

Retrospective Evaluation of Falls From Height Cases Admitted to the Pre-Hospital Emergency Healthcare System

Hastane Öncesi Acil Sağlık Hizmetlerine Başvuran Yüksekten Düşme Vakalarının Retrospektif Değerlendirmesi

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ABSTRACT

Aim: The aim of this study is to analyze the demographic characteristics, timing aspects (time of occurrence, emergency response time, ambulance arrival time), and hospital arrival times in pre-hospital cases of falls in Ankara.

Material and Methods: This cross-sectional observational epidemiological study examined data from patients who received pre-hospital emergency care due to fall-related trauma in Ankara between January 1, 2019, and December 31, 2023. Patients were identified through calls made to the central 112 Call Center and documented in the Emergency Health Automation System. Demographic details, injury epidemiology (ICD-10 codes, injury mechanism, incident timing), and emergency response times (command response time, time from ambulance dispatch to scene arrival, transport time) were collected.

Results: This study includes 16,136 patients, of whom 6,346 are female and 9,790 are male, with an average age of 38.3 ± 24.3 years. The predominant ICD-10 diagnosis codes are W03, W10, W12, W13, W14, W17, Y30, and X80. The year 2019 saw the highest number of incidents ($n=4,014$), with a decrease observed in 2020 ($n=2,790$). The highest number of falls occurred in July, while the lowest was in February, with the fewest falls reported in winter and the most in summer throughout the five years. Most incidents occurred between 08:00 and 15:59 ($n=8,366$), followed by 16:00 to 23:59 ($n=6,456$); 1,314 incidents occurred between 00:00 and 07:59. Falls occurred most frequently during working hours (61.9%, $n=9,983$). The average command center response time was 216.4 ± 203.6 seconds, station response time was 39.6 ± 47.8 seconds, and transport time was 371.6 ± 249.9 seconds. Most patients were transported to Training and Research Hospital ($n=7,827$), followed by State Hospital ($n=3,422$), University Hospital ($n=2,210$), and Private Hospital ($n=249$). Secondary transfers were mostly related to Training and Research Hospital ($n=1,387$), primarily for specialist needs ($n=1,165$). There were 32 patients who received on-scene intervention and 231 patients who died. Significantly increased response times were observed from 2019 to 2023 ($p<0.001$).

Conclusion: Future research focusing on pre-hospital factors affecting mortality rates in fall victims could enhance triage strategies, thereby reducing the burden on tertiary healthcare facilities. Prevention of falls is crucial in reducing deaths associated with this traumatic injury.

Keywords: Falls from height, prehospital emergency care, emergency medical services

ÖZ

Amaç: Bu çalışmanın amacı, Ankara'da düşme sonucu meydana gelen olaylara yönelik hastane öncesi vakalarında demografik özellikleri, zamanlama yönlerini (olayın meydana gelme zamanı, acil müdahale süresi, ambulans varış süresi) ve hastane varış sürelerini analiz etmektir.

Gereç ve Yöntemler: Bu kesitsel gözlemsel epidemiyolojik çalışma, 1 Ocak 2019 - 31 Aralık 2023 tarihleri arasında Ankara'da düşme sonucu travma nedeniyle hastane öncesi acil bakım alan hastaların verilerini incelemiştir. Hastalar, merkezi 112 Çağrı Merkezi'ne yapılan çağrılar sonucunda Acil Sağlık Otomasyon Sistemi'nde tanımlanmıştır. Demografik detaylar, yaralanma epidemiyolojisi (ICD-10 kodları, yaralanma mekanizması, olay zamanlaması) ve acil yanıt süreleri (komuta reaksiyon süresi, ambulans gönderiminden olay yerine varma süresi, taşıma süresi) toplanmıştır.

Bulgular: Bu çalışma, 16.136 hasta içermektedir; bunların 6.346'sı kadın ve 9.790'ı erkektir ve yaş ortalaması $38,3 \pm 24,3$ yıldır. Hakim ICD-10 tanı kodları W03, W10, W12, W13, W14, W17, Y30 ve X80'dir. Olayların en yoğun olduğu yıl 2019'dur ($n=4.014$), 2020'de ise azalma gözlenmiştir ($n=2.790$). En fazla düşme olayı Temmuz ayında görülürken, en az Şubat ayında gerçekleşmiştir, beş yıl boyunca yaz aylarında ve kış aylarında en az düşme olayı bildirilmiştir. Olayların çoğunluğu 08:00-15:59 saatleri arasında meydana gelmiştir ($n=8.366$), bunu 16:00-23:59 saatleri arasında gerçekleşenler takip etmiştir ($n=6.456$); 1.314 vakada ise olay 00:00-07:59 saatleri arasında gerçekleşmiştir. Düşmelerin %61,9'u ($n=9.983$) çalışma saatlerinde gerçekleşmiştir. Komuta merkezi reaksiyon süresi ortalama $216,4 \pm 203,6$ saniye, istasyon reaksiyon süresi $39,6 \pm 47,8$ saniye ve taşıma süresi $371,6 \pm 249,9$ saniyedir. Hastaların çoğu Eğitim ve Araştırma Hastanesi'ne taşınmıştır ($n=7.827$), onu devlet hastanesi ($n=3.422$), Üniversite Hastanesi ($n=2.210$) ve Özel Hastane ($n=249$) izlemiştir. İkincil transferler genellikle Eğitim ve Araştırma Hastanesi ile ilgili olup ($n=1.387$), bunların çoğu uzman ihtiyacı için yapılmıştır ($n=1.165$). Olay yerinde müdahale alan 32 hasta ve hayatını kaybeden 231 hasta bulunmaktadır. 2019'dan 2023'e kadar önemli ölçüde artan cevap süreleri gözlemlenmiştir ($p<0,001$).

Sonuç: Düşme kurbanlarında mortalite oranlarını etkileyen hastane öncesi faktörlere odaklanan gelecekteki araştırmalar, triyaj stratejilerini daha da geliştirerek üçüncü basamak sağlık tesislerinin yükünü azaltabilir. Sonuç olarak, düşmelerin önlenmesi, bu travmatik yaralanma ile ilişkili ölümleri azaltmada temel öneme sahiptir.

Anahtar Kelimeler: Yüksekten düşme, hastane öncesi acil bakım, acil sağlık hizmetleri

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Introduction

Trauma is a major public health problem worldwide. According to the World Health Organization, trauma claims the lives of 4.4 million people annually and accounts for nearly 8% of all deaths (1).

Falls from height result in multi-organ and multi-system trauma. Given their high energy nature and the involvement of multiple organs, these injuries are associated with a significant morbidity and mortality rate. The care provided to patients who have experienced high-level falls, both before and after hospital admission, has a significant impact on mortality and morbidity rates. Various studies have explored the relationship between different factors and patient outcomes (2-6). Nevertheless, we have been unable to locate any prehospital epidemiological studies focusing on fall-from-height injuries conducted within our country.

This study aims to examine cases of fall-from-height injuries who received prehospital emergency medicine services in terms of demographics, time of occurrence, reaction time of the 112 command and control center, departure and arrival times of the ambulance, vital interventions applied at first contact with emergency health services, and time of arrival of the case to the hospital.

Material and Methods

Study Design and Setting

This study was designed as a cross sectional observational epidemiological study and included every patient who received pre-hospital emergency health care due to fall-from-height trauma and who was registered in the Emergency Health Automation System (ASOS) after 112 Call Center calls between January 1, 2019 and December 31, 2023, in Ankara.

In Turkey, a single centralized dispatch center handles all ambulance calls, both from the public and for inter-hospital transfers. This system aligns with the European emergency response model, utilizing the universal emergency number 112. When someone dials 112 for medical assistance, their location is automatically identified. A dedicated EMS call-taker then verifies the address and dispatches the closest ambulance to respond to the emergency. Upon arrival at the scene, the emergency medical services (EMS) team conducts a patient assessment, including a medical history and physical examination. Subsequently, they consult to medical doctor from 112 command center to determine the most appropriate healthcare facility for patient transfer based on the patient's condition.

Demographic information (age and sex) of the patients was collected. Variables focused on injury epidemiology including ICD-10 diagnosis codes, the mechanism of injury, time of occurrence (year, season, month, day of week, time of day, working hour/out of hours) were collected for all patients. Other parameters such as command reaction time (time duration between call and team assignment), station reaction time (team assignment-ambulance departure), duration to reach trauma scene after ambulance departure (transport time), types of hospitals which patients were transferred, the reason for interfacility transport were collected.

Ethics Committee Approval and Patient Consent

The study was conducted in accordance with the Declaration of Helsinki and approved by the ethics committee permission of the Medical Research Scientific and Ethical Evaluation Board of Ankara Bilkent City Hospital (Approved no: TABED 2-24-295 and date: 12/06/2024). As neither the images nor the accompanying text contained potentially identifying markers or patient identifiers, the ethic committee did not require patient consent for the review of their medical records.

Statistical Analysis

Data analysis was performed using the statistical package program IBM SPSS 27.0 (Armonk, NY: IBM Corp.). While evaluating the study data, in addition to descriptive statistical methods (frequency, percentage, mean, standard deviation, median, quartile separation), the Chi-Square test was used to compare qualitative data. In cases where differences were found in multiple comparisons, post-hoc Bonferroni correction was used. The suitability of the data for normal distribution was evaluated with the Kolmogorov-Smirnov test, skewness-kurtosis and graphical methods (histogram, Q-Q Plot, Stem and Leaf, Boxplot). One-Way Anova test was used to compare normally distributed quantitative data between groups, and post-hoc Tukey test was used in cases where there was a difference. Statistical significance level was accepted as $p < 0.05$.

Results

In this study, 16136 patients were included, of whom 6346 cases were female and 9790 cases were male. The average age of the participants was 38.3 ± 24.3 years. The ICD-10 diagnosis codes of the cases participating in this study are W03, W10, W12, W13, W14, W17, Y30, X80. (Table 1)

While the highest number of cases was seen in 2019 ($n=4014$), the lowest number of cases was seen in 2020 ($n=2790$). EMS applications for falls from height were highest in July and least in February for 5 years. When the number of cases was examined according to seasons, it was seen that the most cases were in the summer season and the fewest cases were in the winter season. While most fall cases occur between 08:00-15:59 ($n=8366$), the second most common fall occurs between 16:00-23:59 ($n=6456$) (Table 1).

There were 1314 cases in the remaining time-period (00:00-07:59). 61.9% ($n=9983$) of the fall cases occurred during working hours, while 38.1% ($n=6153$) occurred outside working hours. Command center reaction time (interval from call to team assignment) was determined as 216.4 ± 203.6 seconds. Station reaction time (the time between the commander's team assignment and the ambulance's departure) was found to be 39.6 ± 47.8 seconds. Transport time from ambulance departure to the scene was determined as 371.6 ± 249.9 seconds (Table 1).

Of the cases taken from the scene, 7827 cases were transferred to Training and Research Hospital (TRH), 3422 cases to State Hospital (SH), 2210 cases to University Hospital (UH), and 249 cases to Private Hospital (PH). 1537 cases were transferred to another hospital after secondary triage for specific reasons. These transfers were mostly made from SH ($n=1309$), followed by TRH ($n=211$). While 9 cases from UH were transferred to another hospital, 8 cases were transferred from PH (Table 2).

		n =16136	Percentage
Years	2019	4014	24.9
	2020	2790	17.3
	2021	3025	18.7
	2022	3292	20.4
	2023	3015	18.7
Months	January	1076	6.7
	February	1014	6.3
	March	1222	7.6
	April	1129	7.0
	May	1431	8.9
	June	1696	10.5
	July	1718	10.6
	August	1318	8.2
	September	1454	9.0
	October	1610	10.0
	November	1281	7.9
	December	1187	7.4
Season	Spring	3782	23.4
	Summer	4732	29.3
	Autumn	4345	26.9
	Winter	3277	20.3
Days of Week	Monday	2285	14.2
	Tuesday	2518	15.6
	Wednesday	2396	14.8
	Thursday	2419	15.0
	Friday	2333	14.5
	Saturday	2137	13.2
	Sunday	2048	12.7
Weekdays/Weekend	Weekdays	11951	74.1
	Weekend	4185	25.9
Time Range	00:00 - 07:59	1314	8.1
	08:00 - 15:59	8366	51.8
	16:00 - 23:59	6456	40.0
Shift	Working Hours	9983	61.9
	Out of Hours	6153	38.1
Command Center Reaction Time (seconds)*		216.4 ± 203.6	151.0 (94.0 – 257.0)
Station Reaction Time (seconds)*		39.6 ± 47.8	36.0 (20.0 – 53.0)
Transport Time (seconds) (ambulance departure-case scene arrival)*		371.6 ± 249.9	314.0 (217.0 – 450.0)
Gender	Female	6.346	39.3
	Male	9.790	60.7
Age (year)*		38.3 ± 24.3	37.0 (18.0 – 57.0)

Table 1. Characteristics of Research Participants
*: Mean ± SD / Median (IQR)

		n =16136	%	
Features of Transfer	Transport to Hospital	13708	85.0	
	TRH	7827	57.1	
Transported Hospital	SH	3422	25.0	
	UH	2210	16.1	
	PH	249	1.8	
	Interfacility Transport	1537	9.5	
	TRH	211	13.7	
From	SH	1309	85.2	
	UH	9	0.6	
	PH	8	0.5	
Reason for Interfacility Transport	TRH	1387	90.2	
	SH	20	1.3	
	UH	108	7.0	
	PH	22	1.4	
	To	Need for Specialist	1165	75.8
	Need for Medical Equipment	186	12.1	
	Need for ICU	117	7.6	
	Lack of Empty Bed	48	3.1	
	Patient's wish	21	1.4	
	Refusal of EMS service	628	3.9	
To	Exitus (Left at scene)	231	1.4	
	Intervention at Scene	32	0.2	
	ICD-10 code	W17- Other fall from one level to another	6446	39.9
	W10- Fall on and from stairs and steps	5868	36.4	
	Y30- Falling, jumping or pushed from a high place. undetermined intent	963	6.0	
	W13- Fall from. out of or through building or structure	690	4.3	
	W14- Fall from tree	700	4.3	
	W03- Other fall on same level due to collision with another person	618	3.8	
	W12- Fall on and from scaffolding	435	2.7	
	X80- Intentional self-harm by jumping from a high place	294	1.8	

Table 2. Characteristics of Transport

TRH: Training and Research Hospital, SH: State Hospital, UH: University Hospital, PH: Private Hospital, ICU: Intensive care unit, EMS: Emergency Medical Services

Most of the secondary transfers were made to TRH (n=1387). While 108 cases were transferred to UH, 22 cases were transferred to PH and 20 cases were transferred to SH. The reasons for secondary transfers are need for specialist (n=1165), need for medical equipment (n=186), need for intensive care unit (n=117), lack of empty bed (n=48), and patient's wish (n=21). Some cases (n=628) refused EMS service. When the EMS team arrived at the scene, 231 cases were found dead. Thirty-two cases were intervened at the scene (Table 2).

		2019 (n=4014)	2020 (n=2790)	2021 (n=3025)	2022 (n=3292)	2023 (n=3015)	P	Difference
ICD-10 code	W17- Other fall from one level to another.	2104 (52.4)	1180 (42.3)	1130 (37.4)	1156 (35.1)	876 (29.1)	<0.001 ^a	All
	W10- Fall on and from stairs and steps.	1112 (27.7)	893 (32.0)	1152 (38.1)	1362 (41.4)	1349 (44.7)	<0.001 ^a	All
	Y30- Falling, jumping or pushed from a high place, undetermined intent	168 (4.2)	166 (5.9)	197 (6.5)	195 (5.9)	237 (7.9)	<0.001 ^a	2019 vs others
	W13- Fall from, out of or through building or structure	76 (1.9)	147 (5.3)	176 (5.8)	143 (4.3)	148 (4.9)	<0.001 ^a	2019 vs others
	W14- Fall from tree	198 (4.9)	153 (5.5)	138 (4.6)	121 (3.7)	90 (3.0)	<0.001 ^a	2020 vs 2023
	W03- Other fall on same level due to collision with another person.	214 (5.3)	77 (2.8)	72 (2.4)	130 (3.9)	125 (4.1)	<0.001 ^a	2019 vs 2021
	W12- Fall on and from scaffolding.	43 (1.1)	85 (3.0)	101 (3.3)	93 (2.8)	113 (3.7)	<0.001 ^a	2019 vs others
	X80- Intentional self-harm by jumping from a high place	89 (2.2)	59 (2.1)	42 (1.4)	61 (1.9)	43 (1.4)	0.060 ^a	--
Command Reaction Time (seconds)	191.3 ± 202.7	248.8 ± 231.9	221.6 ± 216.9	197.1 ± 180.3	235.9 ± 178.9	<0.001 ^b	2019-2022 vs 2020-2021-2023	
Station Reaction Time (seconds)	37.1 ± 45.1	38.2 ± 38.6	40.4 ± 56.1	41.2 ± 51.5	41.5 ± 45.6	<0.001 ^b	2019 vs 2021-2022-2023	
Transport Time (seconds) (ambulance departure -case scene arrival)	347.6 ± 238.2	377.7 ± 255.0	379.1 ± 255.2	372.0 ± 241.3	390.2 ± 261.8	<0.001 ^b	2019 vs others	

Table 3. Comparisons of ICD-10 codes, Command Reaction Time, Station Reaction Time and Transport Time by Years
a: Chi-Square Test (n / %), b: One-Way Anova Test (Mean ± SD)

Transfer Reason	Hospital Transferring Patient			
	TRH (n=211)	SH (n=1309)	UH (n=9)	PH (n=8)
Need for Specialist	112 (53.1%)	1047 (80.0%)	2 (22.2%)	4 (50.0%)
Need for Medical Equipment	15 (7.1%)	167 (12.8%)	2 (22.2%)	2 (25.0%)
Need for ICU	49 (23.2%)	65 (5.0%)	2 (22.2%)	1 (12.5%)
Lack of Empty Bed	34 (16.1%)	13 (1.0%)	1 (11.1%)	0 (0.0%)
Patient's wish	1 (0.5%)	17 (1.3%)	2 (22.2%)	1 (12.5%)

Table 4. Transfer Reason by Type of Hospital
TRH: Training and Research Hospital, SH: State Hospital, UH: University Hospital, PH: Private Hospital, ICU: Intensive care unit

The highest number of fall incidents occurred in 2019. There was no significant difference in the number of suicide-related falls from height (ICD-10 code X80) across the years. A significant increase was observed between 2019 and 2023 in command response time, station response time, and transport time (p<0.001) (Table 3).

The most common reason for patient transfers from both TRH and SH was the need for specialist care. For TRH, the second and third most frequent reasons were the need for intensive care and lack of available beds, respectively. In SH, the primary reasons for transfers were the need for medical equipment and the need for intensive care (Table 4).

Discussion

This study sheds light on the epidemiological situation of pre-hospital fall-from-height cases in Ankara, the capital of Turkey, and examines certain parameters of the pre-hospital services provided by 112 emergency services.

In Turkey, accidental falls were the second leading cause of death between 2018 and 2023 (7). Similarly, a separate

study conducted in Japan between 2014 and 2018 yielded comparable results (8). Our study revealed that between 2019 and 2023, 16136 cases of falls from heights in Ankara received 112 EMS services.

Falls from heights are a trauma etiology with high mortality and morbidity due to their mechanism. In our study, a significant proportion of patients were found deceased at the scene (n=231, 1.4%). Unfortunately, post-hospital admission mortality and morbidity data for these patients were not included in this study. Compared to patients experiencing cardiac arrest due to underlying heart conditions, individuals who suffer a traumatic cardiac arrest typically face a poorer prognosis. Despite of advancements in medical care, the survival rate to discharge for patients experiencing traumatic out-of-hospital cardiac arrest remains comparatively low (9,10). In patients with cardiac arrest secondary to trauma, the etiology of the trauma influences the mortality rate. Jun et al. found that the rate of return of spontaneous circulation was significantly lower in patients who experienced cardiac arrest following a fall from height compared to those who suffered cardiac arrest secondary to a traffic accident (11). Therefore, the primary objective lies in implementing effective interventions to minimize preventable trauma deaths.

Identifying factors associated with injury severity prior to hospitalization holds promise for improving patient outcomes. Evaluating these factors through a robust pre-hospital assessment system could facilitate more effective triage. Ultimately, such a system could contribute to a reduction in mortality rates by directing patients to the most appropriate healthcare facilities based on their individual needs (12). An analysis of 112 emergency response system data revealed that a significant proportion of high-fall patients initially presenting at state hospital were subsequently transferred to TRH or UH due to the need for specialized care after secondary triaging. These results cast doubt on the adequacy of the prehospital triage process and

hospital destination selection conducted by prehospital EMS and the command center. It is conceivable that EMS teams and command center should consider incorporating additional parameters beyond vital signs and initial assessment into their triage protocols and may benefit from developing a specialized algorithm for high-fall incidents.

It has been demonstrated that transporting patients in accordance with the "Golden Hour" concept optimizes survival and morbidity (13,14). In this study, the average time from the initial call to scene arrival was calculated to be 9.6 minutes. Similar time intervals have been reported in studies conducted in developed countries (15). However, our study revealed a significant increase in command response, station response, and transport times between 2019 and 2023. This discrepancy is attributed to factors such as reduced traffic due to pandemic-related lockdowns, increasing traffic congestion over the years, and a surge in 112 call center activity and ambulance utilization rates.

Studies conducted in countries with varying levels of development and across different age groups consistently show that the majority of fall cases from heights involve males (16-19). Similarly, in our study majority of patients were male. Middle-aged males are the most frequent demographic group affected by falls from height (20). This finding is consistent with our study, where a similar population was predominant.

In our study, a significant portion of falls from height occurred during working hours. Jagnoor et al. (21) and Fujii et al. (12) reported similar findings concordant with our study, associating falls from height during this timeframe with middle-age male construction workers. Consistent with findings from the existing literature, studies have observed variations in the seasonal distribution of fall incidents across different geographical regions (22-25). Our study identified summer as the season with the highest incidence of falls.

In Ojima et al.'s study on the impact of the COVID-19 pandemic on major traumas, an increase in fall cases was observed in 2020. However, our study found a lower number of fall cases during the same period (26). Farooq et al.'s review demonstrated an increase in suicidal attempts and ideation during the COVID-19 pandemic (27). In our study, however, the yearly distribution of cases involving suicide attempts by jumping from a height did not show a significant difference.

Limitations

It is necessary to acknowledge limitations in our study. These include the absence of vital signs and initial trauma scores of patients, as well as our inability to access information on procedures performed in the emergency department and patient follow-up.

Conclusion

Future studies aiming to elucidate prehospital protective or adverse factors associated with mortality in high-level fall victims would provide a solid foundation for field triage. Appropriate triage protocols can significantly reduce mortality and morbidity rates by directing patients to facilities best equipped to provide the necessary care, thereby alleviating the burden on higher-level hospitals. Based on the findings of this study and the literature, the

most effective way to prevent fatalities from falls is to prevent falls themselves, which can only be achieved by addressing the underlying causes of falls.

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Ethical Approval: This retrospective study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Local Ethics Committee approved this study. The study received approval from the Medical Research Scientific and Ethical Evaluation Board of Ankara Bilkent City Hospital (Approved no: TABED 2-24-295 and date: 12/06/2024)

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