

High Burden of Non-Urgent Emergency Medical Service Utilization: A Three-Year Retrospective Study from an Industrial Region in Saudi Arabia

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High Burden of Non-Urgent Emergency Medical Service Utilization: A Three-Year Retrospective Study from an Industrial Region in Saudi Arabia

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Abstract

Background:

Industrial cities present unique operational challenges for Emergency Medical Services (EMS) due to concentrated occupational hazards and heterogeneous population demands. However, detailed EMS demand data from large industrial regions in the Middle East remain limited. This study examined ambulance call characteristics, temporal trends, and determinants of call severity in Al Jubail Industrial City, Saudi Arabia.

Methods:

A retrospective observational study was conducted using EMS dispatch data from Royal Commission Hospital between January 2022 and December 2024. All ambulance dispatches were included. Descriptive analyses characterized demographic, geographic, and operational features. Poisson regression evaluated temporal trends in call volume. Ordinal logistic regression identified predictors of increasing call severity, and multivariable logistic regression examined predictors of trauma-related versus medical calls. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were reported.

Results:

A total of 13,519 ambulance calls were analyzed. Most calls originated from community areas (90.5%), while industrial zones accounted for 9.5%. Industrial-area calls were predominantly male (92.6%), adult (99.1%), emergency dispatches (91.4%), and trauma-related (50.4% vs 14.7% in community areas; $p < 0.001$). Administrative and transfer-related complaints comprised 29.7% of all calls, largely within community settings. Call volume declined modestly over the three-year period (IRR 0.93 per year; $p < 0.001$) with limited seasonal variation. Increasing call severity was independently associated with trauma, medical emergencies, cardiovascular/metabolic complaints, infant and older adult age groups, and calls originating outside Jubail city (OR 4.67). Industrial location, male sex, and pediatric age group independently predicted trauma-related calls.

Conclusion:

EMS demand in Al Jubail demonstrates a dual operational profile: high-volume community demand driven by non-urgent and administrative calls, and lower-volume but high-acuity trauma demand from industrial zones. Call severity is primarily determined by clinical and geographic factors rather than temporal variation. These findings support context-specific EMS planning and trauma-focused readiness in industrial environments.

Introduction

Emergency Medical Services (EMS) play a critical role in healthcare systems worldwide, serving as the first point of contact for patients experiencing acute medical emergencies and traumatic incidents [1]. Timely and effective prehospital care delivered by EMS professionals is essential for reducing morbidity and mortality associated with time-sensitive conditions [2]. In Saudi Arabia, the development of EMS as a core component of healthcare delivery and public safety has been well documented, reflecting its growing importance to population health and emergency preparedness [3]. Increased public awareness and utilization of EMS have contributed to rising call volumes, indicating greater reliance on these services during emergency situations.

Industrial regions present distinct challenges for EMS systems due to their unique environmental, occupational, and demographic characteristics, which are often associated with higher emergency call burdens. Studies conducted in industrial settings have demonstrated increased ambulance demand, particularly during periods of environmental stress. For example, research from Toronto, Canada, reported significant increases in ambulance calls in industrial areas during periods of extreme heat, attributed to heat-sensitive occupations and physically demanding working conditions [4]. Similarly, occupational emergencies have been shown to frequently require advanced life support resources, underscoring the importance of understanding the nature and severity of calls originating from industrial environments [5].

Al Jubail Industrial City, one of the largest industrial complexes globally, represents a distinctive EMS context. Despite its advanced healthcare infrastructure, the high concentration of petrochemical plants, manufacturing facilities, and industrial workers may pose specific health and safety risks for both residents and employees. These factors are

likely to influence the volume, type, and severity of emergency calls within the city, leading to patterns that differ from those observed in predominantly residential settings [6,7].

Analysis of ambulance call data extends beyond describing emergency characteristics; it provides critical insight into EMS demand patterns, exposure risks, and resource requirements, supporting evidence-based planning and decision-making [8]. Previous research has highlighted the operational and financial impact of non-urgent ambulance utilization, demonstrating how such calls can place considerable strain on healthcare facilities, including Royal Commission Hospital [9]. EMS agencies face ongoing challenges in optimizing ambulance deployment, maintaining adequate geographic coverage, and minimizing response times for high-priority calls [8]. To address these challenges, dispatch data are routinely analyzed to guide workforce planning, ambulance distribution, and future resource allocation [10]. However, such strategies are difficult to implement effectively in large industrial cities like Al Jubail due to the limited availability of detailed, sector-specific EMS data, hindering accurate forecasting and preparedness.

Given these gaps, there remains a global need for comprehensive evaluation of EMS call patterns in industrial regions. This study aims to examine the prevalence, characteristics, and determinants of ambulance calls in Al Jubail Industrial City using dispatch data from Royal Commission Hospital. By analyzing demographic, geographic, temporal, and operational factors, this study seeks to provide evidence that can inform EMS planning, improve response efficiency, and support data-driven decision-making in complex industrial settings.

The primary aim of this study was to investigate the prevalence, characteristics, and patterns of ambulance calls within Al Jubail Industrial City, Saudi Arabia, using EMS dispatch data to support evidence-based service planning and optimization.

Methodology

This retrospective observational study examined ambulance call characteristics, temporal patterns, and determinants within Al Jubail Industrial City, Saudi Arabia, between January 2022 and December 2024. The study was conducted within the Emergency Medical Services (EMS) Department at Royal Commission Hospital, the primary provider of prehospital care for both community residential areas and large industrial zones within the city.

All ambulance calls recorded in the EMS dispatch system during the study period were included, with each record representing a single dispatch event. Dispatch data were entered prospectively by trained dispatchers using a secure internal interface and extracted from the EMS database for analysis. Variables included patient demographics, geographic area, dispatch type, call type, chief complaint category, communication code, and temporal indicators.

Chief complaint categories were retained in their original classification due to their central importance to the study objectives. Communication codes were recoded into clinically relevant severity categories, while purely operational codes were excluded from clinical and multivariable analyses but retained for descriptive reporting.

Statistical analysis followed a structured progression from descriptive summaries to inferential and multivariable modeling. Initial univariate and bivariate analyses were used to characterize EMS demand and examine crude associations. Subsequently, advanced regression models were applied to identify independent predictors of increasing call severity, trauma versus medical dispatches, and temporal variation in EMS demand. Results were reported using odds ratios with 95% confidence intervals and p-values, with statistical significance defined as $p < 0.05$.

Ethical approval was obtained from the relevant institutional review board. All data were anonymized prior to analysis, and the study was conducted in accordance with institutional and national ethical guidelines for research involving human subjects and data protection.

The authors used an artificial intelligence tool (ChatGPT, OpenAI) to assist with language editing and improving clarity of the manuscript [11]. All content was reviewed and verified by the authors, who take full responsibility for the final version.

Results

3.1 Descriptive Overview

A total of 13,519 ambulance calls were recorded between 2022 and 2024, predominantly involving adult patients and medical-related complaints (Table 1). The study population was predominantly adult, with a median age of 49 years (IQR 28–70). Adults aged 15–50 years and those older than 50 years together accounted for over 84% of ambulance calls, while infants and children represented less than 5% of cases. Male patients were slightly more represented than females.

Table 1: Demographic and Patient Characteristics

Category	Level	N= 13,519
	Age, years, Median [IQR]	49.00 [28.00, 70.00]
Age Categories, N (%)	Infant (0 - 12 months)	55 (0.4)
	Child (1 - 14 years)	572 (4.2)
	Adult (15 - 50 years)	5566 (41.2)
	Adult (> 50 years)	5817 (43.0)
Age groups, N (%)	Adult	11457 (84.7)
	Pediatric	554 (4.1)
Gender, N (%)	Male	6776 (50.1)
	Female	5235 (38.7)

Abbreviations: IQR: Interquartile range, N: Number.

Call and dispatch characteristics are presented in Table 2. Most calls originated from community areas, particularly Deffi (35.5%) and Fanateer (25.4%), whereas calls from industrial zones and areas outside Jubail accounted for smaller proportions. Emergency dispatches predominated, with urgent and emergent communication codes comprising a substantial share of calls. Medical complaints were the most common call type, followed by trauma-related incidents. Administrative and transfer-related complaints accounted for

nearly one-third of chief complaints, highlighting a significant non-clinical demand on EMS resources.

Table 2: Call and Dispatch Characteristics

Category	Level	N= 13,519
Area Category, N (%)	Community	12234 (90.5)
	Industrial	1285 (9.5)
Area, N (%)	ABU HADRIYAH RD	18 (0.1)
	AR-REGGAH	6 (<0.1)
	DEFFI	4803 (35.5)
	FANATEER	3428 (25.4)
	HUWAYLAT	907 (6.7)
	INDUSTRIAL AREA	1030 (7.6)
	JALMUDAH	1973 (14.6)
	JUBAIL TOWN	58 (0.4)
	MUTRAFIYAH	699 (5.2)
	OUT OF JUBAIL AREA	359 (2.7)
	RAS AL-KHAIR	237 (1.8)
	RUNNING RACE	1 (0.0)
	CODE 0- DEAD	90 (0.7)
	CODE 1- RESUSCITATION	80 (0.6)
	CODE 10- CANCEL	833 (6.2)
	CODE 11- RED CRESCENT	132 (1.0)
Communication Code, N (%)	CODE 12- STANDBY/ BACKUP	419 (3.1)
	CODE 2- EMERGENT	1163 (8.6)
	CODE 3- URGENT	3434 (25.4)
	CODE 4- LESS URGENT	1555 (11.5)
	CODE 5- NON-URGENT	2710 (20.0)
	CODE 6- FIRE INCIDENT	113 (0.8)
	CODE 8- REFUSE TRANSFER	2975 (22.0)

	CODE 9- TRAINING DRILL	15 (0.1)
Type of Dispatch, N (%)	Disaster	16 (0.1)
	Emergency	8828 (65.3)
	Non-Emergency	4516 (33.4)
	Transfer	159 (1.2)
Type of Call, N (%)	CLINICAL APPOINTMENT	707 (5.2)
	DIALYSIS PATIENTS	998 (7.4)
	DISASTER	18 (0.1)
	DISCHARGE HOME	1903 (14.1)
	LESS URGANT TRANSFER	46 (0.3)
	LIFE SAVING TRANSFER	132 (1.0)
	MEDICAL	5966 (44.1)
	RED CRESEANT	132 (1.0)
	STANDBY	565 (4.2)
	TRAUMA	2900 (21.5)
	URGENT TRANSFER	152 (1.1)
Chief Complaint (%)	Trauma / Injury	2449 (18.1)
	Cardiovascular / Metabolic	606 (4.5)
	Neurological	766 (5.7)
	Respiratory	461 (3.4)
	Abdominal / Obstetric	434 (3.2)
	Psychiatric	251 (1.9)
	Allergy / Toxicology	92 (0.7)
	ENT / Ophthalmic	94 (0.7)
	Musculoskeletal	151 (1.1)
	Administrative / Transfer	4010 (29.7)
	Non-Medical / Operational	1382 (10.2)
	Other / Unclassified	2823 (20.9)

Temporal trends are shown in Table 3. Annual call volume declined modestly over the three-year period. Seasonal distribution was relatively even, with slightly higher call volumes observed during winter months. Monthly call volumes were broadly consistent, with no pronounced seasonal spikes, although minor increases were observed during late spring and early winter months.

Table 3: Temporal Distribution of Calls

Category	Level	N= 13,519
Year, N (%)	2022	4774 (35.3)
	2023	4634 (34.3)
	2024	4111 (30.4)
Season	Winter	3593 (26.6)
	Spring	3384 (25)
	Summer	3175 (23.5)
	Fall	3367 (24.9)
Month, N (%)	April	1005 (7.4)
	August	1112 (8.2)
	December	1266 (9.4)
	February	1115 (8.2)
	January	1212 (9.0)
	July	986 (7.3)
	June	1077 (8.0)
	March	1090 (8.1)
	May	1289 (9.5)
	November	1120 (8.3)
	October	1144 (8.5)
	September	1103 (8.2)
Year – Month, N (%)	2022-01	401 (3.0)
	2022-02	401 (3.0)
	2022-03	388 (2.9)

2022-04	362 (2.7)
2022-05	464 (3.4)
2022-06	390 (2.9)
2022-07	385 (2.8)
2022-08	366 (2.7)
2022-09	376 (2.8)
2022-10	432 (3.2)
2022-11	426 (3.2)
2022-12	383 (2.8)
2023-01	420 (3.1)
2023-02	359 (2.7)
2023-03	353 (2.6)
2023-04	328 (2.4)
2023-05	428 (3.2)
2023-06	372 (2.8)
2023-07	323 (2.4)
2023-08	438 (3.2)
2023-09	428 (3.2)
2023-10	429 (3.2)
2023-11	379 (2.8)
2023-12	377 (2.8)
2024-01	391 (2.9)
2024-02	355 (2.6)
2024-03	349 (2.6)
2024-04	315 (2.3)
2024-05	397 (2.9)
2024-06	315 (2.3)
2024-07	278 (2.1)
2024-08	308 (2.3)
2024-09	299 (2.2)

2024-10	283 (2.1)
2024-11	315 (2.3)
2024-12	506 (3.7)

3.2 Geographic Differences: Community vs Industrial Areas.

Marked differences in ambulance call characteristics were observed between community and industrial areas (Table 4, Figure 1). Calls originating from industrial areas were overwhelmingly associated with male patients (92.6% vs 52.9% in community areas, $p < 0.001$) and were almost exclusively adult cases (99.1% vs 95.0%, $p < 0.001$). Pediatric calls were rare in industrial settings.

Table 4: Comparison of Ambulance Call Characteristics Between Community and Industrial Area.

Variable	Level	Community	Industrial	p_value
Gender, N (%)	Male	5796 (52.9%)	980 (92.6%)	<0.001
	Female	5157 (47.1%)	78 (7.4%)	
Age Group, N (%)	Adult	10409 (95.0%)	1048 (99.1%)	<0.001
	Pediatric	544 (5.0%)	10 (0.9%)	
Type of Dispatch, N (%)	Disaster	7 (0.1%)	9 (0.7%)	<0.001
	Emergency	7654 (62.6%)	1174 (91.4%)	
	Non-Emergency	4415 (36.1%)	101 (7.9%)	
	Transfer	158 (1.3%)	1 (0.1%)	
Chief Complain, N (%)	Trauma / Injury	1802 (14.7%)	647 (50.4%)	<0.001
	Cardiovascular / Metabolic	546 (4.5%)	60 (4.7%)	
	Neurological	711 (5.8%)	55 (4.3%)	
	Respiratory	441 (3.6%)	20 (1.6%)	
	Abdominal / Obstetric	397 (3.2%)	37 (2.9%)	
	Psychiatric	236 (1.9%)	15 (1.2%)	
	Allergy / Toxicology	85 (0.7%)	7 (0.5%)	

ENT / Ophthalmic	81 (0.7%)	13 (1%)
Musculoskeletal	138 (1.1%)	13 (1%)
Administrative / Transfer	4003 (32.7%)	7 (0.5%)
Non-Medical / Operational	1206 (9.9%)	176 (13.7%)
Other / Unclassified	2588 (21.2%)	235 (18.3%)

Abbreviations: N, number of cases. Percentages are calculated within each area category. $p < 0.05$ is considered statistically significant.

Industrial areas demonstrated a pronounced dominance of emergency dispatches, with 91.4% of calls classified as emergency compared with 62.6% in community areas ($p < 0.001$). In contrast, non-emergency dispatches were substantially more common in community areas (36.1% vs 7.9%). Disaster-related dispatches, although infrequent overall, were proportionally higher in industrial zones.

A substantial trauma burden was evident in industrial areas, where trauma or injury accounted for 50.4% of chief complaints, compared with 14.7% in community areas ($p < 0.001$). Conversely, administrative and transfer-related complaints were almost exclusively concentrated in community areas (32.7% vs 0.5%), reflecting differing patterns of EMS utilization. Non-medical and operational complaints were also more frequent in industrial areas (13.7% vs 9.9%), whereas cardiovascular, neurological, and respiratory complaints were similarly distributed across both settings.

Overall, these findings demonstrate that industrial areas generate a smaller proportion of total calls but a disproportionately higher share of high-acuity, trauma-related, and emergency dispatches, while community areas account for the majority of EMS workload driven by medical, administrative, and non-urgent requests. The spatial distribution of calls by area is illustrated in Figure 3.

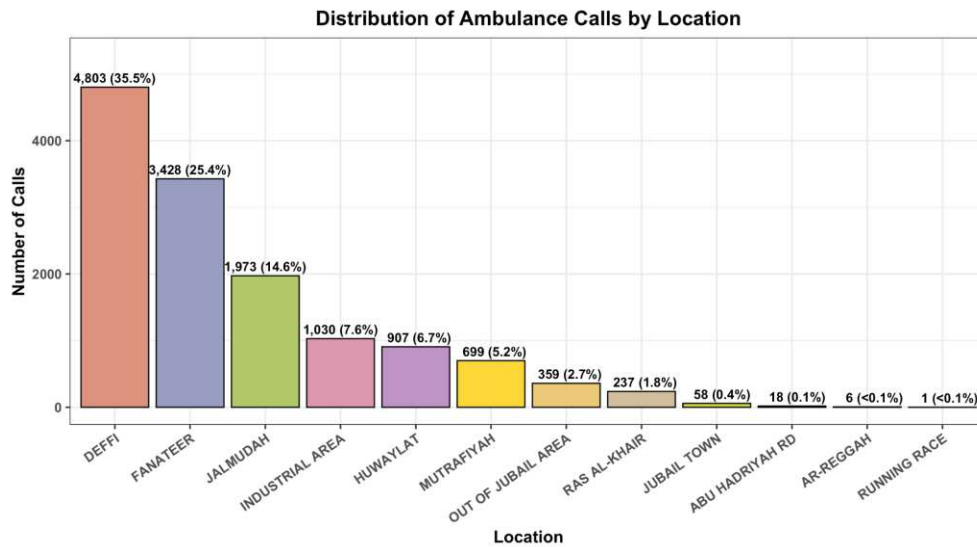


Figure 1: Distribution of Ambulance Calls by Area.

3.3 Temporal Patterns in EMS Demand

Temporal analysis demonstrated clear seasonal variation and a gradual decline in overall ambulance call volume across the study period. Monthly trends showed moderate fluctuations without abrupt spikes, indicating relatively stable EMS demand throughout the year (Figure 2).

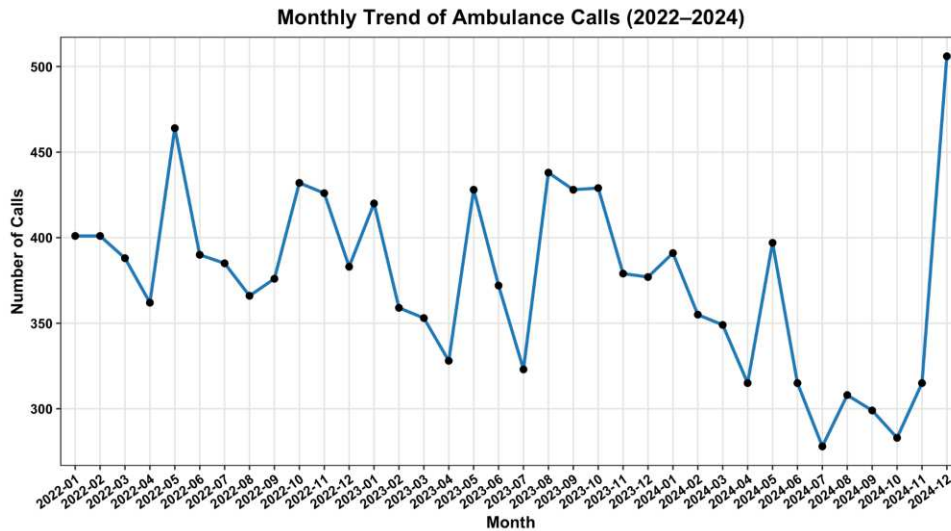


Figure 2: Monthly Trend of Ambulance Calls (2022–2024)

Seasonal distribution was broadly balanced, with slightly higher call volumes observed during winter months and lower volumes during summer, although differences between seasons were modest (Figure 3).

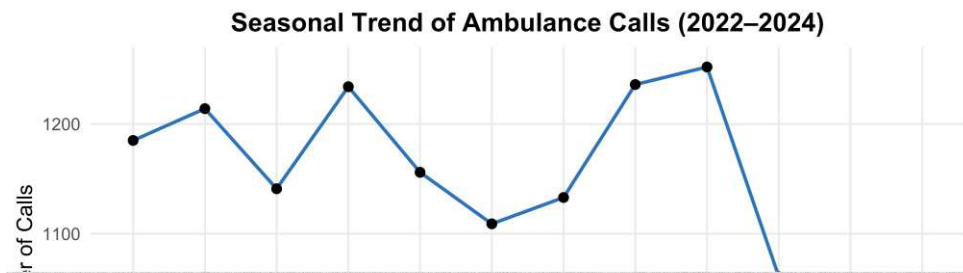


Figure 3: Seasonal trend of ambulance Calls (2022–2024).

Poisson regression analysis (Table 5) confirmed a significant year-over-year decline in ambulance call volume, with fewer calls recorded in 2023 and 2024 compared with the reference year. After adjustment for temporal factors, call volume varied by month and

season, supporting the presence of predictable seasonal patterns rather than random fluctuation.

Table 5: Temporal Trends in Ambulance Call Volume: Poisson Regression Analysis (2022–2024)

Variable	Estimate	IRR	CI_Lower	CI_Upper	P value
February	-0.083	0.92	0.848	0.998	0.044
March	-0.106	0.899	0.829	0.976	0.011
April	-0.187	0.829	0.763	0.901	<0.001
May	0.062	1.064	0.983	1.15	0.124
June	-0.118	0.889	0.819	0.965	0.005
July	-0.206	0.814	0.748	0.885	<0.001
August	-0.086	0.917	0.846	0.995	0.038
September	-0.094	0.91	0.839	0.987	0.024
October	-0.058	0.944	0.871	1.023	0.161
November	-0.079	0.924	0.852	1.002	0.057
December	0.044	1.045	0.965	1.13	0.278
Year	-0.074	0.929	0.91	0.948	<0.001
Area.CategoryIndustrial	-2.253	0.105	0.099	0.111	<0.001

A positive estimate (IRR > 1) indicates an increase in the expected number of ambulance calls compared with the reference category, whereas a negative estimate (IRR < 1) indicates a decrease in call volume.

IRR = Incidence Rate Ratio; CI = Confidence Interval. January 2022, and the Community area served as the reference categories.

Statistical significance is denoted as $p < 0.05$, $p < 0.01$, $p < 0.001$.

Differences in call volume were also observed by area category, with industrial areas generating consistently lower overall call volumes compared with community areas, despite their higher acuity profile.

3.4 Factors Associated with Call Severity

An ordinal logistic regression model was used to identify factors associated with increasing ambulance call severity, classified as low, moderate, or high severity. Severity was derived by recoding communication codes into three ordered categories based on clinical urgency, while non-clinical and operational codes (e.g., training drills, standby-only activities) were excluded from the analysis to ensure clinical relevance. Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) are presented in Table 6.

Table 6: Factors Associated With Increasing Ambulance Call Severity: Ordinal Logistic Regression Analysis

Variable	Adjusted OR	95% CI	P value
Type of call			
Other	22.17	11.49–42.79	<0.001
Trauma	3.32	1.94–5.67	<0.001
Medical	2.86	1.77–4.60	<0.001
Urgent transfer	2.44	1.31–4.55	0.005
Dialysis patients	1.89	1.51–2.36	<0.001
Discharge home	0.09	0.07–0.12	<0.001
Location			
Out of Jubail area	4.67	2.72–8.04	<0.001
Ras Al-Khair	1.45	1.06–1.98	0.021
Industrial area	0.77	0.63–0.93	0.007
Fanateer	0.69	0.61–0.78	<0.001
Patient age group			
Infant (0–12 months)	2.80	1.40–5.63	0.004
Adult (>50 years)	2.67	2.37–2.99	<0.001
Child (1–14 years)	1.20	0.97–1.47	0.093
Chief complaint group			
Cardiovascular/metabolic	2.62	1.98–3.46	<0.001
Neurological	1.42	1.09–1.85	0.009
Trauma/injury	0.63	0.46–0.87	0.005
Psychiatric	0.52	0.38–0.73	<0.001
Administrative/transfer	0.32	0.20–0.52	<0.001
Sex			
Male	1.13	1.03–1.24	0.010
Season			
Summer	1.10	0.99–1.22	0.075
Spring	1.10	0.99–1.22	0.078

Type of call demonstrated the strongest association with call severity. Calls categorized as “other” were associated with markedly higher odds of increased severity (adjusted OR 22.17,

95% CI 11.49–42.79), followed by trauma-related calls (OR 3.32, 95% CI 1.94–5.67) and medical calls (OR 2.86, 95% CI 1.77–4.60). Urgent transfers and dialysis-related calls were also independently associated with higher severity. In contrast, discharge-home calls were strongly associated with lower severity (OR 0.09, 95% CI 0.07–0.12).

Significant geographic variation in call severity was observed. Calls originating outside Jubail city were associated with higher severity (OR 4.67, 95% CI 2.72–8.04), while calls from industrial areas and Fanateer district were associated with lower odds of severe classification. Ras Al-Khair showed a modest but significant increase in severity compared with the reference location.

Patient age was an important determinant of severity. Calls involving infants (0–12 months) and older adults (>50 years) were associated with significantly higher odds of increased severity, whereas severity among children aged 1–14 years did not differ significantly from the reference age group.

With respect to chief complaint categories, cardiovascular/metabolic and neurological complaints were independently associated with higher severity. In contrast, trauma/injury, psychiatric, and administrative/transfer complaints were associated with lower odds of severe classification after adjustment for other factors.

Male sex was associated with a small but statistically significant increase in severity (OR 1.13, 95% CI 1.03–1.24). Seasonal effects were modest and did not reach statistical significance, indicating that severity was driven primarily by clinical and geographic factors rather than seasonal variation.

3.5 Predictors of Trauma vs Medical Calls

A multivariable binary logistic regression analysis was conducted to identify independent predictors of trauma-related versus medical ambulance calls, adjusting for patient demographics, geographic area, and calendar year (Table 7). Infant patients (0–12 months), male sex, and community area served as reference categories.

Table 7: Independent Predictors of Trauma-Related Versus Medical Ambulance Calls.

Variable	Adjusted OR	95% CI	<i>p</i> -value
Patient age group			
Child (1–14 years)	3.10	1.36–7.08	0.007
Adult (15–50 years)	1.74	0.77–3.90	0.181
Adult (>50 years)	0.41	0.18–0.93	0.032
Sex			
Female	0.54	0.48–0.61	<0.001
Area category			
Industrial area	3.57	3.11–4.09	<0.001
Calendar year			
Year (per 1-year increase)	0.96	0.91–1.02	0.226

Reference categories were infant (0–12 months) for age group, male for sex, and community area for location. Odds ratios (ORs) greater than 1 indicate higher odds of a trauma-related call relative to a medical call, while ORs less than 1 indicate lower odds. Statistical significance was defined as $p < 0.05$.

Patient age was significantly associated with call type. Children aged 1–14 years had higher odds of trauma-related calls compared with infants (OR 3.10, 95% CI 1.36–7.08, $p = 0.007$). In contrast, older adults (>50 years) were significantly less likely to generate trauma calls relative to infants (OR 0.41, 95% CI 0.18–0.93, $p = 0.032$). Trauma odds among adults aged 15–50 years did not differ significantly from the reference group.

Female patients had substantially lower odds of trauma-related calls compared with males (OR 0.54, 95% CI 0.48–0.61, $p < 0.001$). Geographic location was a strong predictor, with calls originating from industrial areas demonstrating markedly higher odds of being trauma-related compared with community areas (OR 3.57, 95% CI 3.11–4.09, $p < 0.001$).

Calendar year was not independently associated with trauma versus medical call classification after adjustment, indicating relative temporal stability in the trauma-to-medical call ratio across the study period.

Discussion

This study provides one of the first comprehensive analyses of EMS demand within Al Jubail Industrial City, demonstrating a distinct dual demand profile. Although most ambulance calls originated from community areas, industrial zones generated a disproportionately high burden of trauma-related and high-acuity dispatches. These findings highlight the complex operational role of EMS in industrial cities, where services must simultaneously manage high-volume community demand and maintain readiness for severe occupational and industrial emergencies.

A key finding was the markedly higher proportion of trauma-related and emergency dispatches originating from industrial areas compared with community settings. More than half of industrial calls were trauma-related, and the vast majority were classified as emergency dispatches. This pattern aligns with prior research demonstrating that EMS demand and operational requirements vary substantially across geographic areas and call environments, while injury risks remain elevated in industrial and occupational settings due to hazardous infrastructure, heavy machinery, and physically demanding labor [11–14]. Although industrial zones contributed fewer overall calls, they imposed greater operational intensity per dispatch, reinforcing the need for trauma-capable and advanced life support (ALS)-equipped EMS deployment strategies in such settings.

The predominance of adult male patients in industrial-area calls reflects the demographic composition of the industrial workforce, consistent with global occupational injury trends [15]. The observed age-specific patterns, including higher odds of trauma-related calls among children compared with infants and lower odds among older adults, suggest differential exposure profiles and vulnerability across age groups. These findings highlight the importance of demographic-informed EMS planning, particularly in cities with concentrated working-age populations.

Multivariable ordinal regression analysis demonstrated that call severity was primarily influenced by call type, patient age, chief complaint, and geographic location, rather than temporal or seasonal factors. Trauma, medical emergencies, urgent transfers, and dialysis-related calls were significantly associated with higher severity, whereas discharge-home and administrative calls were associated with lower acuity. Notably, calls originating outside Jubail city were associated with increased severity. This finding is consistent with existing evidence indicating that patients in rural or peripheral regions often experience longer ambulance response and transport intervals, which are associated with delayed definitive care and poorer clinical outcomes [16,17,18]. Prolonged prehospital times in geographically distant areas have been linked to increased risk of adverse events and reduced survival, particularly in time-critical conditions such as trauma and cardiovascular emergencies.

Administrative and interfacility transfer-related complaints constituted nearly one-third of all calls, particularly within community settings, indicating substantial non-emergency utilisation of EMS resources. This pattern is consistent with international evidence demonstrating that a considerable proportion of ambulance dispatches involve non-emergent conditions, with reported estimates ranging from 11% to 52% of total EMS calls [19,20,21]. These cases often lack time-critical clinical indication for emergency intervention, yet they consume limited EMS resources and reduce operational efficiency [21]. These findings suggest that while EMS systems must preserve high-acuity readiness, alternative care pathways, improved triage protocols, and community-based demand management strategies may reduce avoidable dispatches.

Temporal analysis revealed relatively stable monthly trends, modest seasonal variation, and a gradual decline in total call volume from 2022 to 2024. The absence of marked seasonal spikes suggests predictable demand patterns conducive to structured workforce and fleet planning. However, the persistence of high-acuity industrial calls despite declining overall

volumes indicates that reduced call numbers do not necessarily correspond to reduced operational risk.

Binary logistic regression further identified industrial location, male sex, and pediatric age group as independent predictors of trauma-related calls. These findings reinforce the concept that trauma demand within industrial cities represents a distinct operational sub-profile requiring targeted prevention initiatives, strengthened occupational safety collaboration, and trauma-ready EMS resource allocation.

This study contributes to a limited body of EMS research from industrial cities in the Middle East. By integrating descriptive epidemiology, geographic comparison, temporal analysis, and multivariable modeling, the study provides a structured framework for understanding EMS demand in complex industrial environments.

Future research should incorporate patient-level outcomes, response and transport intervals, and hospital disposition data to better contextualize call severity and operational performance. Linkage of EMS dispatch records with emergency department and occupational health databases would allow deeper evaluation of injury mechanisms, care pathways, and potentially preventable demand.

Conclusion

Ambulance call patterns in Al Jubail Industrial City demonstrate a dual EMS demand profile, characterized by high call volumes from community areas and disproportionately high-acuity, trauma-related calls from industrial zones. Call severity was primarily influenced by clinical and geographic factors rather than temporal variation. These findings provide actionable evidence to guide EMS resource allocation, trauma readiness, and demand-management strategies in large industrial cities.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the ethical standards of the institutional research committee and in line with the principles of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board of Royal Commission Health Services Program (RCHSP) (Reference No. IRB-RCH-64; approved on 28 January 2025). The study adhered to Good Clinical Practice (GCP) guidelines and relevant national regulations, including those of the National Committee of Bioethics (NCBE), Saudi Arabia. As this was a retrospective study using de-identified data, the requirement for informed consent to participate was waived by the Institutional Review Board/Ethics Committee.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due to data governance, confidentiality, and institutional restrictions. The data are held by the relevant EMS authority and may be made available from the corresponding author on reasonable request, subject to approval from the data-providing authority and the relevant ethical review bodies.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

A.A. conceptualized the study, conducted the analysis, interpreted the findings, and drafted the manuscript. All authors critically reviewed the manuscript and approved the final version.

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