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Temporal and Meteorological Patterns of Assault-related Emergency Department Presentations

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Abstract

Aim: Assault-related injuries constitute a significant burden on emergency departments and may be influenced by environmental factors. This study aimed to explore the association between meteorological parameters and assault-related emergency department presentations in an urban, upper-middle-income setting, and to describe temporal and clinical characteristics relevant to emergency service planning.

Materials and Methods: This retrospective observational study included adult patients presenting with assault-related injuries to a tertiary emergency department between January 1 and December 31, 2023. Demographic characteristics, injury mechanisms and types, clinical outcomes, and time of presentation were recorded. Meteorological data, including daily mean temperature, wind speed, and precipitation status, were obtained from official records. Associations between weather variables, temporal factors, and clinical outcomes were analyzed.

Results: A total of 4,042 patients were included: 2,606 (64.5%) were male, and the median age was 32 years. Nearly half of the presentations occurred between 16:00 and 23:59 (48.6%), with the highest frequency observed on Sundays (16.1%) and during the summer (31.4%). Physical assault was the predominant mechanism of injury (88.3%), and soft tissue injury was the most common injury type (78.9%). Assault-related presentations peaked when daily mean temperatures ranged between 20 °C and 30 °C, while wind speed and precipitation showed no significant pattern with presentation frequency. Stab/cut-related and firearm-related injuries were significantly more frequent among patients who required hospitalization, who had life-threatening conditions, or who required surgery ($p<0.001$).

Conclusion: Assault-related emergency department presentations demonstrate distinct temporal and environmental patterns in an upper-middle-income urban setting. An increased frequency of presentations within specific temperature ranges and during predictable time periods highlights the importance of incorporating environmental and temporal factors into emergency department resource planning and violence prevention strategies.

Keywords: Assault, emergency service, violence, weather, temperature

Introduction

Injuries are among the leading causes of death and disability worldwide and impose a substantial burden on emergency care (1,2). The World Health Organization classifies injuries broadly as unintentional and intentional (violence-related) injuries (3). The high volume of injury-related emergency department visits underscores the need to address not only clinical management but also resource planning and safety considerations.

Violence-related injuries are predominantly caused by blunt or penetrating trauma mechanisms. Blunt trauma typically results from physical assault, whereas penetrating trauma is caused by sharp objects or firearms (4). The clinical management and

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outcomes associated with these mechanisms differ, necessitating distinct diagnostic and therapeutic approaches (5). Beyond clinical management, however, understanding the factors that precipitate human aggression is essential for effective prevention and emergency preparedness.

Weather represents a key environmental factor that may influence daily human behavior and modify the incidence of aggression and trauma. Previous studies have demonstrated a positive association between increasing ambient temperatures and the frequency of aggression- and trauma-related cases (6,7). In addition to temperature, the potential effects of other meteorological variables, including wind speed, precipitation, and lunar phases, on trauma incidence have been explored (7). The observed increase in emergency department visits during hot summer months and on weekends further suggests that environmental influences on human behavior should be taken into account in emergency healthcare planning (8).

The distribution of injury cases varies across global, national, and local contexts, underscoring the influence of sociocultural, environmental, and climatic factors (6,9). This study aimed to examine associations between weather parameters and the frequency of assault-related injury presentations to an emergency department in an upper-middle-income urban setting and to highlight the implications of environmental conditions for forecasting emergency department demand and service planning.

Materials and Methods

This retrospective observational study was conducted among patients presenting to the emergency department of a tertiary care hospital. The study included patients aged 18 years and older who presented to the emergency department due to assault-related injuries between January 1, 2023, and December 31, 2023. This study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of University of Health Sciences Türkiye, Ankara Training and Research (approval no: E-24-109, date: 10. 05.2024). Due to the retrospective design, informed consent was waived. Patients with inaccessible medical records, pregnant patients, and those injured due to other forensic causes (suicide attempts, drug intoxication, occupational accidents, or traffic-related accidents) were excluded.

Patient data were extracted from the hospital's electronic health record system. Cases were identified using a combination of ICD-10 codes (including W50, W51, W26, Z04.5, and Y28, where applicable), physician documentation in emergency department records, and forensic case classification within the electronic health record system. Recorded variables included demographic characteristics (age, gender), time of presentation (hour, day, and month), mechanism of injury, type of injury, consultation requirement, need for surgical intervention, hospital admission, and 24-hour mortality. A life-threatening condition was defined as any clinical situation requiring immediate intervention to prevent death, including severe hemorrhage, intracranial injury, or hemodynamic instability. Emergency surgical intervention was defined as any operative procedure performed within the first 24 hours following admission for the injury. Patients were categorized into three groups according to the time of presentation: 00:00-07:59, 08:00-15:59, and 16:00-23:59. Assault mechanisms were classified as physical assault (assault by bodily force), stab/cut injuries, firearm injuries, sexual assault, chemical irritant exposure (pepper spray), and burn injury. Injury types were categorized as soft tissue trauma, maxillofacial trauma, extremity fractures, complex wounds, thoracic trauma, abdominal trauma, intracranial trauma, and vertebral trauma. Meteorological data for the study location, including daily mean temperature, wind speed, and precipitation status, were obtained from publicly available aggregated datasets (WeatherSpark), which compile data from official meteorological stations, and entered into the study database. Precipitation was categorized as present or absent based on daily records.

Statistical Analysis

Statistical analyses were performed using Jamovi software (version 2.5.7). Categorical variables were summarized as frequencies and percentages, while continuous variables were presented as medians and interquartile ranges (25^{th}-75^{th} percentiles). Data distribution was assessed using the Kolmogorov-Smirnov test. The Mann-Whitney U test was used to compare continuous variables between groups. For categorical variables, the chi-square test was employed. Bonferroni correction was applied for multiple comparisons, and a $p\text{-value}<0.05$ was considered statistically significant. Monthly case counts were normalized by calculating the mean daily case count to account for differences in the number of days per month.

Results

A total of 4,042 patients with assault-related injuries who presented to the emergency department over a one-year period were included in the study. Of these, 64.5% were male (n=2.606), and the median age was 32 years (interquartile range 24-42). Regarding the time of presentation, the largest proportion of patients presented between 16:00 and 23:59 (n=1.964; 48.6%). Presentations were most frequent on Sundays (n=652; 16.1%) and during the summer season (n=1.271; 31.4%). Monthly data

were presented as mean daily case counts (cases/day) to avoid bias due to differences in the number of days across months. As illustrated in Figure 1, the highest presentation rates were observed during the summer months, peaking in June and remaining elevated through July and August. During the study period, the median daily temperature was 15 °C (range: -6 to 35 °C). The relationship between temperature variation and visit frequency is illustrated in Figure 2, while Figure 3 demonstrates the association between wind speed and the number of visits. Precipitation did not demonstrate a statistically significant association with presentation frequency. Baseline characteristics of the study population are summarized in Table 1.

Among patients presenting after assault-related incidents, 102 patients (2.5%) were identified as having a life-threatening condition, and 126 patients (3.1%) needed emergency surgical intervention. Evaluation of emergency department outcomes showed that 3,817 patients (94.2%) were discharged; 134 (3.3%) were admitted to hospital wards; 60 (1.5%) were admitted to the intensive care unit; and 31 (0.8%) were referred to another medical center. Assessment of 24-hour mortality revealed that 9 patients (0.2%) died.

When assault types were analyzed, physical assault was the most common mechanism, identified in 3,568 patients (88.3%). The most frequently observed injury type was soft tissue injury (78.9%). A total of 1,031 patients (25.5%) required a consultation. Injury types and consultation data are presented in Table 2.

Pairwise comparisons were performed with respect to hospital admission, presence of life-threatening conditions, and need for surgical intervention (Table 3). All clinical outcomes were significantly more frequent among male patients than among female patients ($p<0.001$). In terms of injury mechanisms, stab/cut injuries and firearm injuries were significantly more frequent among patients who required hospitalization, had life-threatening conditions, or needed surgical intervention compared with those who did not ($p<0.001$). Post-hoc analyses demonstrated that, for hospitalization and emergency surgery, all pairwise comparisons between trauma mechanisms were statistically significant after Bonferroni correction (all adjusted p-values <0.001). For life-threatening injuries, significant differences were observed between physical assault and both stab-cut and firearm injuries, whereas no significant difference was detected between stab-cut and firearm injuries.

Regarding the time of presentation, patients presenting during nighttime hours (00:00-07:59) exhibited higher rates of all three clinical outcomes, whereas patients presenting during daytime hours (08:00-15:59) exhibited lower rates; this difference was statistically significant for hospital admission ($p=0.011$) and the presence of life-threatening conditions ($p=0.026$). Post-hoc analyses revealed that statistically significant differences were observed only between the 00:00-07:59 and 08:00-15:59 intervals for both hospital admission and presence of life-threatening conditions (adjusted $p=0.018$ and $p=0.024$, respectively). No significant pairwise differences were detected between the other time intervals for either outcome.

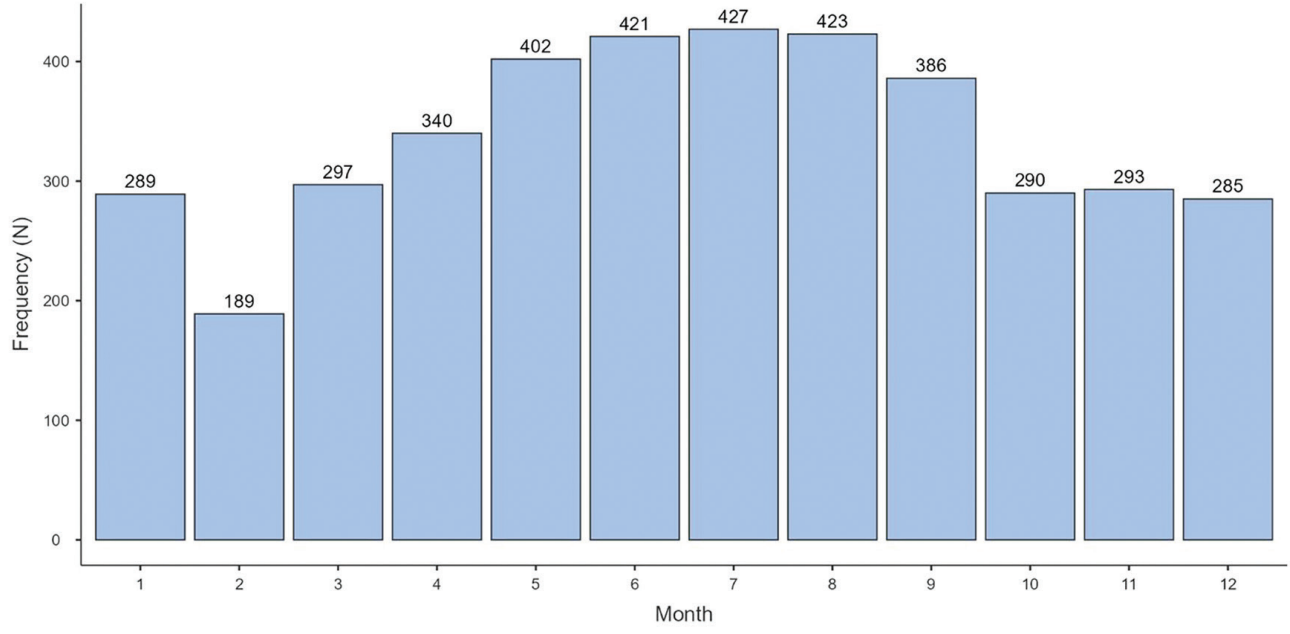

Figure 1. Monthly distribution of assault-related emergency department presentations expressed as mean daily case counts (cases/day)

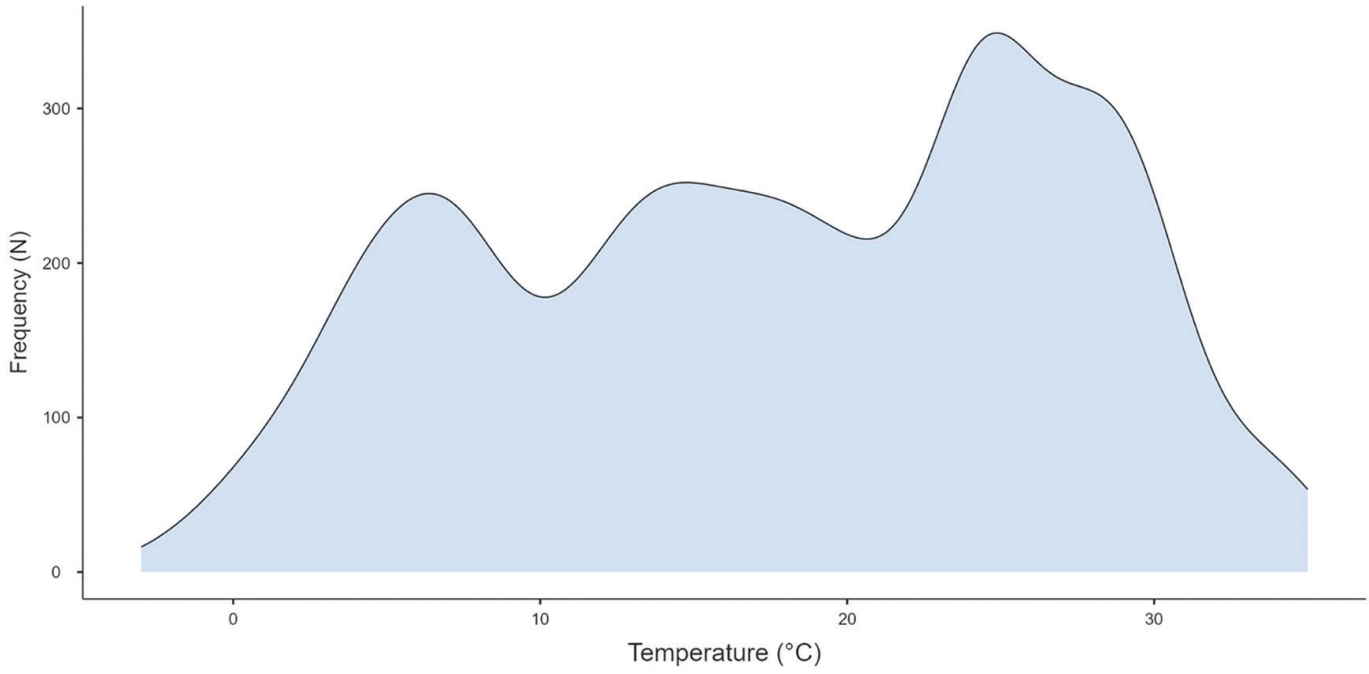

Figure 2. Frequency of assault-related injury presentations by the mean daily temperature on the day of presentation (°C). The plot is a histogram or area-style display; no smoothing was applied (raw counts per temperature bin)

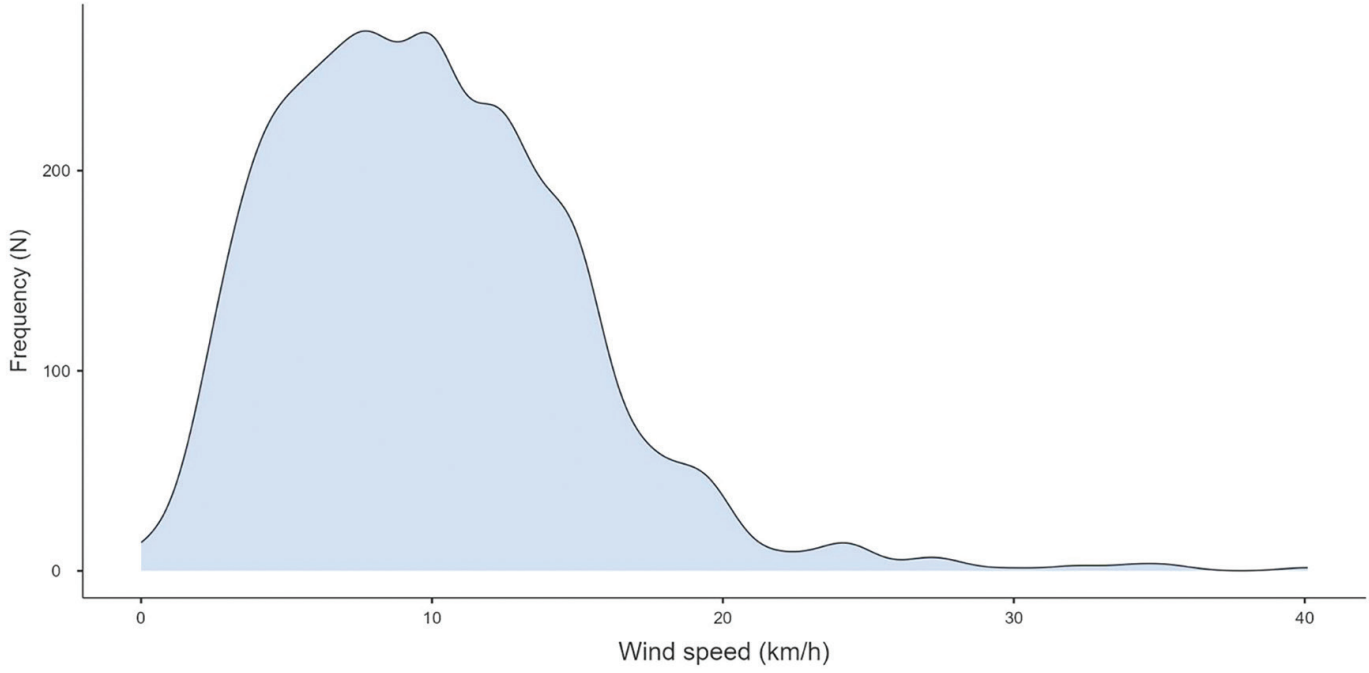

Figure 3. Frequency of assault-related injury presentations by the mean daily wind speed on the day of presentation (km/h). The plot is a histogram/area display; no smoothing was applied (raw counts by wind speed bins)

Table 1. Demographic characteristics, clinical outcomes, and temporal distribution of patients presenting with assault-related injuries	
	Total n= 4042
Male, gender, n (%)	2606 (64.5)
Age, median (IQR 25-75)	32 (24-42)
Temperature at presentation (°C), median (IQR 25-75)	15 (7-22)
Wind speed (km/h), median (IQR 25-75)	9.5 (6.0-13.0)
Patients with life-threatening injury, n (%)	102 (2.5)
Patients requiring surgery, n (%)	126 (3.1)
Emergency department outcome, n (%)	
Discharged	3817 (94.2)
Admitted to ward	134 (3.3)
Admitted to intensive care unit	60 (1.5)
Transferred to another center	31 (0.8)
24-hour mortality, n (%)	9 (0.2)
Time of presentation, n (%)	
00:00-08:00	1018 (25.2)
08:00-16:00	1060 (26.2)
16:00-00:00	1964 (48.6)
Day of presentation, n (%)	
Monday	635 (15.7)
Tuesday	537 (13.3)
Wednesday	626 (15.5)
Thursday	546 (13.5)
Friday	500 (12.4)
Saturday	546 (13.5)
Sunday	652 (16.1)
Season of presentation, n (%)	
Winter	763 (18.9)
Spring	1039 (25.7)
Summer	1271 (31.4)
Autumn	969 (24.0)
Precipitation status, n (%)	
Snow	123 (3.0)
Rain	1197 (29.6)
No precipitation	2722 (67.3)
IQR: Interquartile range	

Table 2. Distribution of injury mechanisms, injury types, and consultation requirements	
	Total n (%) n= 4042
Mechanism of injury	
Physical assault	3568 (88.3)
Stab/cut injury	331 (8.2)
Firearm injury	121 (3)
Pepper spray assault	10 (0.2)
Burn injury	8 (0.2)
Sexual assault	4 (0.1)
Type of injury	
Soft tissue injury	3190 (78.9)
Maxillofacial trauma	416 (10.3)
Extremity fracture	177 (4.4)
Complicated wound	137 (3.4)
Thoracic trauma	68 (1.7)
Abdominal trauma	49 (1.2)
Intracranial injury	34 (0.8)
Vertebral trauma	20 (0.5)
Consultation status	
Patients requiring consultation	1031 (25.5)
Otorhinolaryngology	413 (10.2)
Orthopedics and traumatology	278 (6.9)
Plastic and reconstructive surgery	228 (5.6)
Ophthalmology	227 (5.6)
Neurosurgery	75 (1.9)
General surgery	63 (1.6)
Cardiovascular surgery	57 (1.4)
Obstetrics and gynecology	15 (0.4)
Urology	15 (0.4)
Thoracic surgery	13 (0.3)
Other	8 (0.2)

Table 3. Comparison of demographic characteristics, injury mechanisms, and environmental factors according to clinical outcomes

Variables	Hospital admission		p	Life-threatening condition		p	Need for surgery		p
	Present (n=225)	Absent (n=3817)		Present (n=102)	Absent (n=3940)		Present (n=126)	Absent (n=3916)	
Age, years, median (IQR)	29 (23-41)	32 (24-42)	0.097[1]	28 (23-44)	32 (24-42)	0.198[1]	29 (23-41)	32 (24-42)	0.128[1]
Male, n (%)	200 (88.9)	2406 (63)	**<0.001[2]**	93 (91,2)	2513 (63.8)	**<0.001[2]**	113 (89.7)	2493 (63.7)	**<0.001[2]**
Mechanism of injury, n (%)									
Physical assault	81 (2.3)	3487 (97.7)	**<0.001[2]**	32 (0.9)	3536 (99.1)	**<0.001[2]**	41 (1.1)	3527 (98.9)	**<0.001[2]**
Stab/cut injury	77 (23.3)	254 (76.7)		45 (13.6)	286 (86.4)		46 (13.9)	285 (86.1)	
Firearm injury	66 (54.5)	55 (45.5)		24 (19.8)	97 (80.2)		37 (30.6)	84 (69.4)	

Table 3. Continued

Variables	Hospital admission		P	Life-threatening condition		P	Need for surgery		P
	Present (n=225)	Absent (n=3817)		Present (n=102)	Absent (n=3940)		Present (n=126)	Absent (n=3916)	
Time-of-day interval, n (%)									
00:00–07:59	75 (33.3)	943 (24.7)		36 (35.3)	982 (24.9)		43 (34.1)	975 (24.9)	
08:00–15:59	48 (21.3)	1012 (26.5)	**0.011**[2]	18 (17.6)	1042 (26.4)	**0.026**[2]	29 (23)	1031 (26.3)	0.063[2]
16:00–23:59	102 (45.4)	1862 (48.8)		48 (47.1)	1916 (48.7)		54 (42.9)	1910 (48.8)	
Precipitation, present, n (%)	72 (32.0)	1248 (32.7)	0.829[2]	34 (33.3)	1286 (32.6)	0.883[2]	39 (31.0)	1281 (32.7)	0.678[2]
Wind speed (km/h), median (IQR)	9.3 (6.0-12.5)	9.5 (6.0-13.0)	0.499[1]	10.0 (6.5-13.3)	9.5 (6.0-13.0)	0.385[1]	9.0 (5.9-12.0)	9.5 (6.0-13.0)	0.171[1]
Temperature (°C), median (IQR)	15 (7-21)	15 (7-22)	0.993[1]	17 (10-22)	15 (7-22)	0.098[1]	13 (5-21)	15 (7-22)	0.202[1]

IQR: Interquartile range. [1]Mann Whitney U test, [2]Chi-square test

Discussion

This study describes the profile of 4,042 patients who presented to the emergency department with assault-related injuries over a one-year period. Nearly half of all presentations occurred during the evening hours (16:00-23:59), with a noticeable increase on Sundays and during the summer season. Regarding injury mechanism, physical assault was by far the most common cause (88.3%), and soft tissue injuries predominated among injury types (78.9%). Taken together, our findings suggest a temporal clustering of assault-related presentations and a temperature-related pattern. However, these results do not establish a clear independent association. Violence remains a growing public health concern worldwide, including in our country. In particular, the increasing frequency of violence in developing and upper-middle-income countries contributes substantially to emergency department crowding and places emergency physicians in a critical position for the initial management of these patients (10). Emergency departments serve as the primary points of contact for victims of assault, where rapid assessment, acute management, and decisions regarding further care are initiated. Therefore, examining the clinical characteristics of assault-related injuries, injury mechanisms, and their relationship with environmental factors may provide valuable insights for healthcare planning and resource allocation.

The median age of patients presenting with assault-related injuries was 32 years; 64.5% were male. These findings are consistent with previous studies evaluating forensic and assault-related cases, which have similarly reported a predominance of young male victims (11,12). The overrepresentation of males and younger age groups among victims of violence is a well-established finding in the literature.

Temporal analyses in our cohort demonstrated that assault-related presentations were most frequent during the summer months (31.4%) and on Sundays (16.1%). Atherton et al. (13) reported a higher volume of trauma-related emergency department visits during summer periods. Similarly, Lemon et al. (7) observed that assault cases were more likely to present during weekends, and Khurana et al. (8) reported a significant increase in violent incidents during holiday periods. This temporal increase may be explained by increased social interaction, outdoor activities, and population mobility on weekends and during warmer seasons, which may collectively increase the risk of interpersonal conflict.

In our study, the most common mechanisms of assault-related injuries were physical assaults (88.3%), followed by stab or cut injuries (8.2%) and firearm injuries (3.0%). Similarly, in the study by Demircan et al. (12), which evaluated all forensic cases, physical assault was reported as the most frequent mechanism among violence-related injuries, followed by stab/cut injuries and gunshot injuries. Regarding injury type, soft tissue injury was the most common finding in our cohort (78.9%). Korkmaz et al. (14) also reported soft tissue injuries as the most frequent injury type among forensic cases in their study.

Several studies in the literature have examined the relationship between trauma and assault-related events and weather conditions (15,16). Ho et al. (11) reported a positive association between increasing temperature and trauma-related emergency department presentations. Michel et al. (17) similarly demonstrated that increases in daily maximum temperature were

associated with higher rates of violent crime. Livingston et al. (18) showed that pediatric trauma-related orthopedic consultations and emergency department visits increased by 1% for each 1 °C rise in temperature, while increasing precipitation was associated with a decrease in presentations. The capital city where this study was conducted has a climate characterized by four distinct seasons. In our cohort, the highest number of assault-related presentations was observed when daily mean temperatures ranged between 20 °C and 30 °C. It has been suggested that higher temperatures may increase outdoor activities and social interactions, thereby expanding opportunities for violent encounters; our findings are consistent with this interpretation. However, this observation should be interpreted as a descriptive pattern rather than a causal relationship. In contrast, wind speed did not demonstrate a linear relationship with the number of assault-related presentations in our study. Similarly, previous studies have not identified a significant association between wind speed and violence- or trauma-related emergency department visits (17,19,20). Overall, meteorological variables may be associated with variations in presentation frequency; however, their independent effect could not be established in this study.

When injury mechanisms were evaluated in relation to clinical severity, the proportion of life-threatening conditions was low among physical assault cases but was substantially higher among firearm and stab/cut injuries. In our study, life-threatening conditions were identified in 0.9% of physical assault cases, 13.6% of stab/cut injuries, and 19.8% of firearm injuries. Şenavcı and Erel (21) reported mortality rates of 0.04% for physical assault, 33.1% for sharp-object injuries, and 29.1% for firearm-related injuries, while Karasu et al. (22) reported rates of 5.5%, 48.4%, and 33.7%, respectively. These findings indicate that morbidity and mortality vary markedly according to the mechanism of violence, with penetrative injuries carrying substantially higher risk.

In our cohort, 3.1% of patients presenting with assault-related injuries required emergency surgical intervention. When cases were stratified by injury mechanism, emergency surgery was performed in 1.1% of physical assault cases, 13.9% of stab/cut injuries, and 30.6% of firearm injuries. Hazra et al. (23), in their study of assault patients in India, reported an emergency surgical intervention rate of 15.7%. Although the overall number of assault-related presentations in our study was high, the relatively low rates of hospital admission and surgical intervention suggest that a substantial proportion of patients presented with less severe injuries. This interpretation is further supported by the predominance of isolated soft tissue injuries in our cohort.

The findings of this study support strengthening trauma care capacity during evening and night shifts, including availability of experienced staff, timely access to surgical and imaging services, and adequate security measures. Planned reinforcement of staffing and resource allocation may be particularly beneficial on Sundays and during the summer. From a public health and municipal perspective, preventive field interventions during weekends, especially on warmer days, may be considered. Overall, our results indicate that timing, injury mechanisms, and seasonal factors should be taken into account in emergency department service planning.

Study Limitations

This study has several limitations. First, due to its single-center, retrospective design, the generalizability of the findings is limited, and causal inferences cannot be made. Second, the primary outcome measure was the number of emergency department presentations, which does not reflect population-based incidence and does not capture violent events that did not result in healthcare utilization. In addition, the analysis was primarily descriptive, and no multivariable adjustment was performed for temporal variables such as time of day, day of the week, and season. Third, meteorological data were derived from city-level averages and may not accurately reflect individual exposure, microclimatic variations, or potential discrepancies between the time and location of injury and the time of hospital presentation. Fourth, the study period was limited to one year; therefore, interannual climate variability and long-term trends could not be assessed. Furthermore, the observed association with temperature may reflect increased social interaction rather than a direct environmental effect. For these reasons, the findings should be interpreted as having value for planning and forecasting, and confirmation through multicenter studies with longer follow-up and enriched variable sets is warranted.

Conclusion

In conclusion, this study characterizes the clinical features, injury mechanisms, and temporal distribution of assault-related emergency department presentations in an upper-middle-income urban setting. An increase in presentations was observed within specific temperature ranges; however, this finding should be interpreted as a descriptive pattern rather than a confirmed independent association.

These findings may contribute to emergency department resource planning and to the development of preventive strategies. Further studies using multivariable analytical approaches are needed to clarify the relationship between environmental factors and assault-related injuries.

Ethics

Ethics Committee Approval: This study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of University of Health Sciences Türkiye, Ankara Training and Research (approval no: E-24-109, date: 10. 05.2024).

Informed Consent: Due to the retrospective design, informed consent was waived.

Data Availability: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Footnotes

Authorship Contributions

Concept: A.E.G., S.C.Y., S.A., C.U.T., Design: A.E.G., S.C.Y., C.U.T., Y.K.G., Data Collection or Processing: A.E.G., S.A., C.U.T., Analysis or Interpretation: S.C.Y., S.A., Literature Search: A.E.G., Writing: A.E.G., S.C.Y., Y.K.G.

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

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