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Characteristics of ambulance crashes in Ankara: A retrospective analysis

Ramiz YAZICI*, Efe Demir BALA, Muhammed GÜNER, Ayşe Fethiye BASA KALAFAT, Hilmi KAYA, Salih FETTAHOĞLU, Utku Murat KALAFAT, Rabia Birsen TAPKAN, Bilal YENİYURT, Serkan DOĞAN

Department of Emergency Medicine, University of Health Sciences, Istanbul Kanıuni Sultan Süleyman Training and Research Hospital, Istanbul, Türkiye

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Abstract

One of the threats that Emergency Medical Services (EMS) personnel regularly face on the field is ambulance collisions and crashes. Ambulance crashes cause death and injury burden on both the EMS personnel and the civilians. In our study we aimed to evaluate the characteristics of ambulance crashes in Ankara, capital province of Türkiye. This retrospective study analyzed 812 ambulance crashes in Ankara, Türkiye, from 01/01/2022 to 31/12/2023 using data from the EMS Command Centre. Crashes were categorized by location, date, driver's gender and education, patient presence, and accident mechanism, revealing significant correlations between crash incidence and factors such as patient absence and urban settings with stationary objects. We found that there is no statistically significant correlation between the gender and the educational status of the driver and the risk of an ambulance crash. Our data analysis also points out that crashes occur involving a stationary object and EMS vehicle are more common than other mechanisms. Additionally, there is statistically significant correlation between the incidence of an ambulance crash and the absence of a patient inside the ambulance. Ambulance crashes in Ankara, Türkiye, frequently involve stationary vehicles on straight roads in urban areas and are more common when no patient is on board. These findings highlight the need for improved training and safety measures for ambulance drivers to prevent such accidents.

Keywords: ambulance crashes, emergency medical services, traffic accidents, driver training

1. Introduction

Emergency Medical Services (EMS) personnel face various safety hazards on the ground. Traffic accidents and crashes involving EMS vehicles and ambulances are among these hazards. According to a National Highway Traffic Safety Administration (NHTSA) report published in 2015, there are an estimated 1,500 ambulance crashes annually in the United States (1). A study conducted by Sanddal et al. reported that EMS personnel are at a higher risk for traffic accidents compared to other first responders, such as law enforcement officers and firefighters (2). The National EMS Memorial Service reports that between 1993 and 2010, 97 EMS personnel were killed in ambulance crashes in the United States (3).

Ambulance crashes pose threats not only to EMS personnel but also to the civilian population and patients. A study conducted by Kahn et al. reported that most injuries in ambulance crashes were inflicted upon those not in the vehicle itself, and those injured or killed in the ambulance are often the patients themselves or those in the rear compartment of the vehicle (4). Furthermore, ambulance crashes result in delays in EMS services and impose a financial burden on the system and the civilian population (5).

Alongside vehicle design, poor maintenance, and inadequate personnel training, factors such as fatigue, distraction, and stress are among the most common contributing factors to ambulance collisions (6,7). Various studies and sources also mention a correlation between the use of sirens and the incidence of ambulance crashes. One study by Isenberg et al. noted that EMS personnel using sirens are 15 times more likely to be involved in a crash (8,9). Excluding risk factors stemming from the design and maintenance of the vehicle itself, data from the aforementioned studies underline the importance of personnel-related contributing factors, such as training, fatigue, and stress. A study conducted by Boland et al. evaluated these factors by investigating the driving behavior and demographics of the EMS personnel in charge of the vehicle (10). It was found that regardless of gender and demographic factors, poor compliance with safety protocols while driving resulted in a higher risk of crashing.

The factors contributing to ambulance crashes differ by the location of the accident. Rural ambulance crashes tend to involve fewer other vehicles and occur due to environmental or vehicle factors, while urban ambulance crashes more often occur at intersections and involve other vehicles (4,11). A study conducted by Ray et al. (11) reported no difference in the severity of injuries between urban and rural crashes, while a study conducted by Weiss et al. showed that rural crashes tend to occur at higher speeds and result in higher injury severity compared to their urban counterparts (12).

*Correspondence: dr.ramiz.yazici@gmail.com

In our study, we aimed to evaluate the characteristics of ambulance crashes in Ankara, the capital province of Turkey. We recorded various factors, such as the weekday and hour of the accidents, the gender and license status of the driver, the location of the accident, the mechanism of the accident, and the presence of a patient in the crashing ambulance. By analyzing the actual hour of the shift at the time of the accident, we aimed to determine the effect of fatigue and stress on the incidence of ambulance crashes. By including other potentially contributing factors, we aimed to form a comprehensive study regarding the factors contributing to ambulance crashes. We aim to use this data to provide a better understanding of ambulance crashes and their mechanisms in Turkey.

2. Materials and Methods

2.1. Study Design and Setting

This study was designed as a retrospective study involving data collected from the EMS Command Centre of Ankara, the capital province of Turkey. As this was a retrospective study, historical data collected from previous incidents using the EMS Command Centre database were used, thus informed consent was waived. All researchers and authors involved in this study acted in accordance with the Helsinki Declaration while preparing the study protocol. This study was ethically approved by the Scientific and Ethical Review Board of Ankara Bilkent City Hospital with the approval number: TABED 1-24-283 and approval date: 22/05/2024.

We included all documented crashes that occurred within the provincial borders of Ankara between 01/01/2022 and 31/12/2023 in the study. This includes both rural and urban crashes. To provide a more detailed and meaningful analysis, we categorized the incidents according to the place and date of the accident, the ambulance driver's gender and educational status, and the presence of a patient inside the ambulance at the time of the accidents. We also divided the incidents according to the mechanism of the accident. Accidents involving a front-end or rear-end collision of different vehicles and collisions with stationary objects were categorized into different groups to determine if there is a prominent mechanism in accidents involving EMS vehicles.

2.2. 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), Chi-Square test was used to compare qualitative data. In cases where differences were found in multiple comparisons, post-hoc Bonferroni correction was used. Statistical significance level was accepted as $p<0.05$.

3. Results

We analyzed a total of 812 ambulance crashes occurring in both rural and urban areas of Ankara between 01/01/2022 and 31/12/2023. Our data reveals that more crashes occurred in 2022 compared to 2023, but this difference did not have any statistical significance. Most crashes occurred while the EMS crew was en route to evaluate a case, with 249 crashes (57.4%) occurring this way (Table 1). We did not find any statistically significant difference or correlation between a certain month of the year and ambulance crash incidence. Our data showed that most crashes happened on weekdays rather than weekends, with a total of 605 (74.5%) accidents occurring on weekdays compared to 207 (25.5%) accidents occurring on weekends (Table 1). Our data analysis reports no statistically significant correlation between the educational status of the driver and the incidence of ambulance crashes. Additionally, we did not find any correlation between the gender of the driver and the incidence of ambulance crashes.

Table 1. Comparisons in accordance with the phase at the time of the accident

		The Phase at the Time of the Accident, n (%)						P
		Enroute to case	At he event scene	Transport Phase	At the Hospital Grounds	Returning from a case	Total	
		(249)	(108)	(165)	(98)	(192)	(812)	
Year	2022	143 (57.4)	57 (52.8)	79 (47.9)	59 (60.2)	97 (50.5)	435 (53.6)	0.190
	2023	106 (42.6)	51 (47.2)	86 (52.1)	39 (39.8)	95 (49.5)	377 (46.4)	
Month	January	22 (8.8)	10 (9.3)	18 (10.9)	16 (16.3)	21 (10.9)	87 (10.7)	0.640
	February	22 (8.8)	8 (7.4)	7 (4.2)	7 (7.1)	11 (5.7)	55 (6.8)	
	March	21 (8.4)	8 (7.4)	11 (6.7)	10 (10.2)	20 (10.4)	70 (8.6)	
	April	19 (7.6)	8 (7.4)	13 (7.9)	4 (4.1)	12 (6.3)	56 (6.9)	
	May	19 (7.6)	7 (6.5)	21 (12.7)	6 (6.1)	17 (8.9)	70 (8.6)	
	June	23 (9.2)	4 (3.7)	10 (6.1)	6 (6.1)	13 (6.8)	56 (6.9)	
	July	17 (6.8)	10 (9.3)	9 (5.5)	4 (4.1)	21 (10.9)	61 (7.5)	
	August	26 (10.4)	15 (13.9)	16 (9.7)	11 (11.2)	10 (5.2)	78 (9.6)	
	September	26 (10.4)	8 (7.4)	15 (9.1)	5 (5.1)	15 (7.8)	69 (8.5)	
	October	19 (7.6)	9 (8.3)	18 (10.9)	11 (11.2)	18 (9.4)	75 (9.2)	
	November	16 (6.4)	9 (8.3)	13 (7.9)	6 (6.1)	17 (8.9)	61 (7.5)	
	December	19 (7.6)	12 (11.1)	14 (8.5)	12 (12.2)	17 (8.9)	74 (9.1)	
Weekday /Weekend	Weekday	186 (74.7)	78 (72.2)	115 (69.7)	81 (82.7)	145 (75.5)	605 (74.5)	0.211
	Weekend	63 (25.3)	30 (27.8)	50 (30.3)	17 (17.3)	47 (24.5)	207 (25.5)	
Time Period	00:00 - 07:59	20 (8.0)	17 (15.7)	15 (9.1)	8 (8.2)	17 (8.9)	77 (9.5)	0.072
	08:00 - 15:59	136 (54.6)	56 (51.9)	83 (50.3)	41 (41.8)	87 (45.3)	403 (49.6)	

	16:00 - 23:59	93 (37.3)	35 (32.4)	67 (40.6)	49 (50.0)	88 (45.8)	332 (40.9)	
Driver Title	EMT	54 (21.7)	28 (25.9)	43 (26.1)	30 (30.6)	51 (26.6)	206 (25.4)	0.069
	Paramedic	110 (44.2)	47 (43.5)	65 (39.4)	34 (34.7)	78 (40.6)	334 (41.1)	
	Driver	68 (27.3)	28 (25.9)	39 (23.6)	18 (18.4)	53 (27.6)	206 (25.4)	
	Other	17 (6.8)	5 (4.6)	18 (10.9)	16 (16.3)	10 (5.2)	66 (8.1)	
Driver Gender	Female	34 (13.7)	17 (15.7)	16 (9.7)	10 (10.2)	23 (12.0)	100 (12.3)	0.548
	Male	215 (86.3)	91 (84.3)	149 (90.3)	88 (89.8)	169 (88.0)	712 (87.7)	

Chi-Square Test

We included an analysis of the location of the accidents and the ambulance crash incidence in urban and rural settings. Our findings suggest that in urban settings, accidents on straight roads are statistically significantly more common than those at intersections or traffic lights ($p<0.001$) (Table 2). Our data analysis reveals a statistically significant correlation between the mechanism of the accident and the incidence of ambulance crashes, with accidents involving collisions with stationary objects and EMS vehicles being more common ($p<0.001$) (Table 2). Our data analysis also reports a statistically significant correlation between the absence of a patient in the ambulance and the incidence of ambulance crashes ($p<0.001$) (Table 2).

Table 2. Comparisons in accordance with the phase at the time of the accident (continuation)

		The Phase at the Time of the Accident, n (%)						**P**
		Enroute to case	**At he event scene**	**Transport Phase**	**At the Hospital Grounds**	**Returning from a case**	**Total**	
		(n=249)	**(n=108)**	**(n=165)**	**(n=98)**	**(n=192)**	**(n=812)**	
Accident Place	Urban	243 (97.6)	103 (95.4)	156 (94.5)	97 (99.0)	183 (95.3)	782 (96.3)	0.252
	Traffic Light	7 (2.9)	0 (0.0)	11 (7.1)	0 (0.0)	12 (6.6)	30 (3.8)	**0.001**
	Intersection	33 (13.6)	4 (3.9)	31 (19.9)	14 (14.4)	29 (15.8)	111 (14.2)	
	Straight Road	203 (83.5)	99 (96.1)	114 (73.1)	83 (85.6)	142 (77.6)	641 (82.0)	
	Rural	203 (83.5)	99 (96.1)	114 (73.1)	83 (85.6)	142 (77.6)	641 (82.0)	0.252
	Traffic Light	0 (0.0)	0 (0.0)	1 (11.1)	0 (0.0)	1 (11.1)	2 (6.7)	0.711
	Intersection	1 (16.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.3)	
	Straight Road	5 (83.3)	5 (100.0)	8 (88.9)	1 (100.0)	8 (88.9)	27 (90.0)	
Mechanism	Collision with a Vehicle	90 (37.0)	23 (22.3)	69 (44.2)	21 (21.6)	66 (36.1)	269 (34.4)	**<0.001**
	Collision from Behind	32 (13.2)	7 (6.8)	31 (19.9)	15 (15.5)	38 (20.8)	123 (15.7)	
	Collision with a Stationary Object	127 (52.3)	78 (75.7)	65 (41.7)	62 (63.9)	88 (48.1)	420 (53.7)	
Patient Presence at the Time of the Accident	Patient Absent	249 (100.0)	100 (92.6)	8 (4.8)	94 (95.9)	192 (100.0)	643 (79.2)	**<0.001**
	Patient Present	0 (0.0)	8 (7.4)	157 (95.2)	4 (4.1)	0 (0.0)	169 (20.8)	

Chi-Square Test

We separated the cases into two groups based on the presence of a patient within the ambulance and compared the location, mechanism, and timing of the accident alongside the demographics of the drivers. The subsequent data analysis revealed statistically significant correlations between the location of the accident in urban settings, the mechanism of the accident, and the ambulance schedule at the time of the accident. We did not find a statistically significant correlation between other variables and the incidence of ambulance crashes when comparing these separated groups (Table 3).

Table 3. Comparisons in accordance with the presence of the patients at the time of the accident

		When the crash occurred, there were, n (%)			P
		No Patients (n=643)	Patients (n=169)	Total (n=812)	
Year	2022	350 (54.4)	85 (50.3)	435 (53.6)	0.383
	2023	293 (45.6)	84 (49.7)	377 (46.4)	
Month	January	69 (10.7)	18 (10.7)	87 (10.7)	0.456
	February	48 (7.5)	7 (4.1)	55 (6.8)	
	March	56 (8.7)	14 (8.3)	70 (8.6)	
	April	42 (6.5)	14 (8.3)	56 (6.9)	
	May	47 (7.3)	23 (13.6)	70 (8.6)	
	June	46 (7.2)	10 (5.9)	56 (6.9)	
	July	52 (8.1)	9 (5.3)	61 (7.5)	
	August	62 (9.6)	16 (9.5)	78 (9.6)	
	September	54 (8.4)	15 (8.9)	69 (8.5)	
	October	59 (9.2)	16 (9.5)	75 (9.2)	
	November	48 (7.5)	13 (7.7)	61 (7.5)	
	December	60 (9.3)	14 (8.3)	74 (9.1)	
Weekday/Weekend	Weekday	487 (75.7)	118 (69.8)	605 (74.5)	0.141
	Weekend	156 (24.3)	51 (30.2)	207 (25.5)	
Time Period	00:00 - 07:59	62 (9.6)	15 (8.9)	77 (9.5)	0.865
	08:00 - 15:59	321 (49.9)	82 (48.5)	403 (49.6)	
	16:00 - 23:59	260 (40.4)	72 (42.6)	332 (40.9)	
Driver Title	EMT	163 (25.3)	43 (25.4)	206 (25.4)	0.387
	Paramedic	266 (41.4)	68 (40.2)	334 (41.1)	
	Driver	167 (26.0)	39 (23.1)	206 (25.4)	
	Other	47 (7.3)	19 (11.2)	66 (8.1)	
Driver Gender	Female	83 (12.9)	17 (10.1)	100 (12.3)	0.384
	Male	560 (87.1)	152 (89.9)	712 (87.7)	
Accident Place	Urban	621 (96.6)	161 (95.3)	782 (96.3)	0.565
	Traffic Light	19 (3.0)	11 (6.5)	30 (3.7)	**0.007**
	Intersection	80 (12.4)	31 (18.3)	111 (13.7)	
	Straight Road	522 (81.2)	119 (70.4)	641 (78.9)	
	Rural	22 (3.4)	8 (4.7)	30 (3.7)	0.565
	Traffic Light	2 (0.3)	0 (0.0)	2 (0.2)	0.545
	Intersection	1 (0.2)	0 (0.0)	1 (0.1)	
	Straight Road	19 (3.0)	8 (4.7)	27 (3.3)	
Mechanism	Collision with a Vehicle	202 (31.4)	67 (39.6)	269 (33.1)	**0.018**
	Collision from Behind	92 (14.3)	31 (18.3)	123 (15.1)	
	Collision with a Stationary Object	349 (54.3)	71 (42.0)	420 (51.7)	
The Phase at the Time of the Accident	Enroute to case	249 (38.7)	0 (0.0)	249 (30.7)	**<0.001**
	At the event scene	100 (15.6)	8 (4.7)	108 (13.3)	
	Transport Phase	8 (1.2)	157 (92.9)	165 (20.3)	
	At the Hospital Ground	94 (14.6)	4 (2.4)	98 (12.1)	
	Returning from a case	192 (29.9)	0 (0.0)	192 (23.6)	

Chi-Square Test

4. Discussion

In our study we aimed to analyze the incidence of ambulance crashes in Ankara, the capital province of Türkiye to understand if there is a correlation between driver demographics, environmental conditions and the presence of patients inside the ambulance at the time of the accident.

Ambulance crashes are important issues for the EMS personnel and the civilians involving in these accidents. When

compared to other traffic accidents, ambulance crashes are approximately four times more fatal for the personnel involving in them (13). Injuries and fatalities caused by the ambulance crashes affect both the patients and the EMS personnel, with the injury burden being the most severe on personnel being in the rear end of the vehicle at the time of the accident (14). Bystanders and civilians are also affected by ambulance crashes, with some studies reporting a higher burden of injury and death on those who are not in ambulance (4,15). Alongside the risk of death and injury, ambulance crashes cause delay and economic burden on the public services (7). Damage to civilian properties, lawsuits, loss of productivity and the delay in the EMS services result in high financial costs for the public (16).

Our data analysis reports no statistically significant correlation of the gender or educational status of the driver and the incidence of ambulance crashes. This result is similar to the findings of a study conducted by Boland et al. which also reports no statistically significant correlation between the gender and age of the driver and the incidence of ambulance crashes (10). In another study conducted by Studnek et al. it was stated that the driver's age and sleep problems affected the risk of being involved in an ambulance crash (17). The difference in these results could be explained earlier publishing date of Studnek et al.'s study when compared to Boland et al.'s study. We believe that later developments in driver training, workplace conditions and safety precautions may have a positive effect in terms of reducing the ambulance crashes in the demographic groups which were mentioned previously in Studnek et al.'s study.

Our data reveals that in urban settings, accidents involving crossroads and traffic lights are less common than those occurring at straight roads. This result bears similarity to the data mentioned in a study conducted by Biggers et al. which reports that %85,1 of ambulance crashes occurred outside intersections (18). In another study conducted by Ray et al. in 2007, it was found that intersections are much more prevalent in urban ambulance crashes when compared to rural ones (11). It is our belief that the difference between our data and Ray et al.'s 2007 study data stems from environmental issues. Most emergency vehicle crashes occur during daylight and dry road conditions. This is generally attributed to heavier traffic volumes and reduced driver attentiveness (5). This could also be a sign of the need for an improved ambulance driver certification and training system.

Our data analysis points out that accidents involving stationary objects and EMS vehicles are more common in urban setting. This result is contradictive of other studies which investigated ambulance accidents in a rural and urban setting. Studies conducted by Sanddal et al. and Ray et al. reported that crashes involving moving vehicles and EMS vehicles are more common in urban setting while more rural crashes involved stationary objects and EMS vehicles (2,11). This difference could be interpreted as a sign of the need for improved training system for the EMS personnel and better safety precautions.

Our data analysis highlight that crashes occur more commonly when ambulance does not have a patient inside. There are studies in the literature that report increased risks of accidents in the transport phase, which is the phase where ambulance has a patient assigned to it and is returning to the medical center with the said patient (8). However there are also different studies that mention no statistically significant correlation between the presence of a patient inside the ambulance and the risk of an ambulance crash (14,19).

Ambulance crashes cause significant death and injury burden alongside financial losses and emergency service delays. We aimed to understand the characteristics of the ambulance crashes in Ankara province of Türkiye. Our results showed that in Ankara province, ambulance accidents involving stationary vehicles on straight roads are more common in urban settings. Our data also reports that the incidence of ambulance crashes are higher if there isn't a patient inside the ambulance. The result from this study shows that more and better training for ambulance drivers as well as better safety precautions are needed to improve much more preventable accidents in the urban setting.

Conflict of interest
The authors declared no conflict of interest.

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Authors' contributions
Concept: RY, EDB, UMK, SF, Design: RY, SF, UMK, RBT, BY, Data Collection or Processing: BY, SD, HK, AFBK, SF, BY, Analysis or Interpretation: RBT, HK, SF, BY, MG, Literature Search: RY, EDB, MG, AFBK, RBT, HK, UMK, SD, Writing: RY, SF, EDB, MG, AFBK, SD.

Ethical Statement
Approval was obtained from Scientific and Ethical Review Committe of Ankara Bilkent City Hospital. The ethics committee decision date is 22/05/2024 and the number of ethical committee decisions is TABED 1-24-283.

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