accordingly, ABSI should be interpreted as an adjunctive severity indicator rather than a stand-alone admission criterion.

Severe full-thickness injuries were uncommon, which may reflect the predominance of domestic scald mechanisms and evolving household safety and care-seeking patterns. Longitudinal observations in pediatric burns have described reductions in severe domestic injuries over time, albeit with context-dependent variability [23]. Despite the relative rarity of high-grade burns, the concentration of admissions among the youngest children underscores the persistent vulnerability of this developmental stage and supports targeted prevention and caregiver-focused risk mitigation [24].

From a health-system perspective, pediatric burns impose substantial resource and family burden, and more consistent disposition decisions may support efficient allocation without compromising safety [6,7]. This is particularly relevant where access to specialized burn care and reliable outpatient follow-up is heterogeneous, amplifying the consequences of uncertainty in ED triage [1]. Within these constraints, an explicit rule-based model may provide a structured summary of routinely available variables, while responsible implementation of data-driven tools requires careful attention to transparency, calibration, and clinical oversight [11,25].

This study has several important limitations. Its single-center, retrospective design constrains generalizability and may reflect local referral patterns, admission thresholds, and documentation practices; moreover, several disposition-relevant determinants could not be consistently captured (e.g., prehospital first aid, socioeconomic context, caregiver reliability, outpatient care feasibility). The analysis focused on ED disposition rather than longitudinal endpoints; thus, functional, cosmetic, psychosocial, and rehabilitation-related outcomes—particularly salient for burns involving joints—were not assessed. Although length of stay was reported descriptively, it was not analyzed as a study endpoint, and mortality-related outcomes were not examined. We did not perform multivariable logistic regression benchmarking; therefore, these findings should not be interpreted as demonstrating superiority over classical statistical models. Because transfer decisions may be influenced by institutional capacity and organizational factors, combining transfers with inpatient admissions may have introduced outcome heterogeneity, and temporal drift in admission practices across 2019–2024 (including potential COVID-era effects) was not formally evaluated. In addition, the bootstrap-derived AUC confidence interval was relatively wide, indicating limited precision of the discrimination estimate and warranting cautious interpretation of model stability. Finally, clinical utility was not evaluated using decision curve analysis or net benefit metrics, nor were model-assisted decisions compared against clinician judgment; accordingly, the potential to reduce unnecessary admissions cannot be quantified from this retrospective dataset. Prospective multicenter validation is required to assess transportability, calibration, and clinical impact.

Conclusion

This study provides a comprehensive epidemiological assessment of pediatric burn injuries in children aged 0–5 years and proposes a decision tree–based framework for hospitalization risk stratification in the ED. Scald injuries predominated, underscoring the need for prevention strategies that target domestic hazards in early childhood. The model highlighted second-degree burns, head and neck involvement, and an elevated ABSI score as the most influential factors associated with hospitalization. Pending external validation and prospective impact evaluation, this CART-based model provides explicit decision rules derived from routinely available variables; however, its clinical utility requires external validation and prospective impact assessment.

Ethics

Ethics Committee Approval: This study was approved by the Muğla Sıtkı Koçman University (Date: 05.11.2024, Decision no: 141).

Informed Consent: Written informed consent was obtained.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

Use of AI for Writing Assistance: None declared.

Authorship Contributions: Concept: Ö.F.K., F.C.T., Y.G.; Design: Ö.F.K., H.E.K., F.T, Y.G.; Supervision: Y.G., P.Ç.; Data collection and/or processing: H.E.K., T.B.T., P.Ç.; Analysis and/or interpretation: Ö.F.K., F.C.T., Y.G.; Literature review: Ö.F.K., H.E.K., F.C.T., Y.G., T.B.T., P.Ç.; Writing: Ö.F.K., H.E.K., Y.G., T.B.T., P.Ç.; Critical review: Ö.F.K., Y.G., P.Ç.

Peer-review: Externally peer-reviewed.

References

1. Bresler RM, Barksdale E, Hansen EN. Pediatric burn care in the developing world: where are the gaps in research and what can be done? J Burn Care Res. 2022;43:1286-93.
2. D'cunha A, Rebekah G, Mathai J, Jehangir S. Understanding burn injuries in children-a step toward prevention and prompt first aid. Burns. 2022;48:762-6.
3. Evers LH, Bhavsar D, Mailänder P. The biology of burn injury. Exp Dermatol. 2010;19:777-83.
4. van Zoonen EE, van Baar ME, van Schie CHM, Koppes LLJ, Verheij RA. Burn injuries in primary care in the Netherlands: risk factors and trends. Burns. 2022;48:440-7.
5. Abramowicz S, Allareddy V, Lee MK, Nalliah RP, Rampa S, Allareddy V. Hospital-based emergency department visits with pediatric burns: characteristics and outcomes. Pediatr Emerg Care. 2020;36:393-6.
6. Armstrong M, Wheeler KK, Shi J, Thakkar RK, Fabia RB, Groner JI, et al. Epidemiology and trend of US pediatric burn hospitalizations, 2003-2016. Burns. 2021;47:551-9.
7. Beaulieu E, Zheng A, Rajabali F, MacDougall F, Pike I. The economics of burn injuries among children aged 0 to 4 years in British Columbia. J Burn Care Res. 2021;42:499-504.
8. Christ A, Staud CJ, Krotka P, Resch A, Neumüller A, Radtke C. Revalidating the prognostic relevance of the abbreviated burn severity index (ABSI): a twenty-year experience examining the performance of the ABSI score in consideration of progression and advantages of burn treatments from a single center in Vienna. J Plast Reconstr Aesthet Surg 2024;94:160-8.
9. Althammer A, Prückner S, Gehring GC, Lieftüchter V, Trentzsch H, Hoffmann F. Correction: Systematic review of age brackets in pediatric emergency medicine literature and the development of a universal age classification for pediatric emergency patients—the Munich Age Classification System (MACS). BMC Emerg Med. 2024;24:145.
10. Tobiasen J, Hiebert JM, Edlich RF. The abbreviated burn severity index. Ann Emerg Med. 1982;11:260-2.
11. Wang H, Liang Q, Hancock JT, Khoshgoftaar TM. Feature selection strategies: a comparative analysis of SHAP-value and importance-based methods. J Big Data. 2024;11:44.
12. Nassar JY, Al Qurashi AA, Albalawi IA, Nukaly HY, Halawani IR, Abumelha AF, et al. Pediatric burns: a systematic review and meta-analysis on epidemiology, gender distribution, risk factors, management, and outcomes in emergency departments. Cureus. 2023;15:e49012.
13. Hashemi SS, Sharhani A, Lotfi B, Ahmadi-Juibari T, Shaahmadi Z, Aghaei A. A systematic review on the epidemiology of pediatric burn in Iran. J Burn Care Res. 2017;38:e944-e51.
14. Park JM, Park YS, Park I, Kim MJ, Kim KH, Park J, et al. Characteristics of burn injuries among children aged under six years in South Korea: data from the Emergency Department-Based Injury In-Depth Surveillance, 2011-2016. PLoS One. 2018;13:e0198195.
15. van Zoonen EE, Pijpe A, van Baar ME, Nieuwenhuis MK, van Schie CHM, Trommel N, et al. Aetiology of severe burn incidents in children under 5 years of age in the Netherlands: a prospective cohort study. Burns. 2022;48:713-22.
16. Bildirici Y. Evaluation of pediatric cases followed in burn center. Turk J Pediatr Dis. 2023;17:401-5.
17. García-Díaz A, Gacto-Sánchez P, Durán-Romero AJ, Carrasco-García S, Ruiz-Moya A, Molina-Morales J, et al. Pediatric major burns: a monocentric retrospective review of etiology and outcomes (2008–2020). Eur J Plast Surg. 2022;45:967-75.
18. Zhao X, Zhuang Z, Jia Y, Liu X, Ni X, Chen K. Risk factors of mortality among pediatric burn patients: a systematic review and meta-analysis. Transl Pediatr. 2025;14:2417-36.
19. Ji S, Xiao S, Xia Z; Chinese Burn Association Tissue Repair of Burns and Trauma Committee, Cross-Straits Medicine Exchange Association of China. Consensus on the treatment of second-degree burn wounds (2024 edition). Burns Trauma. 2024;12:tkad061.
20. Demir Yiğit Y, Yiğit E. Pediatric craniofacial and neck burns. Indian J Otolaryngol Head Neck Surg. 2023;75:3216-20.
21. Deng G, Tang L, Yang Q, Li Z. Association of the abbreviated burn severity index with mortality in severely burned patients: a meta-analysis. PLoS One. 2025;20:e0319199.
22. Rahmani F, Jamali F, Vayghan BM, Bakhtavar HE. Comparison of ABSI and full-thickness burns indexes in the prediction of hospital mortality in burn patients. Acta Med Iran. 2021;59:37-43.
23. Yamamoto R, Sato Y, Sasaki J. Pediatric burn injury at home over 30 years: a road to future prevention. Burns. 2025;51:107317.
24. Jullien S. Prevention of unintentional injuries in children under five years. BMC Pediatr. 2021;21(Suppl 1):311.
25. Bernal L, Rastelli G, Pinzi L. Improving machine learning classification predictions through SHAP and features analysis interpretation. J Chem Inf Model. 2025;65:11716-32.

ORIGINAL RESEARCH

DOI: 10.14744/globecc.2026.85231
Glob Emerg Crit Care 2026;5(4):227-233

Functional Independence Beyond Mobility: Instrumental Activities of Daily Living as the Primary Predictor of Psychosocial Disaster Resilience Among Institutionalized Older Adults

Uğur Durmuş, Görkem Alper Solakoğlu

İstanbul Medeniyet University Faculty of Medicine, Department of Emergency Medicine,İstanbul, Türkiye

Abstract

Objective: This study aims to investigate whether independence in instrumental activities of daily living (IADL) is a stronger predictor of psychosocial disaster resilience than basic activities of daily living (ADL) among older adults residing in residential care facilities operated by a national humanitarian organization.

Materials and Methods: A cross-sectional study was conducted with 46 older adults (median age, 80.5 years; 58.7% female) residing in three residential care facilities operated by a national humanitarian organization in two provinces of Türkiye. A structured questionnaire assessed baseline disaster preparedness, functional capacity (ADL and IADL), and psychosocial disaster resilience. Multivariate logistic regression analysis was used to identify independent predictors of high resilience.

Results: Although 58.7% of participants reported receiving prior disaster awareness education, only 8.7% possessed a dedicated emergency go-bag. In univariate analyses, baseline ADL and IADL scores significantly correlated with resilience ($p<0.001$ for both). However, in multivariate analysis, only IADL capacity remained an independent predictor of high resilience (adjusted OR=2.53; 95% CI 1.04–6.18; $p=0.041$), whereas ADL capacity lost statistical significance ($p=0.114$). The model demonstrated excellent discrimination (AUC=0.889).

Conclusion: Compared to basic physical mobility, IADL capacity is the strongest independent predictor of psychosocial disaster resilience in older adults. In addition, a pronounced behavioral gap exists between the acquisition of disaster knowledge and the execution of practical preparedness actions.

Keywords: Activities of daily living, aged, disaster planning, geriatric assessment, nursing homes, psychological resilience

Introduction

The frequency and severity of natural disasters are escalating globally, posing a growing threat to public health. Geriatric populations remain at disproportionately high risk for subsequent morbidity and mortality [1]. Older adults frequently present with multiple physiological limitations, including sensory deficits, impaired mobility, polypharmacy, and cognitive decline, which severely hinder rapid evacuation and survival during the acute phase of a disaster [2]. In emergency medicine, pre-disaster preparedness is universally recognized as the optimal strategy for mitigating adverse outcomes in geriatric cohorts; international response guidelines strongly advocate for coordinated advance planning and the maintenance of essential survival supplies [3].

Historically, geriatric emergency management strategies have relied primarily on basic physical mobility assessments as the core indicator of disaster readiness. However, relying on activities of daily living (ADL) as the primary metric for preparedness overlooks critical underlying cognitive and organizational deficits that rapidly surface during acute crises [4]. For instance, an older adult may possess the physical capacity to perform ADL (e.g., ambulating, bathing, dressing) yet simultaneously lack the necessary cognitive or executive function to complete instrumental activities of daily living (IADL; e.g., managing complex medication regimens, using communication devices, handling finances, preparing meals) [5]. Deficits in IADL have been inextricably linked to heightened frailty and diminished psychological resilience during unforeseen

Address for Correspondence: Uğur Durmuş, İstanbul Medeniyet University Faculty of Medicine, Department of Emergency Medicine, İstanbul, Türkiye
E-mail: ugurdurmus@gmail.com **ORCID-ID:** 0000-0003-1481-4112

Received: 07.04.2026 **Revised Date:** 24.06.2026 **Accepted:** 30.07.2026

Cite this article as: Durmuş U, Solakoğlu GA. Functional independence beyond mobility: instrumental activities of daily living as the primary predictor of psychosocial disaster resilience among institutionalized older adults. Glob Emerg Crit Care 2026;5(4):227-233.

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catastrophic events [6]. Additionally, a notable behavioral gap permeates older adult populations: while many report high levels of perceived disaster risk or acknowledge receiving formal disaster awareness education, very few execute tangible preparedness actions, such as assembling an emergency go-bag or maintaining updated medication lists [7]. This disconnect between knowledge acquisition and actionable preparedness represents a critical failure point in current emergency management frameworks.

Situated at the intersection of multiple active seismic fault lines, Türkiye faces a high risk of catastrophic earthquakes, as evidenced by the 2023 Kahramanmaraş earthquakes [8]. Residential care centers, such as nursing homes, serve as critical infrastructure housing highly vulnerable older adults, and their disaster readiness depends on both the structural resilience of the facility and the functional capacity of its residents. Existing studies of disaster preparedness in older adults have focused largely on community-dwelling and home-care populations, in which physical impairment and mobility limitation are treated as the dominant barriers to readiness [9,10]. Whether this physical-function framework holds in the institutional setting, where residents' basic daily needs are already met by staff but their higher-order organizational capacity varies widely, has not been tested. In particular, no study has directly compared the independent predictive value of IADL capacity versus basic ADL (bADL) capacity for psychosocial disaster resilience among institutionalized older adults. Defining which functional domain carries this predictive weight is a necessary first step toward targeted, capacity-based preparedness interventions in residential care.

This cross-sectional study was designed to investigate the association between bADL capacity, IADL dependence, and psychosocial disaster resilience among older adults residing in nursing homes operated by a national humanitarian organization, with the ultimate goal of identifying actionable targets for evidence-based disaster preparedness interventions in geriatric populations.

Materials and Methods

Study Design and Setting

This cross-sectional, observational study was conducted in strict adherence to the STROBE guidelines [11]. The research took place across three nursing homes operated by a national humanitarian organization in two provinces of Türkiye. These institutions were strategically selected to provide a representative cross-section of the metropolitan and semi-urban institutional care landscape in Türkiye. The study protocol received formal approval from the Non-Interventional Clinical Research Ethics Committee of the participating institution. All procedures complied with the Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from all participants or their legally authorized representatives prior to data collection.

Selection of Participants

The source population comprised individuals aged 65 years and older residing in the aforementioned care facilities. Inclusion criteria were defined as follows: (1) chronological age ≥65 years, (2) sufficient verbal communication skills to comprehend and respond to questionnaire items, and (3) willingness to participate and provide informed consent. Exclusion criteria encompassed: (1) severe cognitive impairment (e.g., advanced dementia precluding questionnaire comprehension), (2) active psychiatric crisis, and/or (3) inability to communicate due to bedbound status. All residents meeting the inclusion criteria were invited to participate, yielding a final analytical cohort of 46 older adults.

Measurements and Outcomes

Data were systematically collected via standardized face-to-face interviews administered by trained research personnel experienced in geriatric assessments. The structured instrument evaluated three primary domains:

Baseline Demographics and Preparedness Status: Demographic variables included age, sex, and educational attainment (categorized as no formal education/primary school, middle/high school, and university/postgraduate). Preparedness variables assessed prior disaster education and specific preparatory actions taken, notably the possession of a dedicated emergency go-bag and the maintenance of essential documentation (e.g., emergency contact lists, medical history records, and current medication lists).

Functional Capacity: The degree of functional independence was quantified using an 11-item scale with a 5-point Likert response format (1=completely dependent, 5=completely independent). Items were stratified into two distinct domains: Basic Activities of Daily Living (bADL), encompassing mobility, bathing/showering, dressing, toileting, and personal hygiene; and Instrumental Activities of Daily Living (IADL), encompassing complex medication administration, financial management, meal preparation, telephone use, grocery shopping, housekeeping, and arranging transportation. Domain-specific scores were calculated as the mean of the respective item ratings.

Psychosocial Disaster Resilience (Primary Outcome): Participants' perceived self-efficacy in managing acute disaster

scenarios was measured using a complementary 7-item scale, also using a 5-point Likert format (1=completely unable, 5=completely able). The items assessed capacity for self-protection, resource acquisition, securing food/water, communicating with family/loved ones, managing disaster-related losses, emotional regulation, and re-establishing routine. A composite resilience score was calculated for each participant as the mean of the 7 items.

Statistical Analysis

The normality of continuous variables was evaluated using the Shapiro-Wilk test. Given the non-normal distribution of most continuous data, these variables are presented as medians with interquartile ranges (IQR). Categorical variables are reported as absolute frequencies and percentages. For bivariate analysis, the primary outcome variable (resilience score) was dichotomized using the median as the threshold: low resilience (<3.0) and high resilience (≥3.0). Group comparisons were executed using the Mann-Whitney U test for continuous variables and the chi-square or Fisher's exact test for categorical variables, as statistically appropriate.

Independent predictors of high disaster resilience were identified via multivariate logistic regression modeling. Variables demonstrating a p-value <0.20 in univariate analysis were selected for inclusion in the multivariate model. To mitigate the risk of data overfitting (a recognized hazard given the sample size constraints), the final multivariate model was strictly limited to a maximum of three clinically significant variables, adhering to standard epidemiological modeling practices of fewer than 1 predictor per 10 events [12]. Model discrimination was quantified using the C-statistic (area under the receiver operating characteristic curve [AUC]), and calibration was assessed via the Hosmer-Lemeshow goodness-of-fit test. The threshold for statistical significance was established at a two-tailed alpha <0.05. All analyses were performed using SPSS Statistics (IBM Corporation, Armonk, NY, USA) and R software (R Foundation for Statistical Computing, Vienna, Austria).

Results

Data Description and Preparedness Status A total of 46 older adults were included in the final analysis. The median age of the cohort was 80.5 years (IQR: 75.0–86.5), and 58.7% (n=27) were female. Educational distribution was as follows: primary school or less, 30.4% (n=14); middle/high school, 41.3% (n=19); and university/postgraduate, 28.3% (n=13).

A pronounced gap in practical disaster preparedness behaviors was observed. While 58.7% (n=27) of participants had previously received formal disaster awareness training, a mere 8.7% (n=4) actually possessed a dedicated emergency go-bag. Other action-based preparedness indicators were similarly deficient: only 45.7% possessed documented emergency contact information, 32.6% maintained accessible medical history records, and just 17.4% kept readily available, up-to-date medication lists.

Functional assessments revealed a stark divergence between physical autonomy and cognitive-organizational autonomy. The cohort demonstrated strong physical independence in bADL (median score=4.5; IQR: 3.6–5.0) but profound dependence in IADL, which require higher-order cognitive and executive function (median score=2.5; IQR: 1.9–3.4). Overall, the cohort's perceived psychosocial disaster resilience was moderate (median=3.0). Categorical dependency distributions were as follows: independent=45.7%; partially dependent=37.0%; and completely dependent=17.4%. Additional baseline characteristics stratified by resilience status are detailed in Table 1.

Univariate Analysis High disaster resilience exhibited no statistically significant association with age (p=0.178), sex (p=0.767), education level (p=0.634), or prior disaster training (p=0.345). Possession of an emergency go-bag was also not significantly correlated with resilience (p=1.000). Conversely, elevated functional capacity scores in both bADL and IADL domains demonstrated strong positive correlations with high resilience scores (p<0.001 for both). Univariate logistic regression corroborated these findings, indicating significant associations between high disaster resilience and both bADL (OR: 11.59; 95% CI: 2.01–66.70; p=0.006) and IADL (OR: 4.04; 95% CI: 1.83–8.94; p=0.001).

Multivariate Analysis and Model Fit Variables meeting the pre-specified inclusion threshold of p<0.20 from univariate analyses, specifically bADL and IADL, were entered into the multivariate logistic regression model. In the adjusted model, bADL capacity lost its statistical significance as an independent predictor of high disaster resilience (adjusted OR: 3.98; 95% CI: 0.72–22.03; p=0.114). In stark contrast, independence in IADL emerged as the sole significant independent predictor (adjusted OR: 2.53; 95% CI: 1.04–6.18; p=0.041). The results of the multivariate model are summarized in Table 2.

The multivariate model demonstrated strong discriminative ability, yielding a C-statistic (AUC) of 0.889, indicating that approximately 89% of participants were accurately classified regarding their resilience status based on the model (see Fig. 1). The Hosmer-Lemeshow test confirmed excellent model calibration (p>0.05).

A graphical representation illustrating the wide behavioral

Table 1. Baseline demographic and clinical characteristics of the study cohort stratified by disaster resilience level

Variable	All participants (n=46)	Low resilience (<3.0) (n=29)	High resilience (≥3.0) (n=17)	p
Age, Median (IQR)	80.5 (75.0–86.5)	84.0 (76.0–87.0)	80.0 (74.0–82.0)	0.178[a]
Sex (Female), n (%)	27 (58.7)	16 (55.2)	11 (64.7)	0.767[b]
Education Level, n (%)				0.634[b]
Illiterate / Primary school	14 (30.4)	9 (31.0)	5 (29.4)	
Middle / High school	19 (41.3)	13 (44.8)	6 (35.3)	
University / Postgraduate	13 (28.3)	7 (24.1)	6 (35.3)	
Prior Disaster Training (Yes), n (%)	27 (58.7)	15 (51.7)	12 (70.6)	0.345[b]
Emergency Kit Possession (Yes), n (%)	4 (8.7)	3 (10.3)	1 (5.9)	1.000[c]
Basic ADL Score, Median (IQR)	4.5 (3.6–5.0)	4.0 (3.0–4.5)	5.0 (4.8–5.0)	<0.001[a]
IADL Score, Median (IQR)	2.5 (1.9–3.4)	2.0 (1.6–2.6)	3.9 (2.7–4.7)	<0.001[a]

ADL: Activities of daily living; IADL: instrumental activities of daily living; IQR: Interquartile Range. [a]Mann-Whitney U test; [b]Pearson chi-square test; [c]Fisher exact test.

Table 2. Predictors of high disaster resilience: univariate and multivariable logistic regression analysis

Variable	Univariate OR (95% CI)	p	Adjusted OR (95% CI)	p
Age	0.96 (0.89–1.04)	0.336	—	—
Sex (Female)	0.69 (0.20–2.31)	0.545	—	—
Prior Disaster Training (Yes)	2.24 (0.63–8.00)	0.214	—	—
Basic ADL Score	11.59 (2.01–66.70)	0.006	3.98 (0.72–22.03)	0.114
IADL Score	4.04 (1.83–8.94)	0.001	2.53 (1.04–6.18)	0.041

ADL: Activities of daily living, CI: Confidence interval, IADL: Instrumental activities of daily living, OR: Odds ratio. Variables with p<0.20 in univariate analysis were included in the multivariable model. The multivariable model C-statistic (AUC) was 0.889.

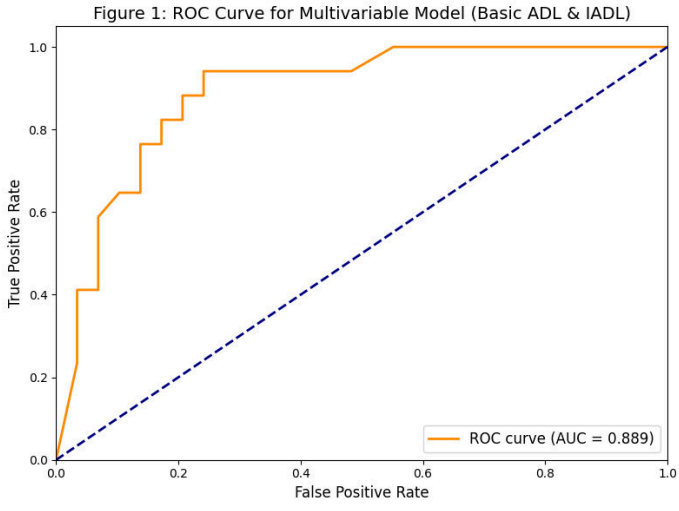


Figure 1. Receiver operating characteristic (ROC) curve demonstrating the discriminative ability of the multivariable logistic regression model (AUC=0.889) in predicting high psychosocial disaster resilience among institutionalized older adults, with instrumental activities of daily living (IADL) capacity as the primary predictor

gap between disaster awareness and actualized preparedness, depicting the stark discrepancy between older adults who received prior disaster training (58.7%) versus those maintaining a dedicated emergency go-bag (8.7%), is provided in Figure 2.

Discussion

This study empirically demonstrates that independence in instrumental activities of daily living (IADL) is the paramount independent predictor of psychosocial disaster resilience among institutionalized older adults, clearly exceeding the prognostic value of basic physical mobility. These findings directly challenge the prevailing model in disaster medicine, which traditionally anchors disaster readiness almost exclusively to physical ambulatory capability.

In addition, the observation that basic activities of daily living (bADL) independence (encompassing physical acts such as walking, dressing, and toileting) loses its predictive significance when controlling for IADL capacity carries profound clinical

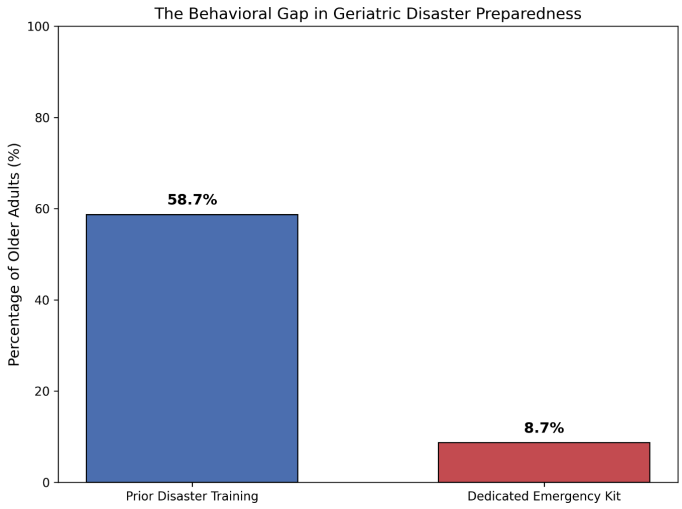


Figure 2. The behavioral gap in geriatric disaster preparedness. Bar chart illustrating the discrepancy between the proportion of older adults who received prior disaster awareness training (58.7%) and those maintaining a dedicated emergency kit (8.7%)

implications. It indicates that an older adult capable of physically exiting a structurally compromised building, yet incapable of independently managing complex medication regimens, locating vital documentation, or securing financial resources, remains just as vulnerable to the prolonged cascading effects of a disaster as an individual with profound physical disabilities. This phenomenon of "hidden dependence" is garnering increasing scrutiny in gerontological literature, as IADL deficits are recognized as early clinical markers of both cognitive decline and deteriorating adaptive capacity [5,6].

The critical behavioral gap identified in this cohort, in which nearly 59% of participants reported formal disaster education yet fewer than 10% maintained an emergency go-bag, mirrors the disconnect between knowledge acquisition and behavioral execution documented in broader international literature [7,13]. The persistence of this gap is particularly alarming in residential care settings, as it frequently engenders institutional complacency. Institutionalized older adults often harbor the subconscious assumption that facility management will unilaterally provide all necessary resources during an emergency, abrogating personal responsibility for preparedness [14]. During catastrophic, large-scale disasters where institutional infrastructure completely collapses, this absolute dependence on facility personnel rapidly transitions into a severe survival disadvantage.

The clinical urgency of these findings is amplified by Türkiye's severe seismic threat profile. The 2023 Kahramanmaraş earthquakes, the most devastating seismic event in Türkiye since 1999, caused unprecedented infrastructural collapse and catastrophic loss of life, starkly exposing systemic inadequacies in disaster preparedness across the entire population, particularly among highly vulnerable cohorts such as institutionalized older adults [8]. These realities mandate that institutional disaster protocols evolve beyond simplistic evacuation schematics to incorporate comprehensive, continuous assessments of residents' cognitive and organizational executive functions.

Several actionable intervention strategies emerge from these data. First, disaster preparedness education within residential care facilities must aggressively pivot from passive didactic lectures toward active, behavior-modifying modalities, using simulated stress drills [15]. Second, at the facility level, personalized emergency survival kits must be curated and maintained in direct correlation to a resident's specific IADL deficits. For example, older adults exhibiting deficits in medication management require automated, pre-sorted medication dispensers integrated into their go-bags [16]. Third, Psychological First Aid (PFA) modules should be systematically incorporated into routine institutional programming to dismantle the fatalistic attitudes that perpetuate the observed behavioral gap [17]. Fourth, micro-level evacuation algorithms must integrate each resident's unique IADL dependency curve, rather than relying exclusively on binary assessments of physical mobility. These recommendations align seamlessly with emerging international frameworks advocating a shift toward highly personalized, capacity-driven interventions, moving away from archaic "one-size-fits-all" approaches in geriatric disaster management [3,18].

Limitations

The methodological limitations of this study must be acknowledged. First, the cross-sectional design inherently precludes the establishment of temporal causality between functional independence and disaster resilience; longitudinal prospective studies are required to validate these causal pathways. Second, the reliance on self-reported questionnaire data introduces the potential for recall bias and social desirability bias, which may artificially inflate the reported frequency of preparedness behaviors or subjective resilience perceptions. Third, while the sample size of 46 was statistically sufficient for the constrained multivariate model deployed, it limits the statistical power and the broad generalizability of the findings to more heterogeneous, community-dwelling older adult populations. Fourth, unmeasured confounding variables, including the duration of institutionalization, the specific curriculum and quality of prior disaster training, pre-existing psychiatric comorbidities, and the baseline adequacy of the institution's structural disaster infrastructure, likely influenced the observed resilience scores.

Finally, the categorical thresholds used to define bADL/IADL dependency levels were empirically derived from the study data itself, lacking external validation against established, standardized classification systems.

Conclusion

In institutionalized older adults, physical independence does not equate to psychosocial disaster resilience. IADL capacity, which reflects both cognitive and organizational autonomy, was the strongest independent predictor of resilience in this cohort. A wide behavioral gap also separated disaster knowledge from practical preparedness actions. Emergency management policies and residential care protocols should move beyond mobility-based screening and passive education toward interventions that address the cognitive and organizational capacity of older residents.

Ethics

Ethics Committee Approval: This study was approved by the Göztepe Prof. Dr. Süleyman Yalçın City Hospital, Non-Interventional Clinical Research Ethics Committee (Decision No: 2026/0134, Date: 04.03.2026).

Informed Consent: Written informed consent was obtained.

Conflict of Interest: The authors declare no conflicts of interest.

Financial Disclosure: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. The study was conducted in collaboration with the Turkish Red Crescent (Kızılay).

Use of AI for Writing Assistance: During the preparation of this work, the author(s) utilized Claude (Anthropic) to assist with language editing and manuscript formatting. After carefully reviewing and editing the generated content, the author(s) take full responsibility for the accuracy, integrity, and originality of the final manuscript.

Acknowledgments: The authors wish to thank the Turkish Red Crescent (Kızılay) administration and the staff of Istanbul Kartal Kızılay Nursing Home, Istanbul Bakırköy Saye Yeşilköy Residential Care Facility, and Düzce Kızılay Akçakoca Nursing Home for their cooperation and support during data collection. The authors also extend their gratitude to all participating residents.

Authorship Contributions: Concept: U.D., G.A.S.; Design: U.D., G.A.S.; Supervision: U.D., G.A.S.; Resource: U.D., G.A.S.; Materials: U.D., G.A.S.; Data collection and/or processing: U.D., G.A.S.; Analysis and/or interpretation: U.D., G.A.S.; Literature review: U.D., G.A.S.; Writing: U.D., G.A.S.; Critical review: U.D., G.A.S.

Data Availability Statement: The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Peer-review: Externally peer-reviewed.

References

1. Malik S, Lee DC, Doran KM, Grudzen CR, Worthing J, Portelli I, et al. Vulnerability of older adults in disasters: emergency department utilization by geriatric patients after hurricane sandy. Disaster Med Public Health Prep 2018;12:184–93.
2. Aldrich N, Benson WF. Disaster preparedness and the chronic disease needs of vulnerable older adults. Prev Chronic Dis 2008;5:A27.
3. World Health Organization. Older persons in emergencies: an active ageing perspective. Geneva: World Health Organization; 2008. Available at: https://extranet.who.int/agefriendlyworld/wp-content/uploads/2014/06/WHO-Older-Persons-in-Emergencies-An-Active-Ageing-Perspective.pdf Accessed 18.11.2026
4. Hattori Y, Hiramatsu M, Isowa T, Kitagawa A, Tsujikawa M. The impact of cognitive impairment on disaster preparedness: a cross-sectional study of older adults over the age of 75 requiring special care in Japan. J Gerontol Soc Work 2022;65:562–79.
5. Jekel K, Damian M, Wattmo C, Hausner L, Bullock R, Connelly PJ, et al. Mild cognitive impairment and deficits in instrumental activities of daily living: a systematic review. Alzheimers Res Ther. 2015;7:17.
6. Moriyama N, Nishikawa Y, Hoshi W, Kuga T, Iwasa H, Murayama T, et al. Association of Instrumental Activities of Daily Living, Physical Function, and Mental Health among Older Returnees after the Fukushima Daiichi Nuclear Power Station Accident. Int J Environ Res Public Health 2021;18:11639.
7. Liao KM, Hu YJ. Factors influencing disaster preparedness behaviors of older adults. PLoS One. 2025;20:e0315617.
8. Tomak L, Demirel T, Demir I. Evaluation of the demographic characteristics and general health status of earthquake survivors affected by the 2023 Kahramanmaraş earthquake; a section from Gaziantep Nurdağı district. BMC Public Health 2024;24:937.
9. Bell SA, Singer D, Solway E, Kirch M, Kullgren J, Malani P. Predictors of Emergency Preparedness Among Older Adults in the United States. Disaster Med Public Health Prep 2021;15:624–30.
10. Gershon RR, Portacolone E, Nwankwo EM, Zhi Q, Qureshi KA, Raveis VH. Psychosocial Influences on Disaster Preparedness in San Francisco Recipients of Home Care. J Urban Health. 2017;94:606–18.
11. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet 2007;370:1453–57.
12. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. J Clin Epidemiol 1996;49:1373–9.
13. Al-Rousan TM, Rubenstein LM, Wallace RB. Preparedness for natural disasters among older US adults: a nationwide survey. Am J Public Health 2014;104:506–11.
14. Shapira S, Aharonson-Daniel L, Clarfield AM, Feder-Bubis P. Giving a voice to medically vulnerable populations: A mixed-methods investigation of their unique perceptions and needs in emergency situations. Health Soc Care Community 2020;28:811–22.
15. Matsuo Y, Hirano M. Effectiveness of disaster preparedness education in helping older people prevent isolation. Public Health Nurs 2021;38:837–49.

16. Maleki M, Mardani A, Kakemam E, Huertas-Zurriaga A, Vaismoradi M. Robot-assisted medication management in home care and long-term care settings: a mixed-method systematic review. Expert Rev Pharmacoecon Outcomes Res 2025;25:1167–82.
17. Brown LM, Bruce ML, Hyer K, Mills WL, Vongxaiburana E, Polivka-West L. A Pilot study evaluating the feasibility of psychological first aid for nursing home residents. Clin Gerontol 2009;32:293–308.
18. World Health Organization. Health emergency and disaster risk management framework. Geneva: World Health Organization; 2019. Available at: https://www.who.int/publications/i/item/9789241516181 Accessed 18.11.2026

ORIGINAL RESEARCH

DOI: 10.14744/globecc.2026.22535
Glob Emerg Crit Care 2026;5(4):234-242

Macroscopic Surrogates of Tumor Heterogeneity: Spatial Distribution of Non-Mass Enhancement Predicting Ki-67 Proliferation

Mahmut Küsbeci[1], Umut Deniz Pak[1], Özlem Sezgin Okçu[2], Ayşenur Oktay Alfatlı[2], Işıl Bilgen[2]

[1]*Division of Interventional Radiology, Department of Radiology, Ege University Faculty of Medicine, İzmir, Türkiye*
[2]*Department of Radiology, Ege University Faculty of Medicine, İzmir, Türkiye*

Abstract

Objective: Managing non-mass enhancement (NME) on breast MRI is challenging due to its histological and molecular heterogeneity. This study evaluated the correlation between BI-RADS NME descriptors and histopathological diagnoses, specifically investigating the predictive value of NME distribution patterns regarding breast cancer molecular subtypes and the Ki-67 proliferation index.

Materials and Methods: We retrospectively evaluated 61 patients (62 isolated NME lesions) who underwent dynamic contrast-enhanced breast MRI. Lesions were characterized by distribution patterns, internal enhancement, kinetic curves, and background parenchymal enhancement (BPE). Malignant lesions were analyzed for immunohistochemical profiles (ER, PR, HER2) and the Ki-67 index to determine molecular subtypes.

Results: Of the 62 lesions, 41 (66.1%) were malignant and 21 (33.9%) were benign. Spatial distribution strongly predicted malignancy (p=0.002); focal distribution was predominantly benign, whereas segmental and diffuse patterns indicated malignancy. NME distribution strongly correlated with cellular proliferation: 100% of malignant lesions with focal distribution exhibited a low Ki-67 index (<10%). Marked BPE and asymmetric enhancement were also significantly correlated with malignancy (p=0.020).

Conclusion: NME distribution patterns serve as macroscopic imaging surrogates for tumor heterogeneity. The correlation between focal NME and a low Ki-67 index highlights MRI's potential to noninvasively assess tumor biological aggressiveness. Integrating these features into clinical practice may offer a useful risk stratification tool, laying a preliminary foundation for future radiogenomic predictive models.

Keywords: BI-RADS, breast MRI, Ki-67 index, non-mass enhancement, tumor heterogeneity

Introduction

Breast cancer remains the most prevalent malignancy among women globally, with patient survival closely associated with tumor size and lymph node involvement at the time of diagnosis [1]. Although the incidence of breast cancer continues to rise, associated mortality has declined significantly in recent years, largely due to advances in treatment and the widespread adoption of screening mammography, which has been shown to reduce mortality by up to 30–40% [1,2]. However, mammography has inherent limitations; it fails to detect approximately 9–16% of breast cancers, and its diagnostic sensitivity is markedly reduced in patients with dense breast parenchyma [3–5].

To overcome these limitations, magnetic resonance imaging (MRI) has emerged as a crucial diagnostic and problem-solving tool in breast imaging [4,6–8]. Dynamic contrast-enhanced MRI (DCE-MRI) significantly improves the sensitivity of breast cancer detection by enabling quantitative and qualitative evaluation of contrast enhancement kinetics, which indirectly reflect tumor-induced angiogenesis and capillary permeability [9].

Despite advances in imaging, breast cancer remains a biologically heterogeneous disease [10]. Traditional anatomical staging systems (TNM) are often insufficient to fully predict tumor behavior and patient outcomes [10,11]. Consequently, clinical decision-making now relies heavily on tumor biology and specific prognostic markers, including histological grade, lymph node status, and the

Address for Correspondence: Mahmut Küsbeci, Division of Interventional Radiology, Department of Radiology, Ege University Faculty of Medicine, İzmir, Türkiye
E-mail: drmahmutkusbeci@gmail.com **ORCID-ID:** 0000-0002-7583-1170

Received: 03.09.2026 **Revised Date:** 19.10.2026 **Accepted:** 15.11.2026

Cite this article as: Küsbeci M, Pak UD, Sezgin Okçu Ö, Oktay Alfatlı A, Bilgen I. Macroscopic Surrogates of Tumor Heterogeneity: Spatial Distribution of Non-Mass Enhancement Predicting Ki-67 Proliferation. Glob Emerg Crit Care 2026;5(4):234-242.

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expression of estrogen receptor (ER), progesterone receptor (PR), and human epidermal growth factor receptor 2 (HER-2) [12,13]. Furthermore, advances in gene expression profiling have led to the molecular classification of breast cancer (e.g., luminal A, luminal B, HER-2-enriched, and triple-negative), which plays a pivotal role in guiding targeted and individualized therapies [11,14]. In recent years, the integration of multiparametric MRI—combining DCE-MRI, diffusion-weighted imaging (DWI), and T2-weighted imaging—has significantly advanced the noninvasive prediction of these molecular subtypes [15]. Current evidence highlights distinct imaging phenotypes among subtypes; for instance, HER-2-overexpressing tumors are significantly more likely to manifest as non-mass enhancement (NME), often demonstrating segmental distribution or clumped enhancement, whereas triple-negative and luminal breast cancers predominantly present as distinct mass lesions [15,16].

In contemporary breast MRI interpretation, the American College of Radiology (ACR) Breast Imaging Reporting and Data System (BI-RADS) lexicon provides a standardized framework. While mass lesions are relatively straightforward to characterize, NME presents a unique diagnostic challenge. NME exhibits variable morphological and kinetic features that frequently overlap between benign conditions (e.g., fibrocystic changes) and malignant etiologies (e.g., ductal carcinoma in situ or invasive carcinoma). Although the correlation between BI-RADS NME descriptors and histopathology has been widely explored, imaging features are rarely integrated with molecular subtypes and cellular proliferation indices. Furthermore, recent research has emphasized the critical role of the Ki-67 proliferation index as a marker of tumor aggressiveness and heterogeneity [17]. While conventional visual assessment of BI-RADS descriptors provides a fundamental diagnostic framework, contemporary research is increasingly shifting toward multiparametric and quantitative image analyses to characterize complex tumor heterogeneity [18,19]. Integrating these advanced imaging features to accurately predict Ki-67 expression levels and specific molecular subtypes before surgery remains an area of active investigation [18,20].

Therefore, this study aims to retrospectively evaluate the morphological distribution patterns, internal enhancement characteristics, and kinetic features of NME on breast MRI according to the BI-RADS lexicon (5th edition, 2013) and to correlate these findings with definitive histopathological diagnoses. Specifically, we aim to investigate the potential predictive value of NME imaging features for breast cancer molecular subtypes and the Ki-67 proliferation index in malignant lesions.

Although emerging artificial intelligence and radiomics models have gained popularity for predicting Ki-67 expression and molecular subtypes, these methods often require specialized software and extensive computational resources, limiting their adoption in routine clinical practice. This study addresses a critical knowledge gap by demonstrating that routine, standardized BI-RADS morphological descriptors can serve as noninvasive, accessible surrogate markers of tumor biological aggressiveness, facilitating rapid risk stratification in clinical workflows without the need for additional complex processing.

Materials and Methods

Study Design and Patient Population

This retrospective cohort study was conducted at the Department of Radiology, Faculty of Medicine, of our tertiary academic center. The study protocol was approved by the institutional review board, and the requirement for informed consent was waived due to the retrospective nature of the study. We evaluated dynamic contrast-enhanced (DCE) breast MRI examinations performed between January 2013 and November 2015. Patients were included if they presented with non-mass enhancement (NME) on breast MRI and had definitive histopathological diagnoses available in the institutional database. Patients with incomplete imaging data or concomitant suspicious mass lesions were excluded from the analysis. A total of 61 patients (age range: 13–75 years; mean age: 48 years) with 62 isolated NME lesions were included in the final study cohort.

Ethical Considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki. The study protocol was reviewed and approved by the Ege University Medical Research Ethics Committee (approval date: December 28, 2015; decision no. 15-12.1/47). The requirement for informed consent was waived by the ethics committee due to the retrospective nature of the study.

Imaging Protocol

Breast MRI examinations were performed using 1.5-T (Siemens Symphony Vision, Siemens Healthineers, Erlangen, Germany) and 3-T (Siemens Verio, Siemens Healthineers, Erlangen, Germany) scanners equipped with dedicated bilateral breast coils. The standard imaging protocol included axial T1-weighted and T2-weighted fat-suppressed images, followed by DCE sequences acquired before and at multiple time points after the intravenous administration of a gadolinium-based contrast agent (0.1 mmol/kg). Key sequence parameters for T1-weighted sequences included a repetition time (TR) of 5.5 ms, an echo time (TE) of 1.78 ms, a slice thickness of 1 mm, a field of view (FOV) of 280 mm, and a matrix size of 320×320. The DCE series were acquired with a temporal

resolution of approximately 60 seconds per phase. Subtraction images were generated to highlight areas of enhancement.

Image Interpretation

Two board-certified breast radiologists (with 15 and 5 years of experience in breast imaging, respectively) independently reviewed all MRI examinations [21]. Both readers were blinded to the patients' clinical data, original radiological reports, and final histopathological diagnoses. NME features were characterized according to the American College of Radiology (ACR) BI-RADS lexicon (5th edition, 2013). The evaluation included distribution patterns, internal enhancement characteristics, background parenchymal enhancement (BPE), and associated findings. Time-intensity curves (TICs) were extracted from the most avidly enhancing portion of the NME and classified into three types based on the delayed phase: persistent (type I), plateau (type II), or washout (type III). In cases of disagreement regarding BI-RADS NME descriptors or kinetic curve assessment, consensus was reached through discussion.

Histopathological and Molecular Correlation

Histopathological results obtained through image-guided biopsy or surgical excision served as the reference standard. The expression levels of ER, PR, HER-2, and the Ki-67 proliferation index were determined using immunohistochemistry (IHC). ER and PR positivity were defined as nuclear staining in ≥1% of tumor cells. HER-2 status was considered positive if the IHC score was 3+, whereas tumors with an equivocal score of 2+ underwent fluorescence in situ hybridization (FISH) to confirm gene amplification [22].

Ki-67 expression was evaluated using two distinct categorization approaches based on the analytical objective. First, for molecular subtyping, a 14% cutoff was adopted based on the 2011 St. Gallen International Expert Consensus criteria (Goldhirsch et al., 2011) [23] to help distinguish luminal A (Ki-67<14%) from luminal B (Ki-67≥14%) subtypes, consistent with the histopathological classification approach used at our institution during the study period. Second, to evaluate the relationship between NME spatial distribution patterns and tumor proliferation, Ki-67 values were grouped into three categories (<10%, 10–30%, and >30%). The <10% category was used to identify tumors with low proliferative activity [24].

Breast cancer molecular subtypes were classified as luminal A, luminal B, HER-2-enriched, and triple-negative based on these profiles.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 21.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize patient demographics and imaging findings. Categorical variables, including NME distribution patterns, internal enhancement features, BPE, molecular subtypes, and Ki-67 proliferation categories, were compared using Pearson's chi-square test or Fisher's exact test when expected cell counts were less than 5. Exact p-values and effect size estimates (Cramér's V or odds ratios with 95% confidence intervals [CIs]) were reported where appropriate.

The relationships between BI-RADS descriptors (distribution pattern, internal enhancement, and BPE) and histopathological results (benign vs. malignant status, molecular subtypes, and Ki-67 expression) were evaluated using Pearson's chi-square test and Fisher's exact test.

Ki-67 expression was evaluated as a categorical variable. In accordance with the St. Gallen International Expert Consensus criteria, a 14% threshold was adopted to differentiate luminal A from luminal B molecular subtypes. Additionally, to analyze spatial heterogeneity across NME distribution patterns, Ki-67 values were categorized into clinically relevant proliferation tiers (<10%, 10–30%, and >30%).

Given the limited sample size (61 patients, 62 lesions, and 41 malignant cases) and the risk of model overfitting, multivariable logistic regression was not performed. This decision was based on the events-per-variable (EPV) consideration of approximately 10–15 events per predictor variable. Instead, univariable comparisons were performed. Interobserver agreement for BI-RADS descriptors was assessed using Cohen's kappa (κ) statistic [23]. A p-value <0.05 was considered statistically significant [15].

Results

Patient Demographics and Histopathological Findings

The baseline clinicopathological characteristics and imaging findings of the final study cohort (n=61) are summarized in **Table 1**. The final study cohort comprised 61 female patients with 62 isolated non-mass enhancement (NME) lesions. The mean patient age was 48.19±11.31 years (range: 13–75 years). Based on histopathological evaluation, 41 lesions (66.1%) were malignant, and 21 lesions (33.9%) were benign. Among the malignant lesions, invasive ductal carcinoma (IDC) was the most common histological subtype (n=27, 43.5%), followed by ductal carcinoma in situ (DCIS) (n=6, 9.7%) and invasive lobular carcinoma (ILC) (n=5, 8.1%). According to the immunohistochemical classification of the 41 malignant lesions, 17 (41.4%) were luminal A, 14 (34.1%) were luminal B, 7 (17.0%) were HER-2-enriched, and 3 (7.3%) were triple-negative. The patient selection process is detailed in Figure 1.

Table 1. Baseline demographic characteristics, background parenchymal enhancement, and additional MRI findings of benign and malignant non-mass enhancement lesions

Variable	Benign (n=21)	Malign (n=41)	p
Age (Years)			0.129
<48	7 (33.3)	22 (53.7)	
≥48	14 (66.7)	19 (46.3)	
Bpe Degree			**0.020**
Minimal	12 (57.1)	19 (46.3)	
Mild	4 (19.0)	4 (9.8)	
Moderate	5 (23.8)	6 (14.6)	
Marked	0 (0.0)	12 (29.3)	
BPE Symmetry			**0.038**
Symmetric	19 (90.5%)	26 (63.4%)	
Asymmetric	2 (9.5%)	15 (88.2%)	
Additional Findings*			**0.024**
Absent	19 (90.5)	26 (63.4)	
Present	2 (9.5)	15 (36.6)	

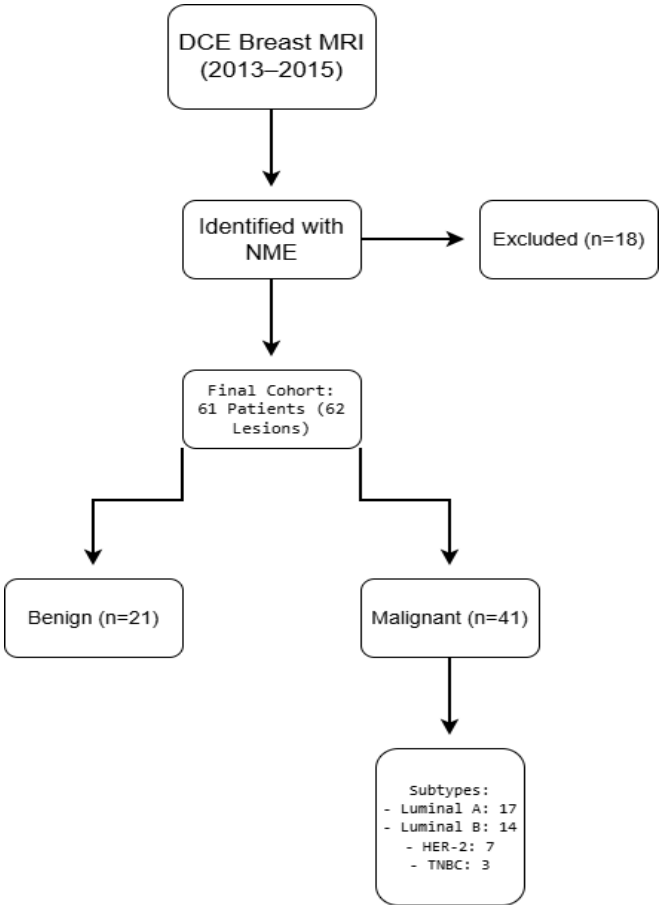


Figure 1. Flowchart of patient selection and lesion classification based on final histopathological and molecular subtype analysis

Morphological MRI Features and Malignancy Prediction

The distribution pattern of NME demonstrated a highly significant correlation with malignancy (p=0.002). Focal distribution was predominantly associated with benign pathology (68.8% benign), whereas linear and segmental distributions were strongly predictive of malignancy (73.7% malignant). Furthermore, regional, multiregional, and diffuse distribution patterns exhibited the highest risk of malignancy (81.5% malignant) (Table 2). Representative MRI cases demonstrating benign focal NME and malignant segmental NME with clumped enhancement are illustrated in Figures 2 and 3, respectively.

Regarding internal enhancement characteristics, although heterogeneous internal enhancement was frequently observed in both groups, it did not provide statistically significant discrimination between benign and malignant etiologies (52.4% vs. 48.8%, respectively; p=0.284). Conversely, clustered ring and clumped enhancement patterns were significantly associated with malignancy, with specificities of 95.2% and 90.5%, respectively (p<0.001).

The degree and symmetry of background parenchymal enhancement (BPE) served as significant predictors of malignancy (p=0.020). Notably, extreme BPE presentations carried the highest risk; all lesions occurring in the setting of marked BPE were confirmed as malignant, and asymmetric BPE was associated with an 88% malignancy rate. The presence of additional MRI findings (e.g., nipple retraction, skin thickening, and structural distortion) was significantly correlated with a higher likelihood of malignancy (88.2% vs. 57.8% in patients without additional findings; p=0.024). Kinetic curve assessments did not reveal a statistically significant difference between the benign and malignant groups (p=0.392).

Table 2. Diagnostic performance of BI-RADS NME morphological descriptors

Feature	Benign (n=21)	Malign (n=41)	p
Distribution Pattern			**0.002**
Focal	11 (52.4)	5 (12.2)	
Linear	3 (14.3)	2 (4.9)	
Segmental	2 (9.5)	12 (29.3)	
Regional	4 (19.0)	5 (12.2)	
Multiregional	1 (4.8)	13 (31.7)	
Diffuse	0 (0.0)	4 (9.8)	
Internal Enhancement			0.284
Homogeneous	7 (33.3)	5 (12.2)	
Heterogeneous	11 (52.4)	20 (48.8)	
Clumped	2 (9.5)	7 (17.1)	
Clustered Ring	1 (4.8)	9 (22.0)	

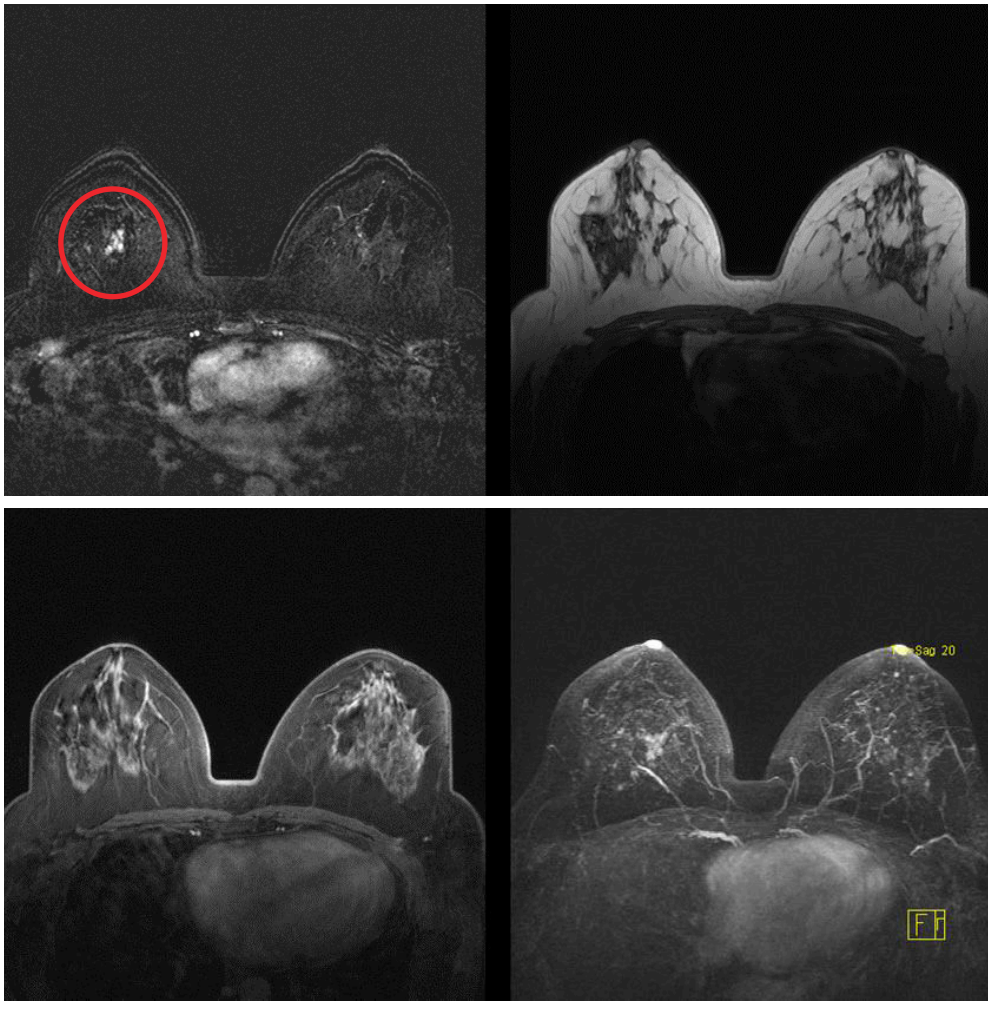


Figure 2. Axial dynamic contrast-enhanced breast MRI of a 47-year-old female patient demonstrating focal non-mass enhancement (NME) in the right breast. The lesion exhibits a heterogeneous internal enhancement pattern. Definitive histopathology confirmed benign fibrocystic changes, illustrating the biologically indolent nature and limited spatial heterogeneity characteristically associated with focal distribution patterns.

Interobserver agreement between the two breast radiologists was evaluated for all primary BI-RADS NME descriptors. Overall, interobserver agreement ranged from substantial to almost perfect across features. Substantial agreement was achieved for spatial distribution patterns (κ=0.76, 95% CI: 0.63–0.89) and internal enhancement characteristics (κ=0.69, 95% CI: 0.54–0.84). High agreement was also demonstrated for BPE degree assessment (κ=0.72, 95% CI: 0.57–0.87), BPE symmetry (κ=0.81, 95% CI: 0.68–0.94), and kinetic curve patterns (κ=0.74, 95% CI: 0.59–0.89). Detailed interobserver agreement statistics are summarized in Table 3.

Correlation with Molecular Subtypes and Ki-67 Proliferation Index

Intrinsic molecular subtyping (luminal A vs. luminal B), based on the 2011 St. Gallen Ki-67 cutoff of 14%, was not significantly associated with NME morphological descriptors (p>0.05). However, when Ki-67 expression was evaluated using proliferation categories (<10%, 10–30%, and >30%), a statistically significant association was observed between NME distribution patterns and Ki-67 expression (Pearson's chi-square test, p=0.037). Specifically, all five focal malignant NME lesions (100%, 5/5) had a low Ki-67 index (<10%). When focal NME was compared with nonfocal distribution patterns (linear, segmental, regional, multiregional, and diffuse), focal distribution was significantly associated with low Ki-67 expression (<10% vs. ≥10%; Fisher's exact test, p=0.015). In contrast, extensive enhancement patterns (segmental, diffuse, and multiregional) were more frequently associated with elevated Ki-67 expression (≥10%).

This observation aligns with contemporary radiomic concepts, suggesting that rapid cellular proliferation and subsequent microenvironmental hypoxia manifest as spatially heterogeneous and morphologically diffuse enhancement patterns on MRI [25,26].

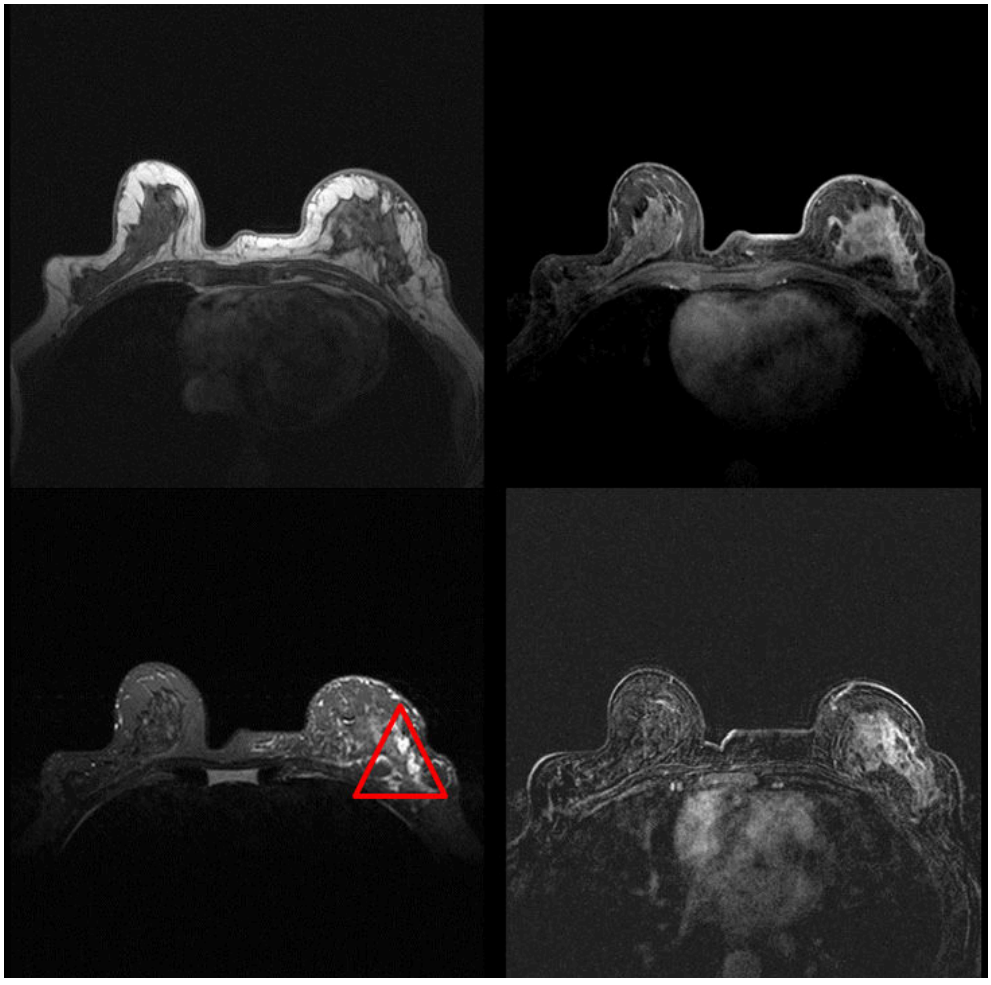


Figure 3. Axial dynamic contrast-enhanced breast MRI of a 53-year-old female patient demonstrating malignant non-mass enhancement (NME) in the left breast. The lesion shows a distinct segmental distribution with a clustered ring internal enhancement pattern. Definite histopathological analysis confirmed invasive ductal carcinoma (Luminal B subtype) with an elevated Ki-67 index, reflecting aggressive ductal spread and active angiogenesis.

Table 3. Inter-observer agreement (Cohen's Kappa) for BI-RADS NME descriptors between two breast radiologists

BI-RADS Descriptor	Observed Agreement (%)	Cohen's Kappa (κ)	95% Confidence Interval (CI)	Agreement Level
Spatial Distribution Pattern	83.9%	**0.76**	0.63 – 0.89	Substantial
Internal Enhancement Pattern	79.0%	**0.69**	0.54 – 0.84	Substantial
BPE Degree	82.3%	**0.72**	0.57 – 0.87	Substantial
BPE Symmetry	88.7%	**0.81**	0.68 – 0.94	Almost Perfect
Kinetic Curve Type	83.9%	**0.74**	0.59 – 0.89	Substantial

BPE: Background Parenchymal Enhancement. Landis and Koch criteria were applied for agreement interpretation (0.61–0.80: Substantial; 0.81–1.00: Almost Perfect).

Discussion

Principal Findings

In this retrospective cohort study, we comprehensively evaluated the morphological distribution, internal enhancement characteristics, and kinetic features of non-mass enhancement (NME) on breast MRI, correlating these findings with definitive histopathology and molecular subtypes. Our findings suggest that the spatial distribution pattern of NME and the degree of background parenchymal enhancement

Table 4. Diagnostic performance metrics of NME features				
Feature	**Sensitivity (%)**	**Specificity (%)**	**PPV (%)**	**NPV (%)**
Segmental Distribution	29.3	90.5	85.7	39.6
Multiregional Distribution	31.7	95.2	92.9	41.7
Diffuse Distribution	9.8	100.0	100.0	36.2
Clustered Ring Enhancement	22.0	95.2	90.0	38.5
Clumped Enhancement	17.1	90.5	77.8	35.8

(BPE) are imaging features significantly associated with malignancy.

Furthermore, we report a striking and novel correlation between the focal distribution pattern of malignant NME and a significantly low Ki-67 proliferation index (<10%), highlighting the potential of MRI to noninvasively reflect spatial tumor heterogeneity and intrinsic biological aggressiveness.

Demographics and Population Analysis

The demographic profile and malignancy distribution of our study cohort (61 patients, 62 lesions; mean age: 48.19 years) demonstrate intriguing similarities and differences when compared with the pioneering NME literature. Our sample size is highly comparable to those of other established single-center retrospective cohorts evaluating isolated NME, such as the series reported by Cho et al. [25] (n=88), Ballesio et al. [26] (n=94), Newell et al. [27] (n=116), Dratwa et al. [28] (n=119), and Thomassin-Naggara et al. [29] (n=131).

Notably, the malignancy rate observed in our study (66.1%) was higher than those reported by Dratwa et al. [28] (18.9%), Newell et al. [27] (39.0%), and Thomassin-Naggara et al. [29] (42.7%), yet remained lower than the malignancy rate documented by Cho et al. [25] (83.0%). This distinct distribution was largely driven by our strict inclusion criteria, which explicitly excluded cases with accompanying mass lesions (n=18) and focused exclusively on histopathologically verified isolated NME lesions managed at a tertiary academic referral center. Such a clinical setting inherently results in a preselected patient group with a higher pretest probability of malignancy, emphasizing that isolated NME encountered in tertiary care databases carries an elevated clinical risk and necessitates careful optimization of biopsy criteria to prevent false-negative assessments.

NME Distribution Patterns and Malignancy Prediction

In the present study, the spatial distribution pattern of NME emerged as a robust and highly significant imaging biomarker for malignancy (p=0.002). Consistent with contemporary radiologic-pathologic paradigms, our analysis revealed that extensive enhancement distributions—specifically segmental, multiregional, and diffuse patterns—yielded exceptionally high malignancy rates, ranging from 81.5% to 100%. These results build upon earlier foundational studies; for instance, Thomassin-Naggara et al. [29] and Dratwa et al. previously reported that malignant NME predominantly manifests in segmental or regional distributions, reflecting the ductal anatomy of the breast. Similarly, Cho et al. [25] highlighted a 93.3% specificity for segmental distribution in predicting malignancy. Recent investigations corroborate and extend these earlier findings, underscoring that segmental distribution is a hallmark of malignant ductal spread and extensive tumor angiogenesis, frequently yielding positive predictive values (PPVs) exceeding 80% [30,31]. This macroscopic imaging presentation directly reflects the biological tendency of high-grade in situ and invasive carcinomas (such as DCIS and IDC) to aggressively infiltrate along the ductal networks.

Conversely, focal NME distribution in our cohort was predominantly associated with benign etiologies (68.8%). This observation parallels recent evidence demonstrating that localized focal enhancement typically reflects benign proliferative changes or fibrocystic disease with limited spatial heterogeneity rather than malignant progression [32]. Ultimately, our findings validate the use of macroscopic NME distribution patterns as a critical noninvasive risk stratification tool. Integrating these spatial features into routine clinical decision-making underscores the clinical importance of prompt tissue sampling for segmental or diffuse lesions while offering a potential basis for safely minimizing unnecessary interventions for purely focal enhancement.

The Ki-67 Milestone and Spatial Tumor Heterogeneity

A key finding of our study is the strong association between focal NME distribution and a low Ki-67 proliferation index (<10%), in stark contrast to the higher Ki-67 indices (>10–30%) observed in diffuse, segmental, and multiregional patterns. This phenomenon can be explained through the lens of modern tumor biology, specifically the interplay among rapid cellular proliferation, intratumoral hypoxia, and neoangiogenesis. Contemporary research indicates that a high Ki-67 index reflects aggressive cellular proliferation that rapidly outstrips the

local vascular supply, generating a microenvironment highly prone to ischemia and hypoxia. This hypoxic state acts as a catalyst for chaotic angiogenesis and increased vascular permeability, which manifest macroscopically on MRI as extensive, infiltrative NME patterns (e.g., segmental or diffuse) [33] (Fig. 3). Consequently, the pronounced spatial tumor heterogeneity inherent in highly proliferative tumors is reflected in these extensive distributions, whereas focal NME lesions represent biologically indolent, localized lesions with balanced perfusion and limited spatial heterogeneity [33] (Fig. 2).

The Clinical Significance of BPE and Kinetic Ineffectiveness

Furthermore, our analysis revealed that while marked and asymmetric background parenchymal enhancement (BPE) was significantly associated with malignancy (88–100% malignancy rate, p=0.020), traditional kinetic curve assessments (types I, II, and III) failed to distinguish between benign and malignant NME lesions (p=0.392). Although type III (washout) kinetic curves are highly specific for malignant mass lesions—owing to their dense cellularity and uniform aberrant neovascularization—their diagnostic utility is significantly compromised in NME lesions. Recent literature attributes this limitation to the inherent infiltrative growth pattern of NME, which characteristically features interspersed normal fibroglandular tissue and fat within the enhancing abnormality [29,34]. During the extraction of time-intensity curves, the inadvertent inclusion of intervening normal breast parenchyma within the region of interest (ROI) leads to substantial partial volume effects [29]. This signal averaging dampens the classic rapid wash-in and washout dynamics of malignant angiogenesis, causing aggressive NME lesions to frequently exhibit nondiagnostic persistent or plateau curves. In contrast, marked asymmetry in BPE likely reflects global hormonal or angiogenic stimulation of the entire breast tissue harboring the malignancy, thereby remaining a reliable macroscopic indicator of breast cancer presence.

Our study has certain limitations, most notably its retrospective, single-center design and the relatively small cohort of 61 patients. However, rather than representing a definitive constraint, this focused dataset serves as an essential foundation for further research. To ensure high diagnostic reliability and minimize subjective interpretation, we strengthened our methodology by incorporating a rigorous interobserver agreement analysis using Cohen's kappa statistics. Ultimately, our findings provide a preliminary pathophysiological foundation that paves the way for future large-scale, prospective multicenter trials. Furthermore, integrating these detailed macroscopic MRI features into emerging artificial intelligence and deep learning frameworks will be critical for overcoming human variability and unlocking the full potential of automated, high-throughput tumor phenotyping [35].

In conclusion, our findings suggest that NME spatial distribution patterns may provide useful imaging information for malignancy risk stratification. In particular, the observed association between focal NME and low Ki-67 expression may reflect differences in tumor proliferation. However, these imaging features should not be considered definitive indicators of biological aggressiveness or independent predictors of malignancy. Given the retrospective, single-center design and relatively small sample size, our results should be interpreted as exploratory. Larger prospective, multicenter studies are needed to validate these associations and assess their potential role in clinical decision-making.

Ethics

Ethics Committee Approval: The study protocol was approved by the Ege University Medical Research Ethics Committee (Approval Date: 28.12.2015 , Decision No: 15-12.1/47).

Informed Consent: The requirement for informed consent was waived by the ethics committee due to the retrospective nature of the study.

Conflict of Interest: The authors declare that the research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

Financial Disclosure: The authors received no financial support for the research, authorship, and/or publication of this article.

Use of AI for Writing Assistance: None declared.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request. Image data were extracted and processed from the clinical PACS (Sectra AB, Linköping, Sweden) at the Ege University Medical School using Digital Imaging and Communications in Medicine (DICOM) query/retrieve software. The PACS system is closed to external users. All clinical data, including laboratory and clinical follow-up, were obtained from the Ege University Hospital Electronic Patient File Repository. The Electronic Patient File Repository is closed to external users. Data are provided in a spreadsheet format (Microsoft Excel). The spreadsheet is secured and deposited by the corresponding author.

Authorship Contributions: Concept: M.K., U.D.P.; Design: U.D.P, Ö.S.O.; Resource: M.K., U.D.P., Ö.S.O.; Materials: M.K., U.D.P., Ö.S.O., A.O.A., I.B.; Data collection and/or processing: Ö.S.O., A.O.A., I.B.; Analysis and/or interpretation: M.K., U.D.P., I.B.; Literature review: M.K., U.D.P., Ö.S.O., A.O.A., I.B.; Writing: U.D.P., Critical review: M.K., U.D.P., Ö.S.O., A.O.A., I.B.

Peer-review: Externally peer-reviewed.

References

1. Hortobagyi GN, de la Garza Salazar J, Pritchard K, Amadori D, Haidinger R, Hudis CA, et al. The global breast cancer burden: variations in epidemiology and survival. Clin Breast Cancer 2005;6:391-401.
2. Kopans DB. The positive predictive value of mammography. AJR Am

J Roentgenol 1992;158:521-6.

3. Carney PA, Miglioretti DL, Yankaskas BC, Kerlikowske K, Rosenberg R, Rutter CMet al. Individual and combined effects of age, breast density, and hormone replacement therapy use on the accuracy of screening mammography. Ann Intern Med 2003;138:168-75. https://doi.org/10.7326/0003-4819-138-3-200302040-00008
4. Szabó BK, Aspelin P, Kristoffersen Wiberg M, Tot T, Boné B. Invasive breast cancer: correlation of dynamic MR features with prognostic factors. Eur Radiol 2003;13:2425-35.
5. Kerlikowske K, Grady D, Barclay J, Sickles EA, Ernster V. Likelihood ratios for modern screening mammography. Risk of breast cancer based on age and mammographic interpretation. JAMA 1996;276:39-43.
6. Leung JW. Screening mammography reduces morbidity of breast cancer treatment. AJR Am J Roentgenol 2005;184:1508-9.
7. Kolb TM, Lichy J, Newhouse JH. Comparison of the performance of screening mammography, physical examination, and breast US and evaluation of factors that influence them: an analysis of 27,825 patient evaluations. Radiology 2002;225:165-75.
8. Segel MC, Paulus DD, Hortobagyi GN. Advanced primary breast cancer: assessment at mammography of response to induction chemotherapy. Radiology 1988;169:49-54.
9. Boulogianni G, Chryssogonidis I, Drevelegas A. Diffusion weighted MRI and spectroscopy in invasive carcinoma of the breast at 3Tesla. Correlation with dynamic contrast enhancement and pathologic findings. Hippokratia 2016;20:192-7.
10. Çelebiler Çavuşoğlu A, Saydam S, Canda T, Sakızlı M. Meme tümör sınıflamasında yenilik çabaları. Meme Sağlığı Dergisi 2009;5:187-90. [in Turkish]
11. Contesso G, Mouriesse H, Friedman S, Genin J, Sarrazin D, Rouesse J. The importance of histologic grade in long-term prognosis of breast cancer: a study of 1,010 patients, uniformly treated at the Institut Gustave-Roussy. J Clin Oncol 1987;5:1378-86.
12. Stewart JF, Rubens RD, Millis RR, King RJ, Hayward JL. Steroid receptors and prognosis in operable (stage I and II) breast cancer. Eur J Cancer Clin Oncol 1983;19:1381-7.
13. Donegan WL. Tumor-related prognostic factors for breast cancer. CA Cancer J Clin 1997;47:28-51.
14. Eroğlu A, Çiçek E. Meme Kanserinde moleküler alt tiplere göre cerrahi tedavi yaklaşımları. Yeni Tıp Dergisi 2014;31:83-7. [in Turkish]
15. Li J, Huo G, Lei X, Li G, Yu M, Nie Z, et al. Correlation analysis of multiparametric magnetic resonance imaging features and molecular subtypes of breast cancer. J Clin Imaging Sci 2025;15:37.
16. El-Rawy AS, Gaballa A, Shafik A, Ramadan M, Yones H. Magnetic resonance imaging correlation with molecular and epigenetic markers in assessment of breast cancer. Egypt J Radiol Nucl Med 2022;53:211.
17. Liu J, Wang X, Hu M, Zheng Y, Zhu L, Wang W, Hu J, et al. Development of an ultrasound-based radiomics nomogram to preoperatively predict Ki-67 expression level in patients with breast cancer. Front Oncol 2022;12:963925.
18. Wang Q, Zheng N, Yu Q, Shao S. Multimodal imaging and advanced quantitative techniques for HER-2 status prediction in breast cancer. Discov Oncol 2025;16:1820.
19. Pinker K, Chin J, Melsaether AN, Morris EA, Moy L. Precision medicine and radiogenomics in breast cancer: new approaches toward diagnosis and treatment. Radiology 2018;287:732–47.
20. Li JW, Sheng DL, Chen JG, You C, Liu S, Xu HX, et al. Artificial intelligence in breast imaging: potentials and challenges. Phys Med Biol 2023;68.
21. Lunkiewicz M, Forte S, Freiwald B, Singer G, Leo C, Kubik-Huch RA. Interobserver variability and likelihood of malignancy for fifth edition BI-RADS MRI descriptors in non-mass breast lesions. Eur Radiol 2020;30:77–86.
22. Shen Y, Zhang X, Zheng J, Wang S, Ding J, Sun S, et al. Distinguishing low expression levels of human epidermal growth factor receptor 2 in breast cancer: Insights from qualitative and quantitative magnetic resonance ımaging analysis. Tomography 2025;11:31.
23. Goldhirsch A, Wood WC, Coates AS, Gelber RD, Thürlimann B, Senn HJ, et al. Strategies for subtypes--dealing with the diversity of breast cancer: highlights of the St. Gallen International Expert Consensus on the Primary Therapy of Early Breast Cancer 2011. Ann Oncol Off J Eur Soc Med Oncol 2011;22:1736–47..
24. Liu X, Liu Y, Ma T, Zhang S, Liu L, Wang S, et al. Clinicopathological and imaging factors of surgical margin status and prognosis in breast-conserving therapy. Sci Rep 2026;16:10450.
25. Cho YH, Cho KR, Park EK, Seo BK, Woo OH, Cho SB. Significance of additional non-mass enhancement in patients with breast cancer on preoperative 3t dynamic contrast enhanced MRI of the breast. Iran J Radiol 2016;13:e30909.
26. Ballesio L, Di Pastena F, Gigli S, D'ambrosio I, Aceti A, Pontico M, et al. Non mass-like enhancement categories detected by breast MRI and histological findings. Eur Rev Med Pharmacol Sci 2014;18:910-7.
27. Newell D, Nie K, Chen JH, Hsu CC, Yu HJ, Nalcioglu O. Selection of diagnostic features on breast MRI to differentiate between malignant and benign lesions using computer-aided diagnosis: differences in lesions presenting as mass and non-mass-like enhancement. Eur Radiol 2010;20:771–81.
28. Dratwa C, Jalaguier-Coudray A, Thomassin-Piana J, Gonin J, Chopier J, Antoine M. Breast MR biopsy: Pathological and radiological correlation. Eur Radiol 2016;26:2510–9.
29. Thomassin-Naggara I, Trop I, Chopier J, David J, Darai E, Uzan S, et al. Nonmasslike enhancement at breast MR imaging: the added value of mammography and US for lesion categorization. Radiology 2011;261:69–79.
30. Elboghdady AA, Shawky SA, Mohsen M, Zaky MM. Can early post-operative MRI describe a predictor model for the likelihood of early breast cancer recurrence after conservative surgery? Egypt J Radiol Nucl Med 2024;55:103.
31. Kareem TF, Kamal AM, Nakash MA. Dynamic curve type serves as an effective tool for the diagnosis of benign or malignant non-mass enhancements on breast MRI. Oncol Lett 2026;31:212.
32. Pötsch N, Dietzel M, Kapetas P, Clauser P, Pinker K, Ellmann S. An A.I. classifier derived from 4D radiomics of dynamic contrast-enhanced breast MRI data: potential to avoid unnecessary breast biopsies. Eur Radiol 2021;31:5866–76.
33. Goto Y, Ochi T, Sakaguchi Y, Yoshida T, Fujitani S, Maeda K. Usefulness of computed tomography angiography "spot sign" in the endoscopically assisted evacuation of acute subdural hematoma in the elderly. Interdiscip Neurosurg Adv Tech Case Manag 2021;24.
34. Ziada K, Aggarwal R, Siu M, Jallad N, Gatt R, Al-Attar M. Comparison of preoperative breast cancer disease extent on contrast-enhanced mammography (CEM) versus magnetic resonance imaging (MRI. Clin Radiol 2026;98.

CASE REPORT

DOI: 10.14744/globecc.2026.79553
Glob Emerg Crit Care 2026;5(4):243-245

High-Pressure Water Jet–Induced Liver Injury With Minimal External Findings: A Rare Diagnostic Challenge in Abdominal Trauma

Gürkan Güneri

Department of General Surgery, Seyh Edebali University Faculty of Medicine, Bilecik, Türkiye

Abstract

High-pressure water jet devices used in car wash facilities operate at pressures between 1200 and 1900 psi and are known to cause severe extremity injuries [1]. Intra-abdominal solid organ injuries related to this mechanism are extremely rare and may be overlooked because of minimal external findings, potentially leading to delays in diagnosis. A 25-year-old male car wash worker presented with severe epigastric pain after accidental exposure to a high-pressure water spray device. Physical examination revealed a small dermal abrasion and a punctate entry wound. The patient was hemodynamically stable. Abdominal computed tomography demonstrated a Grade II liver laceration involving segments III and IVa according to the AAST liver injury scale. Nonoperative management was performed. High-pressure water jet injuries may cause clinically significant intra-abdominal solid organ damage despite minimal skin findings. Early imaging should be considered in suspicious cases. Nonoperative management is effective in hemodynamically stable patients.

Keywords: Abdominal trauma, high-pressure water jet, liver injury, nonoperative management.

Introduction

High-pressure water jet injuries are uncommon but potentially serious mechanisms of trauma. While most reported cases involve the extremities, intra-abdominal injuries are rare and may be easily overlooked due to minimal external findings [1-3]. This creates a risk of delayed diagnosis and potential complications. This case highlights the diagnostic challenge and emphasizes the importance of early imaging in patients with a suspicious clinical presentation.

Case Report

A 25-year-old male working in a car wash facility presented to the emergency department after sustaining an abdominal injury caused by a high-pressure water spray device. On admission, he was alert and hemodynamically stable, with a blood pressure of 120/75 mmHg and a heart rate of 82 beats/min. Epigastric pain was present.

Physical examination revealed a 3×3 cm superficial dermal abrasion and a small punctate entry wound in the epigastric region. Abdominal examination showed localized tenderness and guarding in the epigastrium and left upper quadrant. Laboratory analysis demonstrated a hemoglobin level within normal limits and normal liver function tests. The white blood cell count was elevated at $15.5\times10^3/\mu L$.

The patient had no known chronic diseases, was not on regular medication, and had no history of allergies. He denied smoking and alcohol use. There was no relevant family history.

Contrast-enhanced abdominal computed tomography revealed a Grade II liver laceration involving segments III and IVa according to the AAST liver injury scale (2018 revision), with millimetric air densities adjacent to the liver and stomach (Fig. 1) [4]. No active bleeding or free intra-abdominal fluid was detected.

Differential diagnoses included hollow viscus perforation, penetrating abdominal trauma, and gastrointestinal injury. However, the absence of free fluid and the presence of localized air adjacent to the liver supported the diagnosis of isolated liver injury.

Address for Correspondence: Gürkan Güneri, Department of General Surgery, Seyh Edebali University Faculty of Medicine, Bilecik, Türkiye
E-mail: gurkan.guneri@bilecik.edu.tr **ORCID-ID:** 0000-0001-6749-2159

Received: 26.01.2026 **Revised Date:** 22.04.2026 **Accepted:** 15.05.2026

Cite this article as: Güneri G. High-pressure water jet–induced liver injury with minimal external findings: a rare diagnostic challenge in abdominal trauma. Glob Emerg Crit Care 2026;5(4):243-245.

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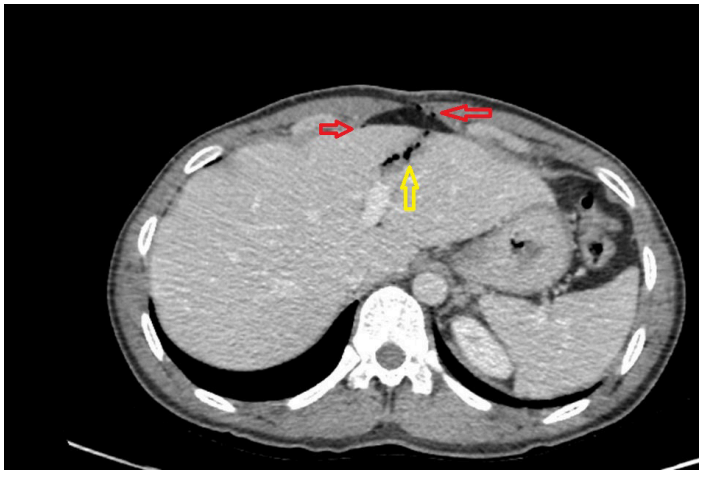


Figure 1. Contrast enhanced CT image showing a Grade II liver laceration. Yellow arrow indicates intraparenchymal free air within the liver, Red arrows indicate , intraperitoneal free air adjacent to the liver.

The patient was hemodynamically stable; therefore, nonoperative management was planned in accordance with current trauma guidelines. Oral intake was stopped, and intravenous fluid therapy was initiated. Empirical antibiotic therapy (ceftriaxone 2 g/day) was administered. Serial abdominal examinations and laboratory monitoring were performed.

At 24 hours, the patient remained stable without a decline in hemoglobin level. Abdominal pain had significantly decreased, and oral intake was gradually resumed. On hospital day 3, follow-up abdominal ultrasonography demonstrated no free fluid or free air. The patient was discharged with outpatient follow-up instructions. At the 10-day follow-up, no complications were identified, and the patient remained asymptomatic.

Clinical Timeline:

Day 0: Admission, CT diagnosis of Grade II liver injury

Day 1: Stable clinical course, decreased pain

Day 3: Control ultrasonography, no complications

Day 10: Outpatient follow-up, no complications

Discussion

High-pressure water jet injuries represent an uncommon but potentially serious mechanism of trauma. Although these injuries are classically associated with severe soft tissue damage in the extremities, intra-abdominal involvement is rare and may be easily overlooked due to minimal external findings [2,5-9]. This discrepancy between the severity of internal injury and the benign appearance of the skin constitutes a significant diagnostic challenge and may lead to delayed diagnosis.

In the present case, the patient exhibited only a small dermal abrasion and a punctate entry wound yet had a clinically significant liver injury. This highlights the importance of maintaining a high index of suspicion in patients presenting with localized abdominal pain following exposure to high-pressure water devices, even when physical examination findings appear limited.

Computed tomography plays a crucial role in the early diagnosis of such injuries. Clinical examination and laboratory parameters may be nonspecific or deceptively normal, as observed in this case. Early imaging should therefore be strongly considered in patients with a compatible mechanism of injury, particularly when symptoms are disproportionate to external findings. Differential diagnoses such as hollow viscus perforation, penetrating abdominal trauma, and gastrointestinal injury should be carefully evaluated and excluded.

Management strategies should be guided by hemodynamic status and injury severity. According to current trauma guidelines and the AAST liver injury scale, nonoperative management is the standard of care in hemodynamically stable patients with low-grade liver injuries. In this case, close clinical monitoring, serial examinations, and supportive care resulted in a favorable outcome without the need for surgical intervention. However, clinicians should remain vigilant, as delayed complications or clinical deterioration may necessitate escalation of care.

From a clinical perspective, this case underscores several important points: first, high-pressure water jet exposure should be recognized as a potential cause of intra-abdominal injury; second, minimal external findings do not exclude significant internal damage; and third, early imaging is essential to prevent missed or delayed diagnosis. Increased awareness of this rare mechanism of injury among emergency physicians and surgeons may improve diagnostic accuracy and optimize patient outcomes.

Although limited by the nature of a single case report and the relatively short follow-up period, this report contributes to the existing literature by emphasizing the diagnostic pitfalls and management considerations associated with this rare injury pattern. Further accumulation of similar cases may help refine clinical guidelines and improve recognition of this entity.

Conclusion

High-pressure water jet injuries should be considered a potential cause of intra-abdominal trauma, even in the absence of significant external findings [2]. Early imaging is crucial to avoid delayed diagnosis. Nonoperative management is safe and effective in hemodynamically stable patients with low-grade liver injuries.

Ethics

Ethics Committee Approval: This is a single case report, and therefore ethics committee approval was not required in accordance with institutional policies.

Informed Consent: Written informed consent was obtained from the patient for the publication of this case report and accompanying images. The patient was informed that personal and institutional identifiers would be anonymized, and confidentiality was strictly maintained throughout the study.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

Use of AI for Writing Assistance: None declared.

Peer-review: Externally peer-reviewed.

References

1. Costello MW, Bolling RP, Gonzalez RP. Intra-abdominal injury as a result of high-pressure water injection. J Trauma. 2008;65:222–4; discussion 224.
2. Redmond CE, McEvoy SH, Ryan ER, Hoti E. Pancreatic transection as a result of a high-pressure water jet injury. BMJ Case Rep. 2013;2013:bcr2013200403.
3. Tejero-Trujeque R. High-pressure water jet injuries: a surgical emergency. J Wound Care. 2000;9:175–9.
4. AAST. Injury scoring scale. Avaible at: https://www.aast.org/trauma-acs-resources/trauma-tools/injury-scoring-scale.html Accsessed 18 May, 2026
5. Dailiana HZ, Kotsaki D, Varitimidis S, Moka S, Bakarozi M, Oikonomou K, et al. Injection injuries: seemingly minor injuries with major consequences. Hippokratia. 2008;12:33–6.
6. Amsdell SL, Hammert WC. High-pressure injection injuries in the hand: current treatment concepts. Plast Reconstr Surg. 2013;132:586e–91e.
7. Borenstein TR, Johnson JP, Cohen B, Kane P. High-Pressure Injection to the Great Toe with River Water. R I Med J. 2015;98:38–41.
8. Magneson F, O'Rear J, Liew-Spilger A, Capannari J, Donne ED. High-pressure water jet injury to the abdomen: a case report and literature review. Occup Med Health Aff. 2014;2:1–4.
9. Sharma OP, Oswanski MF. Hydroblast intra-abdominal organ trauma. J Emerg Med. 2002;22:49–53.

LETTER TO THE EDITOR

DOI: 10.14744/globecc.2026.85047
Glob Emerg Crit Care 2026;5(4):246-247

Hemoglobin in Geriatric SVT: A Statistically Significant Yet Clinically Impractical Predictor

Ahmet Faruk Yıldız[1], Mert Gültekin[2]

[1]*Kızıltepe State Hospital, Department of Emergency Medicine, Mardin, Türkiye*
[2]*Şanlıurfa Training and Research Hospital, Department of Emergency Medicine, Şanlıurfa, Türkiye*

Dear Editor,

We read the article titled "Comparative Effectiveness of Adenosine, Diltiazem, and Metoprolol in Rate Control of Supraventricular Tachyarrhythmias in Geriatric Patients" by Eyüpoğlu et al. with great interest [1]. While the study addresses a significant clinical topic, we believe that the following points require clarification to ensure accurate interpretation of the results.

A numerical discrepancy is evident between the Methods and Results sections. Although the study cohort consisted of 167 patients, Table 1 presents data for only 59 individuals. This figure's proximity to the "rate control achieved" subgroup (n=58) suggests that the table may inadvertently exclude the majority of the cohort (n=109), hindering a complete comparative analysis of the study.

Second, although the title specifies adenosine, diltiazem, and metoprolol, the results broadly group agents as "beta-blockers" and "calcium channel blockers," lacking specific efficacy data for adenosine. Moreover, the term "supraventricular tachyarrhythmias" encompasses atrial fibrillation (AF). The current ESC guidelines strictly distinguish AF from other SVTs [2,3]. If patients with AF were included, the low treatment success rate (34.7%) is understandable. However, if they were excluded, this rate contradicts the high efficacy (76–100%) typically associated with adenosine and diltiazem in SVT, raising questions about dosing protocols or patient selection [4].

Third, we noted statistical inconsistencies in hemoglobin levels. The text reports hemoglobin as a significant predictor in the multivariate analysis (p=0.037); however, the corresponding data are missing in Table 2. Furthermore, a discrepancy was noted in the univariate p-value for hemoglobin, reported as 0.011 in the text and 0.192 in the table.

Finally, tachycardia in patients with anemia commonly represents a compensatory physiological response [5]. Consequently, persistent tachycardia may not indicate treatment failure. Hemoglobin levels may be more suitable as a retrospective explanatory variable rather than a prospective criterion for drug selection in the acute setting.

Rectifying these concerns would substantially enhance the study's contribution to the literature.

Ethics

Authorship Contributions: Concept: A.F.Y., Design: A.F.Y., Data Collection or Processing: M.G., Analysis or Interpretation: M.G., Literature Search: M.G., Writing: A.F.Y.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

Use of AI for Writing Assistance: During the preparation of this work, the author utilized Google's Gemini solely for language editing, grammatical refinement, and to improve the readability of the manuscript. After carefully reviewing and editing the content as necessary, full responsibility for the publication's content is taken by the author.

References

1. Eyüpoğlu G, Tatlı M, Akkoç E, Zengin E. Comparative effectiveness of adenosine, diltiazem, and metoprolol in rate control of supraventricular tachyarrhythmias in geriatric patients: a retrospective cohort study.

Address for Correspondence: Ahmet Faruk Yıldız, Kızıltepe State Hospital, Department of Emergency Medicine, Mardin, Türkiye
E-mail: ahmetfarukyldz@yandex.com **ORCID-ID:** 0000-0002-5242-6236

Received: 03.12.2025 **Revised Date:** 03.12.2025 **Accepted:** 14.04.2026

Cite this article as: Yıldız AF, Gültekin M. Hemoglobin in Geriatric SVT: A Statistically Significant Yet Clinically Impractical Predictor. Glob Emerg Crit Care 2026;5(4):246-247.

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Glob Emerg Crit Care. 2025;4:55-60.

2. Kotadia ID, Williams SE, O'Neill M. Supraventricular tachycardia: An overview of diagnosis and management. Clin Med (Lond). 2020;20:43-7.
3. Calkins H. he 2019 ESC Guidelines for the Management of Patients with Supraventricular Tachycardia: What you need to know about the 2019 ESC Guidelines are discussed by Professor Hugh Calkins, Member of the Guideline Writing Group. Eur Heart J. 2019;40:3812-3.
4. Nithin PR, Wilben V, Kumar V, Kanchi M. Adenosine versus diltiazem in stable supraventricular tachycardia unresponsive to vagal maneuver. Circulation. 2021;144(Suppl 1):10459.
5. Porter WB, James GW 3rd. The heart in anemia. Circulation. 1953;8:111-6.

LETTER TO THE EDITOR

DOI: 10.14744/globecc.2026.48568
Glob Emerg Crit Care 2026;5(4):248-249

Peripheral Perfusion Index As an Early Biomarker of Acute Kidney Injury: Methodological Considerations

Mehmet Necmeddin Sutaşır

Department of Emergency Medicine, Başakşehir Çam and Sakura City Hospital, Istanbul, Turkiye

Dear Editor,

I read Altınsoy's article in Global Emergency and Critical Care, which investigated the peripheral perfusion index (PI) and arterial blood gas parameters as potential early indicators of acute kidney injury (AKI), with great interest [1]. The study provides preliminary evidence suggesting that PI could serve as a noninvasive, real-time biomarker for diagnosing AKI and assessing its severity in the emergency department. However, given its retrospective observational case-control design, these findings should be regarded as hypothesis-generating rather than confirmatory. I commend the author for addressing an important clinical gap, particularly given the well-documented limitations of serum creatinine as a delayed marker of renal dysfunction.

The reported area under the curve (AUC) of 0.97 for PI in predicting AKI is notably high, and this unusually strong apparent discrimination warrants cautious interpretation. Although promising, this result requires careful evaluation. The exclusion of patients with sepsis, shock, and respiratory failure—conditions commonly encountered in emergency departments and known to independently influence PI measurements—may have led to an overestimation of diagnostic performance [2]. Equally important, these exclusions raise concerns regarding spectrum and selection bias, as the resulting study population may not adequately represent the heterogeneous patient population typically encountered in real-world emergency department settings, thereby limiting the external validity of the reported findings [2]. Additionally, several physiological factors can affect PI values, including ambient temperature, peripheral vascular tone, and the use of vasoactive medications. These factors were not systematically controlled for in this study [3]. These considerations underscore that PI is fundamentally a physiological marker of peripheral perfusion rather than a kidney-specific biomarker, a distinction that warrants caution when interpreting its apparent diagnostic association with AKI. Future studies should standardize measurement conditions and incorporate these potential confounding factors into multivariable analyses.

I would also like to highlight that the study employed a cross-sectional approach, with measurements obtained at a single time point. This limits the ability to assess changes in PI over time. Because AKI is a dynamic process, serial monitoring of PI levels may provide additional information regarding disease progression and treatment response.

I also note an important inconsistency in the original article regarding the study design: the abstract describes the study as prospective, whereas the Methods section explicitly defines it as a retrospective observational study. This discrepancy is not merely semantic, as it has important implications for participant selection, the timing of PI measurements relative to AKI diagnosis, the risk of selection and information bias, and ultimately the interpretation of the reported diagnostic performance. I would welcome clarification from the author regarding the actual study design employed. Furthermore, PI was assessed at only a single clinical time point in the study. The absence of serial measurements limits the ability to

Address for Correspondence: Mehmet Necmeddin Sutaşır, Department of Emergency Medicine, Başakşehir Çam and Sakura City Hospital, Istanbul, Turkiye
E-mail: drmehmetns@gmail.com **ORCID-ID:** 0000-0001-6472-5092

Received: 27.12.2025 **Revised Date:** 25.08.2026 **Accepted:** 07.09.2026

Cite this article as: Sutaşır MN. Peripheral perfusion index as an early biomarker of acute kidney injury: Methodological considerations. Glob Emerg Crit Care 2026;5(4):248-249.

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evaluate temporal changes in PI, within-patient variability, and responsiveness to treatment or disease progression. Because AKI is a dynamic process, serial monitoring of PI levels may provide additional information regarding disease progression and treatment response.

Another important consideration concerns the characterization of PI as an "early" marker of AKI. In the study, PI appears to have been measured in patients already diagnosed with AKI according to creatinine-based criteria. The study did not demonstrate that PI became abnormal before serum creatinine levels increased, shortened the time to diagnosis, or predicted the subsequent development of AKI. Therefore, the reported findings reflect concurrent discrimination between AKI and non-AKI groups rather than genuine early diagnostic performance, and this distinction warrants clarification.

Furthermore, although the study appropriately used the Kidney Disease: Improving Global Outcomes (KDIGO) criteria to diagnose AKI, the partial availability of urine output data for Acute Kidney Injury Network (AKIN) and Risk, Injury, Failure, Loss, and End-stage Kidney Disease (RIFLE) staging represents a methodological limitation that could affect the accuracy of severity classification [4]. In conclusion, this study contributes to the growing literature on noninvasive biomarkers for AKI, but its findings should be regarded as preliminary rather than confirmatory. Before PI can be integrated into clinical algorithms, its diagnostic utility must be confirmed through prospective studies involving consecutive and clinically representative emergency department patients, standardized and serial PI measurements, appropriately adjusted multivariable analyses, and internal or external validation. Further multicenter prospective studies involving larger and more heterogeneous populations are warranted to confirm these findings and establish standardized PI cutoff values for clinical use.

Ethics

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The author declared that this study received no financial support.

Peer-review: Externally peer-reviewed.

References

1. Altınsoy KE. Comparative validation of blood gas analysis, perfusion index, and AKIN and RIFLE scoring systems in the diagnosis of acute kidney injury. Glob Emerg Crit Care. 2025;4:67–74.
2. Ostermann M, Zarbock A, Goldstein S, Kashani K, Macedo E, Murugan R, et al. Recommendations on acute kidney ınjury biomarkers from the acute disease quality ınitiative consensus conference: a consensus statement. JAMA Netw Open. 2020;3:e2019209.
3. Lima A, Bakker J. Clinical assessment of peripheral circulation. Curr Opin Crit Care. 2015;21:226–31.
4. Kellum JA, Romagnani P, Ashuntantang G, Ronco C, Zarbock A, Anders HJ. Acute kidney injury. Nat Rev Dis Primers 2021;7:52.