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Evaluation of Mortality in Patients Involved In-vehicle and Out-of-vehicle Traffic Accidents

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Abstract: Traffic accidents are among the most common causes of mortality due to trauma. This study aimed to examine demographic and clinical characteristics that may affect mortality among patients who were involved in-vehicle and out-of-vehicle traffic accidents. In this retrospective study conducted with 2,120 patients, the patients were divided into two groups according to whether they had an in-vehicle or out-of-vehicle traffic accident. The patients in both groups were evaluated according to gender, Glasgow Coma Scale (GCS) scores, injury sites, and characteristics of the injured person. Then, factors that could be effective in mortality were compared between the two groups using statistical methods. Mortality occurred in 3.2% of the patients in the out-of-vehicle and 0.9% of the patients in the in-vehicle accident groups (p=0.001). There was a statistically significant difference between the two groups in relation to the GCS scores (p = 0.001). The pedestrians were the most injured individuals in out-of-vehicle traffic accidents (p=0.001). The most common injury site was the head and neck region at a rate of 24.8% (p=0.001). Mortality was higher in out-of-vehicle traffic accidents than in in-vehicle traffic accidents. Mortality was also higher among patients with low GCS scores, regardless of whether an accident occurred inside or outside a vehicle. ©2023 NTMS.

Keywords: In-vehicle Traffic Accident; Out-of-vehicle Traffic Accident; Mortality; Trauma.

1. Introduction

Traumas constitute the most common reason for mortality under the age of 40. The most common causes of trauma are traffic accidents, falling from a height, gunshot wounds, and stab wounds [1]. Traffic accidents are the most common cause of trauma, which increases mortality and morbidity.

In-vehicle and non-vehicle traffic accidents result in the deaths of thousands of people across the world every year. Motorcycle accidents and falls from vehicles are included in the category of out-of-vehicle traffic accidents. Mortality rates in in-vehicle and out-of-vehicle traffic accidents depend on many factors [2]. The mortality rate in in-vehicle traffic accidents varies according to the type of vehicle, its speed, and the type of collision. In out-of-vehicle traffic accidents, fatalities occur depending on the type, location, and type of the crashing vehicle. However, the main factor determining morbidity and mortality is whether the accident has high energy [3].

Evaluation of mortality in in-vehicle and out-of-vehicle traffic accidents is important to understand the impact of these accidents and help develop traffic safety policies. Studies carried out for this purpose are mostly studies conducted specifically for in-vehicle or out-of-vehicle traffic accidents. In this study, it was aimed to evaluate both groups together. Therefore, this study

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aimed to examine factors such as demographic data, type of accident, and injury site that could affect mortality and morbidity among in-vehicle and out-of-vehicle traffic accident victims presenting to the emergency department.

2. Material and Methods

This study was retrospectively conducted with patients who presented to the emergency department of a tertiary hospital from January 1, 2020, through December 31, 2021, following a traffic accident. The study was approved by the Local Ethics Committee (ethics committee number: B.30.2.ATA.0.01.00/66).

To obtain the related data, the hospital automation system and the physical files of the patients were screened. Patient screening on the hospital automation system was undertaken using the International Classification of Diseases codes (V39.4, V39.5, V39.6, V39.9, V79.9, V86.0, V86.1, V86.2, V86.3, V69.4, V69.5, V69.6, V69.9, V79.6, V79.4, V79.5, V49.4, V49.5, V49.6, V59.4, V59.5, V59.9, V87, V82.1, V82.9, Z04.1, V85.0, V85.1, V85.2, V85.3, and V81.1). Patients from all age groups who had been involved in in-vehicle or out-of-vehicle traffic accidents were included in the study. Pregnant women, patients with missing data, those who left the hospital without waiting for the completion of follow-up or procedures, and those who had suffered from trauma due to causes other than a traffic accident were excluded from the study. As a result of the screening, the data of 2,802 patients were obtained. However, since 581 patients had missing data and 101 left the hospital before their procedures were completed, the final sample consisted of 2,120 patients.

The patients were divided into two groups according to whether they had an in-vehicle or out-of-vehicle accident. The patients' age and gender, the type of vehicle that caused the traffic accident, whether the injured was the driver or passenger, the Glasgow Coma Scale (GCS) scores, the date and time of the accidents, the diagnoses made, injury sites, and outcomes were recorded. The types of vehicles were evaluated as automobiles, tractors, motorcycles, pedestrians, trucks, and other vehicles. The injured were evaluated as drivers, passengers, and pedestrians. Motorcycle accidents were considered out-of-vehicle traffic accidents. The diagnoses of the patients were divided into head-brain injuries, upper extremity, clavicular pathologies, lower extremity pathologies, abdominal pathologies, rib fractures, lung pathologies, vertebral fractures, three or more organ injuries (multi-trauma), facial bone pathologies, and ecchymosis-laceration pathologies. Injury sites were grouped as head-neck, lower extremity, upper extremity, abdomen, thorax, face region, pelvis, multi-injury region (multi-trauma), and back-scapula region. The diagnoses made as a result of head injuries were evaluated as cephalohaematoma, subarachnoid hemorrhage, epidural-subdural hemorrhage, intracranial hemorrhage, contusion cerebri, and diffuse axonal injury. The diagnoses of abdominal injury were evaluated as liver laceration, spleen laceration, multi-organ injury, and perforation. The clinics to which the patients were admitted were recorded as discharge from the emergency department, emergency department intensive care unit, anesthesia intensive care unit, and other intensive care units. The outcomes of the patients were evaluated as discharge from the emergency department, death in the emergency department, and admission to inpatient wards. Finally, mortality during hospitalization was recorded.

2.1. Statistical Analysis

Data analysis was calculated using the IBM SPSS v. 24 statistical program. Normal variables were expressed as mean, standard deviation, percentage, and numbers, and continuous variables as median and minimum-maximum values. Whether the data followed a normal distribution was checked using the Kolmogorov-Smirnov test. The independent-samples t-test was used for the pairwise group comparisons of normally distributed data, and the Mann-Whitney U test was used for non-normally distributed data. The Pearson chi-square test was used for categorical variables. A logistic regression model for mortality was created using significant variables. Logistic regression was performed for each variable. Then, the final results were specified for significant parameters using the backward stepwise (likelihood ratio) model. The statistical significance level was taken as $p<0.05$.

3. Results

The study included a total of 2.120 patients, of whom 1.716 (80.9%) had an in-vehicle traffic accident and 404 (19.1%) had an out-of-vehicle traffic accident.

Male patients constituted 1.134 (66.1%) of the patients in the in-vehicle traffic accident group and 279 (69.1%) of those in the out-of-vehicle traffic accident group. When the whole sample was considered, 1.413 (66.7%) of the patients were male. There was no statistically significant difference between the in-vehicle and out-of-vehicle traffic accident groups in terms of gender ($p=0.265$). The mean age was 34.00±17.76 years for the in-vehicle traffic accident group and 29.97±22.17 years for the out-of-vehicle traffic accident group, indicating a statistically significant difference ($p=0.000$) (Table 1).

In the in-vehicle traffic accident group, the GCS score of 1,662 (96.9%) patients was 15, and that of the remaining 20 (1.2%) patients was 3. In the out-of-vehicle traffic accident group, the GCS score was 15 in 369 (91.3%) patients and 3 in the remaining 13 (3.2%). There was a statistically significant difference between the two groups in relation to the GCS scores ($p=0.000$) (Table 1).

Of the patients involved in an in-vehicle traffic accident, 1.629 (94.9%) had a collision with a car, while 59 (14.6%) patients in the out-of-vehicle traffic accident group had a motorcycle accident. The difference between the two groups was statistically

significant (p=0.000). While 828 (48.3%) patients who had an in-vehicle traffic accident were drivers, 336 (83.2%) of those who had an out-of-vehicle traffic accident were pedestrians. When the characteristics of the people involved in a traffic accident were examined, a statistically significant difference was found between the two groups (p=0.000) (Table 1).

According to the time of the accident, 191 (47.3%) patients had an out-of-vehicle traffic accident between 12:01 and 18:00, and this rate was statistically significant (p=0.000). When the patients were evaluated according to injury sites, 119 (29.5%) of the patients who had an out-of-vehicle traffic accident had injuries in the lower extremity region, 20 (5.0%) in the pelvis region, and 69 (17.1%) in more than one region. Injury sites statistically significantly differed between the in-vehicle and out-of-vehicle traffic accident groups (p=0.000). The detailed demographic and clinical characteristics of the patients who had an in-vehicle or out-of-vehicle traffic accident are detailed in Table 1.

Table 1: Comparison of demographic and clinical data between the in-vehicle and out-of-vehicle traffic accident groups.

Variables		In-vehicle traffic accident (n=1.716, 80.9%)	Out-of-vehicle traffic accident (n=404, 19.1%)	Total (n=2.120, 100%)	P (0.000)
Age (Mean±SD)		34.00±17.76	29.97±22.17	33.23±18.74	0.000
Gender	Male	1,134 (66.1%)	279 (69.1%)	1,413 (66.7%)	0.265
	Female	582 (33.9%)	125 (30.9%)	707 (33.3%)	
GCS score	15	1,662 (96.9%)	369 (91.3%)	2,031 (95.8%)	0.000
	11-14	10 (0.6%)	8 (2.0%)	18 (0.8%)	
	7-10	11 (0.6%)	7 (1.7%)	18 (0.8%)	
	4-6	13 (0.8%)	7 (1.7%)	20 (0.9%)	
	3	20 (1.2%)	13 (3.2%)	33 (1.6%)	
Type of vehicle	Car	1,629 (94.9%)	289 (71.5%)	1,918 (90.5%)	0.000
	Tractor	39 (2.3%)	9 (2.2%)	48 (2.3%)	
	Motorcycle	0 (0%)	59 (14.6%)	59 (2.8%)	
	Truck	13 (0.8%)	3 (0.7%)	16 (0.8%)	
	Other	35 (2.0%)	44 (10.9%)	78 (3.7%)	
Injured Person	Driver	828 (48.3%)	57 (14.1%)	885 (41.7%)	0.000
	Passenger	888 (51.7%)	1 (2.7%)	899 (42.4%)	
	Pedestrian	0 (0%)	336 (83.2%)	336 (15.8%)	
Time of accident	00:01-06:00	165 (9.6%)	21 (5.2%)	186 (8.8%)	0.000
	06:01-12:00	377 (22.0%)	51 (12.6%)	428 (20.2%)	
	12:01-18:00	609 (35.5%)	191 (47.3%)	800 (37.7%)	
	18:01-00:00	565 (32.9%)	141 (34.9%)	706 (33.3%)	
Injury site	Head-neck	451 (26.3%)	74 (18.3%)	525 (24.8%)	0.000
	Lower extremity	210 (12.2%)	119 (29.5%)	329 (15.5%)	
	Upper extremity	370 (21.6%)	54 (13.4%)	424 (20%)	
	Abdomen	66 (3.8%)	6 (1.5%)	72 (3.4%)	
	Thorax	123 (7.2%)	23 (5.7%)	146 (6.9%)	
	Face	177 (10.3%)	24 (5.9%)	201 (9.5%)	
	Pelvis	40 (2.3%)	20 (5.0%)	60 (2.8%)	
	Multi-trauma	151 (9.0%)	69 (17.1%)	223 (10.5	
	Back-scapula	125 (7.3%)	15 (3.7%)	140 (6.6%)	
Patient outcome	Discharge	986 (57.5%)	187 (46.3%)	1,173 (55.3%)	0.001
	Ward admission	721 (42.0%)	210 (52.0%)	931 (43.9%)	
	Mortality in ED	9 (0.5%)	7 (1.7%)	16 (0.8%)	
Mortality status	Discharged	1,701 (99.1%)	391 (96.8%)	2,092 (98.7%)	0.001
	Died	15 (0.9%)	13 (3.2%)	28 (1.3%)	

SD: standard deviation, GCS: Glasgow Coma Scale, ED: emergency department.

While 1,701 (99.1%) patients in the in-vehicle traffic accident group were discharged and 15 (0.9%) patients died. While 391 (96.8%) patients in the out-of-vehicle traffic accident group were discharged and 13 (3.2%) patients died, indicating a statistically significant difference between the two groups (p=0.001). When the patients who died were compared in terms of clinical characteristics and etiology, 13 (46.4%) had an out-of-vehicle traffic accident (p=0.001), 19 (67.9%) had a GCS score of 3 (p=0.001), three (10.7%) had a motorcycle accident (p =0.025), and 11 (39.3%) had a pedestrian accident (p=0.002). Furthermore, in the mortality group, 17 (60.7%) patients had head-brain injuries, and three (10.7%) patients had three or more

organ injuries (p=0.001). When evaluated according to injury sites, 18 (64.3%) patients who died had multi-trauma (p=0.001). The remaining characteristics of the discharged and deceased traffic accident patients are detailed in Table 2.

Table 2: Comparison of mortality according to the etiology and clinical characteristics of the patients.

Variables		Discharged (n=2.092, 98.7%)	Died (n=28, 1.3%)	**P**
Injury mechanism	In-vehicle	1.701 (81.3%)	15 (53.6%)	0.001
	Out-of-vehicle	391 (18.7%)	13 (46.4%)	
GCS score	15	2.027 (96.9%)	4 (14.3%)	0.001
	11-14	16 (0.8%)	2 (7.1%)	
	7-10	17 (0.8%)	1 (3.6%)	
	4-6	18 (0.9%)	2 (7.1%)	
	3	14 (0.7%)	19 (67.9%)	
Type of vehicle	Car	1.894 (90.5%)	24 (85.7%)	0.025
	Tractor	48 (2.3%)	0 (0%)	
	Motorcycle	56 (2.7%)	3 (10.7%)	
	Truck	15 (0.7%)	1 (3.6%)	
	Other	79 (3.8%)	0 (0%)	
	Pedestrian	36 (1.7%)	0 (0%)	
Gender	Female	702 (33.6%)	5 (17.9%)	0.056
	Male	1.390 (66.4%)	23 (82.1%)	
Injured Person	Driver	874 (41.8%)	11 (39.3%)	0.002
	Passenger	893 (42.7%)	6 (21.4%)	
	Pedestrian	325 (15.5%)	11 (39.3%)	
Diagnoses	Head-neck injuries	136 (6.5%)	17 (60.7%)	0.001
	Upper extremity and clavicula injuries	120 (5.7%)	0 (0%)	
	Lower extremity injuries	201 (9.6%)	2 (7.1%)	
	Abdominal injury	62 (3.0%)	2 (7.1%)	
	Thorax injuries	133 (6.4%)	3 (10.7%)	
	Vertebral fracture	102 (4.9%)	1 (3.6%)	
	Multiple organ injuries	61 (2.9%)	3 (10.7%)	
	Facial bone injuries	99 (4.7%)	0 (0%)	
	Soft tissue injuries	1178 (56.3%)	0 (0%)	
Injury site	Head-neck	517 (24.7%)	8 (28.6%)	0.001
	Lower extremity	329 (15.7%)	0 (0%)	
	Upper extremity	424 (20.3%)	0 (0%)	
	Abdomen	70 (3.3%)	2 (7.1%)	
	Thorax	146 (7.0%)	0 (0%)	
	Face	201 (9.6%)	0 (0%)	
	Pelvis	60 (2.9%)	0 (0%)	
	Multi-trauma	205 (9.8%)	18 (64.3%)	
	Back-scapula	140 (6.7%)	0 (0%)	

GCS: Glasgow Coma Scale.

Table 3 shows the logistic regression model for predicting mortality in patients involved in traffic accidents. In this model, the GCS score was associated with increased mortality risk following a traffic accident (p=0.017), i.e. as the GCS decreased, mortality increased.

4. Discussion

Traffic accidents constitute a part of patient visits to the emergency department. There are variables that affect mortality in traffic accidents. In our study, when traffic accident patients were evaluated, those who had been involved in an out-of-vehicle traffic accident had a higher rate of mortality than those involved in an in-vehicle traffic accident. Mortality was also higher among the patients with head-brain injuries and multi-organ injuries. Traffic accidents rank first among all accidents around the world [4]. Fatalities due to traffic accidents rank 11th among all deaths and constitute 2.1% of all deaths [5]. In our study, the mortality rate due to traffic accidents was 1.3%. We consider that our rate differs from the global mortality rate associated with traffic accidents due to the many independent variables that have an effect on mortality.

Table 3: Results of logistic regression analysis for the prediction of mortality in traffic accident patients.

Variables		Exp (B)	95% CI for Exp(B)		P
			Lower	Upper	
Step 1	Type of vehicle	1.694	0.420	6.825	0.545
	Mechanism of injury	16.197	0.024	1003.186	0.095
	GCS score	0.003	0.101	3.822	0.000
	Person injured	0.008	0.000	6.175	0.177
	Diagnosis	0.035	0.001	2.509	0.094
	Injury site	2.195	0.091	52.753	0.004
Step 2	GCS score	0.018	0.002	0.199	0.017
	Injury site	0.361	0.011	6.374	0.387

GCS: Glasgow Coma Scale, CI: confidence interval, Exp(B): exponentiation of the B coefficient.

In the literature, it has been reported that the majority of deaths due to traffic accidents (63.4%) occur in male patients [6-8]. In addition, the age range of patients who die after a traffic accident has been reported to be 21-30 years and 30-49 years in previous studies [4, 6, 9-10]. Similar to the literature, in our study, mortality was more common among the male patients, regardless of whether the accident occurred inside or outside a vehicle, and the ages of the patients ranged from 30 to 49 years.

There are some scoring systems used for evaluating trauma systems and assessing the outcomes of major trauma. These include the Injury Severity Score, the GCS score, the Revised Trauma Score, and the Abbreviated Injury Scale. Many studies have shown that a low GCS score is associated with high mortality [11, 12]. Similarly, in the current study, it was determined that a low GCS score was a factor affecting mortality in patients who had an in-vehicle or out-of-vehicle traffic accident.

Traffic accidents usually occur between 18:00 and 00:00 [8, 9, 13, 14]. In a study by Meral et al. it was reported that while the rate of traffic accidents was 27.4% between 12:00 and 17:59 hours, this rate increased to 36.3% between 18:00 and 00:00 [15]. In our study, the rate of traffic accidents that occurred between 12:01 and 18:00 was determined to be 47.3% for in-vehicle traffic accidents and 34.9% for out-of-vehicle traffic accidents. In other studies, the reason why traffic accidents mostly occurred between these hours was attributed to the drivers' fatigue, carelessness, and lack of visibility in the evening [15]. In our study, we consider that the higher incidence of out-of-vehicle traffic accidents between 12:00 and 18:00 could be related to the traffic being busier during the day than at night and previous studies not including a separate category for out-of-vehicle traffic accidents.

The majority of injuries in traffic accidents are caused by the driver or the passenger sitting next to the driver [15-17]. Although this only applies to in-vehicle traffic accidents, in our study, we also determined that pedestrians were the most injured individuals in out-of-vehicle traffic accidents. Mortality due to traffic accidents was seen in 39.3% of pedestrians.

In traffic accidents, the most common injury site is reported to be the head-neck region, followed by the lower extremity [8, 18-20]. Upper extremity injuries have been detected in 16.5% of traffic accident victims [15]. In our study, similar to the literature, the head and neck region was the most frequently injured site in all accidents, and this was followed by lower extremity injuries. However, the most common injury site in out-of-vehicle traffic accidents was the lower extremity. This may be because vehicles hit pedestrians at the lower extremity level, according to the trauma mechanism. Facial injuries were observed in 10.3% of the patients involved in an in-vehicle traffic accident, which can be attributed to the trauma caused by airbags in vehicles.

5. Conclusions

Mortality was found to be higher in out-of-vehicle traffic accidents than in in-vehicle traffic accidents. Furthermore, mortality was higher among the patients with a low GCS score, regardless of whether they had been involved in an accident inside or outside a vehicle. We consider that mortality due to traffic accidents can be reduced if both drivers and pedestrians comply with traffic rules and take the necessary precautions.

Limitations of the Study

Our study has certain limitations. First concerns the single-center design, as a result of which the data of traffic accident patients who were referred to other centers could not be reached. Second, although we investigated mortality due to traffic accidents, we were not able to evaluate the data of patients who died at the accident scene before referral to our hospital. And lastly, patients with simple injuries may have been excluded from our study since they would not have applied to the hospital.

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Conflict of Interests

The authors declare no conflict of interest.

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Author Contributions

AG contributed to the writing-original draft preparation of the manuscript, writing-review & editing, methodology, visualization, and investigation. FC contributed to conceptualization, writing-review &

editing, and data curation. BKC contributed to formal analysis, resources, and visualization. FC contributed to investigation, software, and resources. Final approval was given by AG, FC, BKC.

Ethical Approval

The study was approved by the Ataturk University Ethics Committee (B.30.2.ATA.0.01.00/66).

Data sharing statement

None.

Consent to participate

Informed consent was obtained from the patients.

Informed Statement

The study complies with the principles of the Declaration of Helsinki. The consent of all the patients was obtained before commencing the study.

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