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Factors Affecting the Number of Fatalities and Injuries in Motor Vehicle Accidents in Turkey

Mahmut Aşırdizer[1*], Yasin Etli[2], Siddik Keskin[3]

[1]*Department of Forensic Medicine, Medical Faculty of Bahcesehir University, Istanbul, Turkey*
[2]*Department of Forensic Medicine, Medical Faculty of Selcuk University, Konya, Turkey*
[3]*Department of Biostatistics, Medical Faculty of Van Yuzuncu Yil University, Van, Turkey*

ABSTRACT

Reducing traffic-related deaths and injuries by 50% by 2030 is the main objective of the General Assembly of the United Nations in 2020. The current study aimed to investigate the characteristics of motor vehicle accidents (MVAs) that occurred between 2013 and 2022 in Turkey and the factors influencing the number of injuries and fatalities in these MVAs, to determine how close this target is.

Crude data for the study was taken from the Turkish Statistical Institute's (TUIK) public website. To enable secure comparisons, these crude data were proportionately standardized for this study.

Both the number of MVAs per 1,000 registered vehicles and the number of injured and deceased victims per 100,000 people in Turkey decreased after peaking in 2015. Urban regions contributed to 76.2% of the MVAs which resulted in injuries and fatalities. Males accounted for 76.9% of all fatalities, 69.4% of all injured victims, 97.7% of dead drivers, and 92.5% of injured drivers. While most injuries and deaths occurred between the ages of 25 and 64, the highest risk of death was observed among individuals aged 65 and older in comparison with the 100,000 people. Most of the fatalities and injuries in MVAs happened in August, during weekends and daylight hours. Twilight MVAs had the highest fatality risk. Automobile MVAs were the most common cause of all MVAs, injuries, and deaths. Drivers were accountable for 88.5% of the faults that caused MVAs.

In Turkey, the frequency of MVAs, together with the number of injuries and fatalities sustained, continues to be comparatively high. Therefore, a road safety committee should be established, and an emergency action plan for safe road vehicle traffic in Turkey should be designed.

Keywords: Motor vehicle accidents, injured victims, fatality, driver, fault

Introduction

Currently regarded as one of the most serious worldwide health risks due to its high rates of morbidity and mortality, motor vehicle accidents (MVAs) (1). According to World Health Organization (WHO) data, MVAs cause 20-50 million non-fatal injuries, numerous lasting impairments, and more than 1.3 million fatalities annually (2).

Personal factors, vehicular factors, and road and environmental conditions are fundamental risk factors for the occurrence of MVAs. Personal risk factors in MVAs include victims' and drivers' age, gender, income, education, and social standing (3). It has been stated that vehicular factors, such as mass, size, or safety features within, are more closely linked to the likelihood of injury and death during an accident than they are to the accident itself (4). Another vehicle-related factor of MVAs is vehicles that have not undergone thorough inspections or repairs (5). Road and environmental factors, including road type, poor visibility, location and scene of accident, weather conditions, seasons, and time of day, were found to significantly correlate with the frequency of MVAs (6,7).

The WHO states that by identifying risk factors and implementing appropriate road safety measures, MVAs can be prevented and are predictable (8). To decrease MVAs, several developed countries have identified risk factors for MVAs and created prevention programs. According to WHO data covering from 2013 to 2018, the number of MVA-related deaths rose in 27 of the 28 low-income countries and was stable in one; among the 98 middle-income countries, it grew in 60, fell in 23, and remained unchanged in 15. It rose in forty-nine high-income countries, fell in 25, and stayed the same in seven. High-income countries, which had 15% of the global population and 40% of the global motor vehicles, were only responsible for 7% of all MVA-

***Corresponding Author:** Mahmut Asirdizer, Professor of Forensic Medicine. Head of the Department of Forensic Medicine, Medical Faculty of Bahçeşehir University, Istanbul-Turkey
E-mail: mahmut.asirdizer@bau.edu.tr, Phone: +90-216 579 8263
ORCID ID: Mahmut Aşırdizer: 0000-0001-7596-5892, **Yasin Etli:** 0000-0002-7369-6083, **Siddik Keskin:** 0000-0001-9355-6558
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related deaths, but low-income countries, which had 9% of the global population and 1% of the global motor vehicles, were responsible for 13% of MVA deaths (2). The relative reduction in death rates related to MVAs in high-income nations can be attributed in large part to identifying risk factors and implementing precautionary measures.

The current study aimed to investigate the characteristics of MVAs that occurred in Turkey between 2013 and 2022 and the factors influencing the number of injuries and fatalities in these MVAs.

Materials and Methods

The current study was based on the crude data obtained from the public website of the Turkish Statistical Institute (TUIK) (https://www.tuik.gov.tr/). The number of vehicles which was registered in traffic, the number of vehicles involved in MVAs, and the number of the general and driver population were also accessed through the TUIK public website. Calculations for the period after this date have been performed to be percentages, since statistics on MVA death numbers in urban and rural areas, and whether they happened at the scene, in the hospital, or within 30 days following MVAs, became available on the TUIK website after 2015.

In the current study, the TUIK raw data were proportionally standardized and explained in the tables for safe proportional comparisons. The data was categorized and compared using the following major headings:

- The number of vehicles involved in MVAs, the number of injuries or fatalities of the victims, and all of them distribution by year;
- The rate of MVAs per 1,000 vehicles which was registered for traffic between 2013 and 2022.
- The rate of fatalities and injuries from MVAs per 100,000 people;
- The rate of victims who died and were injured depending on their gender and traffic role;
- The rate of fatalities per 100,000 injured victims classified by gender and traffic role;
- The gender-specific rates of fatalities and injuries among victims of MVAs;
- The numerical and proportional distribution of those injured and died in MVAs by age group;
- The ratio of people injured and died by MVA in each age group to the total population;
- The rate of fatalities per 100,000 injured victims according to age groups;
- The percentage distribution of injuries, fatalities, and MVA numbers by day, month, and time of MVA;
- The rates of injury and fatality per 1,000 MVAs include injuries and fatalities;
- The numeric and percentile distribution of vehicle types involved in MVAs and victims who were injured and died in MVAs according to these vehicle types.
- The numeric and percentile distribution of faults that caused MVAs that resulted in fatalities and injuries.

Statistical Analysis: Descriptive statistics for the studied variables (characteristics) were presented as numbers and percentages. The two proportions Z test was used to compare proportions. Data were analyzed statistically by MINITAB for Windows (Ver: 14) statistical program. The statistical significance level in the calculations was set at 5%.

Results

A total of 11,905,556 MVAs resulted in injuries and fatalities occurred in Turkey between 2013 and 2022. During these 10 years, 54.5 out of every 1,000 vehicles were engaged in an accident that concluded in injuries or fatalities. The rate of MVAs resulting in injuries and fatalities per 1,000 vehicles was 67.3‰ in 2013, and this decreased to 46.6‰ in 2022 ($p<0.001$) (Table 1). During the same period, 2,848,386 people (351.3 per 100,000 people) were injured and 57,071 people (7 per 100,000 people) died because of these MVAs. There was a tendency for fluctuation in the rate of MVA injury victims per 100,000 people, with the highest levels recorded in 2015 and a minimum value in 2018 ($p<0.001$).

The fatality rate from MVAs per 100,000 people was the lowest level in 2014 at 4.5, but it continued to rise quickly until 2017 when it reached 9.2. Following this point, it started to decline and was determined to be 6.1 in 2022 ($p<0.001$) (Table 1). 47.4% of MVA-related deaths, happened at the location of the accident, and 52.6% happened either while the patient was being treated at the hospital or within the first 30 days after the accident ($p<0.001$). Most MVAs that resulted in injuries and fatalities (76.2%) were recorded in urban areas, while 23.8% occurred in rural areas ($p<0.001$). The rate of injuries and fatalities per 1,000 MVAs resulted in injury and fatalities were 2,107 and 71 in rural areas, respectively, while these rates were 1,445 for injuries and 20 for fatalities in urban areas ($p<0.001$ for each).

Table 1. The Numerical Distribution of Vehicles Involved in MVAs and Victims Who Were Injured Or Died in MVAs; The Rate of MVAs per 1,000 Vehicles Registered For Traffic and The Rate of Numbers of Victims Who Were Injured Or Died in MVAs per 100,000 people

Year	Total Number of Motor Vehicles	Total Number of RTAs	The Rate of MVAs per 1,000 Vehicles Registered for Traffic	Toal Population	Number of Injured Persons	The rate of victims injured in MVAs per 100,000 People	Number of Victims Died in MVAs	The rate of victims died in MVAs per 100,000 People
2013	17.939.447	1.207.354	67,3	76.667.864	274.829	358,5	3.685	4,8
2014	18.828.721	1.199.010	63,7	77.695.904	285.059	366,9	3.524	4,5
2015	19.994.472	1.313.359	65,7	78.741.053	304.421	386,6	7.530	9,6
2016	21.090.424	1.182.491	56,1	79.814.871	303.812	380,6	7.300	9,1
2017	22.218.945	1.202.716	54,1	80.810.525	300.383	371,7	7.427	9,2
2018	22.865.921	1.229.364	53,8	82.003.882	307.071	374,5	6.675	8,1
2019	23.156.975	1.168.144	50,4	83.154.997	283.234	340,6	5.473	6,6
2020	24.144.857	983.808	40,7	83.614.362	226.266	270,6	4.866	5,8
2021	25.249.119	1.186.353	47,0	84.680.273	274.615	324,3	5.362	6,3
2022	26.482.847	1.232.957	46,6	85.279.553	288.696	338,5	5.229	6,1
Total Number	221.971.728	11.905.556	-	812.463.284	2.848.386	-	57.071	-
Mean	-	-	54,5	-	-	351,3	-	7,0
P Values ↓	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*

Table 2: Gender and Role in Traffic (Driver, Pedestrian and Passenger) of Victims who were Injured or Died in MVAs

The Percentage of Injured Victims by Their Role in Traffic	Drivers			Passengers			Pedestrians			Total			P Values →
	n	% ↓	% →	n	% ↓	% →	n	% ↓	% →	n	% ↓	% →	
Injured Male Victims	1.166.655	92,5%	59,0%	626.819	49,8%	31,7%	182.822	55,7%	9,3%	1.976.296	69,4%	100,0%	0,001
Injured Female Victims	94.149	7,5%	10,8%	632.450	50,2%	72,5%	145.491	44,3%	16,7%	872.090	30,6%	100,0%	0,001
All Injured Victims	1.260.804	100,0%	44,3%	1.259.269	100,0%	44,2%	328.313	100,0%	11,5%	2.848.386	100,0%	100,0%	0,001
P Values ↓		0,001			0,932			0,001				0,001	
The Percentage of Died Victims by Their Role in Traffic	Drivers			Passengers			Pedestrians			Total			P Values →
	n	% ↓	% →	n	% ↓	% →	n	% ↓	% →	n	% ↓	% →	
Died Male Victims	24.451	97,7%	55,7%	10.858	55,8%	24,7%	8.592	68,3%	19,6%	43.901	76,9%	100,0%	0,001
Died Female Victims	585	2,3%	4,4%	8.603	44,2%	65,3%	3.982	31,7%	30,2%	13.170	23,1%	100,0%	0,001
All Died Victims	25.036	100,0%	43,9%	19.461	100,0%	34,1%	12.574	100,0%	22,0%	57.071	100,0%	100,0%	0,001
P Values ↓		0,001			0,001			0,001					
Fatality Rate of Victims per 1,000 Injured Victims		Males			Females			All Victims			P Values →		
Drivers		23			9			22			0,001		
Passengers		16			14			15			0,001		
Pedestrians		46			28			38			0,001		
Total		23			16			21			0,001		
P Values ↓		0,001			0,001			0,001					

Table 3. Age-Group Distribution of MVA Victims who were Injured or Died

Percentage of Victims in MVAs	0--9		10--24		25--64		65--65+		Total		P Values →
	n	% →	n	% →	n	% →	n	% →	n	% →	
Victims Injured in MVAs	205.881	7,2%	865.204	30,4%	1.592.605	55,9%	184.569	6,5%	2.848.259	100,0%	0,001
Victims Died in MVAs	2.641	4,6%	10.500	18,4%	32.921	57,7%	10.989	19,3%	57.051	100,0%	0,001
The Rate of Injured People to Total Population (Per 100,000 People)	163		450		377		258		350		0,001
The Rate of Died People to Total Population (Per 100,000 People)	2		5		8		15		7		0,001
The Rate of Died People to Injured People (Per 1,000 Injured People)	12,8		12,1		20,7		59,5		20,0		0,001

Males represent 76.9% of the fatalities and 69.4% of the injuries in MVAs (p<0.001, per each). MVAs were responsible for the deaths of 16 of 1,000 injured females and 23 of 1,000 injured males (p<0.001). The majority of those injured (44.3%) and died (43.9%) in MVAs were drivers (p<0.001). Among drivers, the rates of males who were injured and died were significantly higher than females (92.5% and 97.7%) (p<0.001 for each). Among pedestrians, the rates of males who were injured and died were also significantly higher than females (55.7% and 68.3%) (p<0.001, per each). When it came to passengers who were injured, the gender distribution was about equal (p=0.932), but male passengers were more likely to die (55.9%) than female passengers (p<0.001). 55.8% of the injured passengers (p<0.001) and 49.8% of the dead passengers (p>0.05) were males. More than half of the males who suffered fatalities (55.7%) or injuries (59.0%) in MVAs were drivers (p<0.001, per each). On the other hand, most females who suffered fatalities (65.3%) or injuries (72.5%) were in the passenger seats of the vehicles (p<0.001, per each). The fatality rate for pedestrians (38.0‰) was higher among 1,000 injured victims in MVAs, whereas the fatality rate for drivers (22‰) and passengers (15‰) was comparatively low (p<0.001).

Male drivers faced 2.6 times the fatality rate as female drivers (p<0.001). This rate was 1.6 times higher among male pedestrians than in females and 1.1 times higher among male passengers than of those in females (Table 2). Most of those injured (55.9%) and killed (57.7%) due to MVAs were between 25-64 years old (p<0.001 for each). Injury rates per 100,000 people were highest between 10-24 years old (450/100,000) (p<0.001), while death rates per 100,000 people were highest at 65 years old and older (15/100,000) (p<0.001). The fatality rate per 1,000 injured victims in each age group was highest at 65 years old and older (59.5‰) (p<0.001) (Table 3).

Throughout the summer, there was an increase in the number of accidents, injuries, and fatalities; these figures peaked in August with 10.7% of MVAs, 11.4% of injuries, and 11.9% of fatalities (p<0.001 for each). In examining the prevalence by month, two details came to light. The first was the higher-than-mean rates of injuries and fatalities per 1,000 motor vehicle accidents from June to September, which is considered the summer holiday season. August and July were the months when both rates were at their highest (1,704 and 1,690 for injuries, and 35 and 35 for fatalities) (p<0.001 for each). (Table 4). The decrease in the number of MVAs, injuries, and fatalities during the COVID-19 pandemic was the second notable outcome. The full or partial lockdown periods due to the COVID-19 pandemic between the 22nd of March 2020 and the 30th of June 2020, and between the 25th of November 2020 and 1st of March 2021, was when the decline in the number of MVAs, injuries, and fatalities (Figure 1).

Fridays had the highest rate of MVAs (15.0%), Sundays had the highest rate of injuries (15.4%), and Saturdays had the highest rate of fatalities (15.7%) (p<0.001 for each). The majority of MVAs (67.3%),

Table 4: Distribution of Victims who were Injured or Died in MVAs according to Months, Days and Times of Day

Distribution by MVA Time	MVAs with Fatality and Injury		Injured Victims		Injury Rates in Per 1,000 MVAs Resulted in Fatality and Injury	Died Victims		Fatality Rates in Per 1,000 MVAs Resulted in Fatality and Injury
Months	n	%	n	%		n	%	
January	109.901	6,2%	177.141	6,2%	1.612	3.286	5,8%	30
February	103.608	5,8%	163.319	5,7%	1.576	3.122	5,5%	30
March	125.356	7,1%	193.538	6,8%	1.544	3.622	6,3%	29
April	131.684	7,4%	202.090	7,1%	1.535	3.977	7,0%	30
May	148.886	8,4%	233.555	8,2%	1.569	4.725	8,3%	32
June	166.871	9,4%	273.575	9,6%	1.639	5.529	9,7%	33
July	189.335	10,7%	320.028	11,2%	1.690	6.667	11,7%	35
August	191.079	10,7%	325.689	11,4%	1.704	6.763	11,9%	35
September	174.273	9,8%	280.685	9,9%	1.611	5.808	10,2%	33
October	164.706	9,3%	258.127	9,1%	1.567	5.535	9,7%	34
November	143.746	8,1%	221.755	7,8%	1.543	4.449	7,8%	31
December	128.108	7,2%	198.884	7,0%	1.552	3.588	6,3%	28
P Values ↓	0,001			0,001			0,001	
Days	n	%	n	%		n	%	
Monday	260.054	14,6%	405.910	14,3%	1.561	8.195	14,4%	32
Tuesday	246.181	13,8%	381.118	13,4%	1.548	7.660	13,4%	31
Wednesday	248.219	14,0%	384.778	13,5%	1.550	7.643	13,4%	31
Thursday	248.187	14,0%	388.161	13,6%	1.564	7.681	13,5%	31
Friday	265.822	15,0%	418.480	14,7%	1.574	8.026	14,1%	30
Saturday	260.672	14,7%	430.943	15,1%	1.653	8.972	15,7%	34
Sunday	248.418	14,0%	438.996	15,4%	1.767	8.894	15,6%	36
P Values ↓	0,001			0,001			0,001	
Time of Day	n	%	n	%		n	%	
Daytime	1.195.885	67,3%	1.885.680	66,2%	1.577	33.905	59,4%	28
Night	533.169	30,0%	881.619	31,0%	1.654	21.084	36,9%	40
Twilight	48.499	2,7%	81.087	2,8%	1.672	2.082	3,6%	43
Total	1.777.553	100%	2.848.386	100%	1.602	57.071	100%	32
P Values ↓	0,001			0,001			0,001	

injuries (66.2%), and fatalities (59.4%) occurred during daytime hours (p<0.001 for each). The highest rates of injury and fatality per 1,000 MVAs involved both occurred on Sundays (1,767 injuries and 36 fatalities) and during the twilight hours (1,672 injuries and 43 fatalities) (p<0.001 for both) (Table 4).

Two vehicles were involved in 49.3% of MVAs that resulted in injuries or fatalities, one vehicle in 44.9%, and more than two vehicles in 5.8% of MVAs (p<0.001). Some accidents resulted in death in 3.3% of MVAs involving a single vehicle, 2.5% of MVAs involving more than two vehicles, and 2.0% of MVAs involving two vehicles; the remaining MVAs resulted in injuries (p< 0.001).

Automobiles made up most of the vehicles involved in the MVA (53.6%) (p<0.001). For each vehicle type, the MVA rate per 1,000 registered vehicles was highest in the vehicle group defined as "other" (240‰), followed by buses (29‰) and minibuses (18‰) (p<0.001). Tractor accidents (60‰) had the

Table 5: Vehicle Types Involved in MVAs and the Distribution of the Rate of Victims who were Injured or Died in MVAs Involving these Vehicles

Vehicle Type	Vehicles Registered to Traffic		Vehicles involved in MVA[1]		Drivers Injured in MVAs		Drivers Died in MVAs		The Ratio of Vehicles involved in a MVA to all Registered Vehicles.	Drivers Injured in MVAs for Each Vehicle Type Involved in MVA	Drivers Died in in MVAs for Each Vehicle Type Involved in MVA	Fatality Rate Per 1,000 Injured Driver Victims for Each Vehicle Type
	n	%	n	%	n	%	n	%	(Per 1,000 Vehicle[1])	(Per 1,000 Vehicle1)	(Per 1,000 Vehicle1)	
Automobile	119.060.848	53,6%	1.459.703	51,2 %	523.134	41,5%	9.707	38,8%	12	358	7	19
Small truck	36.219.796	16,3%	437.875	15,4 %	136.576	10,8%	2.555	10,2%	12	312	6	19
Motorcycle	32.537.703	14,7%	495.162	17,4 %	426.884	33,9%	7.199	28,8%	15	862	15	17
Tractor	18.364.510	8,3%	30.054	1,1%	13.084	1,0%	1.816	7,3%	2	435	60	139
Truck/Tow Truck	8.353.090	3,8%	141.455	5,0%	44.376	3,5%	1.784	7,1%	17	314	13	40
Minibus	4.687.358	2,1%	82.496	2,9%	14.792	1,2%	270	1,1%	18	179	3	18
Bus	2.151.999	1,0%	61.745	2,2%	5.877	0,5%	160	0,6%	29	95	3	27
Other	596.424	0,3%	142.975	5,0%	96.081	7,6%	1.545	6,2%	240	672	11	16
Total	221.971.728	100,0 %	2.851.465	100,0 %	1.260.804	100,0 %	25.036	100,0 %	13	442	9	20
P Values ↓	*0,001*		*0,001*		*0,001*		*0,001*		*0,001*	*0,001*	*0,001*	*0,001*

(1) It only refers to the number of vehicles involved in accidents with injuries and/or deaths.

Table 6: Distribution of Faults Resulting in MVAs with Fatalities and Injuries

Distribution of Faults		
Driver Faults	88,5%	
Not adjusting the vehicle speed to road, weather and traffic conditions		39,5%
Violating right of way at junctions		13,1%
Violating the general conditions of maneuvers		8,0%
Crashing from back		7,3%
Violating direction changing (turning) rules		6,6%
Violating "no vehicle entry" sign		2,7%
Crashing to vehicles parked properly		2,5%
Running red lights or violating stop signs of traffic officer		2,3%
Violating the lane following and changing rules		1,5%
Drunk driving		1,5%
Driving over speed		1,1%
Passing through places with no-pass prohibition		0,6%
Other driver faults		13,0%
P Value		0,001
Pedestrian Faults	8,6%	
Violating crossing rules where pedestrian crossings and junctions not exist		33,0%
Acting behaviors on vehicle roads that endanger traffic vehicles		21,5%
Violating traffic lights and signals		15,0%
Violating traffic rules while crossing roads		6,7%
Entering the vehicle road		5,5%
Not taking accident preventing cautions where night and day vision is unclear		2,7%
Not walking on the left side of the vehicle road		1,5%
Other pedestrian faults		14,0%
P Value		0,001
Passenger Faults	0,9%	
Not using safety belt and helmet		12,9%
Getting on and off to vehicles carelessly		3,8%
Other passenger faults		83,3%
P Value		0,001
Vehicle Faults	1,3%	
Brake fault		13,3%
Tire blowout		8,7%
Headlight fault		3,1%
Rod fault		2,7%
Steering wheel fault		2,5%
Door fault		2,2%
Shear, shaft, gearbox, gear fault		1,9%
Rear lamps fault		1,7%
Axle breakdown		1,5%
Turning signal fault		1,0%
Other vehicle faults		61,4%
P Value		0,001
Road and Environmental Faults	0,6%	

Louse material on road surface		26,1%
Discrete dips on road		13,1%
Lane collapse		8,1%
Partial or discrete collapse		4,6%
Surface collapse at wheel print		4,4%
Low shoulder		1,8%
Other road faults		41,9%
P Value		0,001
P Value (Total)	0,001	

highest driver fatality rates per 1,000 MVAs (p<0.001), whereas motorcycle accidents (862‰) had the highest driver injury rates (p<0.001). Additionally, tractor accidents exhibited the highest driver death rate (139) per 1,000 injured drivers (p<0.001) (Table 5).

The problems that resulted in 88.5% of MVAs were linked to driver fault, although 8.6% of them were caused by pedestrian fault, 1.3% by vehicle fault, 0.9% by passenger fault, and 0.6% by road and environmental condition fault (p<0.001). The primary issues with drivers that were reported were described as "not adjusting the vehicle speed to the road, weather, and traffic conditions" (39.5%), "violating the right of way at junctions" (13.1%), and "violating the general conditions of maneuvers" (8%) (p<0.001). The driver fault rate for drunk driving was 1.5%, which was higher than the rates for passenger, vehicle, road, and environmental faults (p<0.001). The most prevalent categories of faults were stated as "violating crossing rules where there are no pedestrian crossings and junctions" for pedestrians (33%), "not using seatbelt or helmet" for passengers (12.9%), "brake fault" for vehicles (13.3%), and "loose material on road surface" for road and environmental conditions (26.1%) (p<0.001) (Table 6).

Discussion

A report from the United Nations Economic Commission for Europe states that motor vehicle accidents (MVAs)-related deaths and injuries are still a significant global health issue. The objective of the resolution (64/255) that the UN General Assembly adopted in 2010 as part of the Decade Plan of Action for Road Safety was to cut the overall number of road deaths in half between 2010 and 2020. It was declared in the resolution (74/299) adopted in 2020 as a component of the second ten-year action plan approved by the United Nations General Assembly that there would be a minimum 50% decrease in MVA-related deaths and injuries by the year 2030. The same analysis showed that several countries were still seeing increases in injuries and fatalities between 2010 and 2019, even though there was a smaller-than-anticipated drop in these numbers. Turkey was among the countries seeing an increase in MVAs leading to injury and death. According to study data, Turkey's MVA rate increased by 57.4% between 2009 and 2019 [9].

The current study's results revealed that although the number of vehicles registered in Turkey increased by nearly 47.6% and the population increased by 11.2% between 2013 and 2022, the number of MVAs with injuries and deaths showed a lower increase rate of 2.1% The rate of MVAs that caused injuries and fatalities per 1,000 registered vehicles was 67.3 in 2013, but by 2022, it had decreased to 46.6 (Table 1). Even though projects for infrastructure are created daily, the growing population, and the increase in the number of motor vehicles, particularly in metropolitan areas, create the conditions for overcrowding and inadequacy on the roads as well as a spike in MVAs (10). The injury and death rates per 1,000 MVAs resulted in injuries and fatalities have decreased over the last four years, despite no obvious improvements in these rates. This relative decrease is considered because of improvements to roads, advancements in vehicle safety systems, and health systems that are always developing (11-13).

In Turkey, between 2013 and 2022, the great majority (76.2%) of MVAs that resulted in injuries and fatalities took place in urban areas. In a similar vein, it was noted that urban areas accounted for 53% of accidents resulting in fatalities and injuries in Iran and the United States (US) (14,15). A high-risk area of MVAs has also been identified as residential streets that are located on the left or right side of collector or arterial highways (16). The present study included urban settlement regions in rural areas may help to explain the high prevalence of MVAs with death and injury that occurred in urban areas when compared to previous studies. Although there were many injuries and fatalities in urban areas, there were 3.6 times as many deaths per 1,000 MVAs in rural areas as in urban areas and 1.5 times as many injuries per 1,000

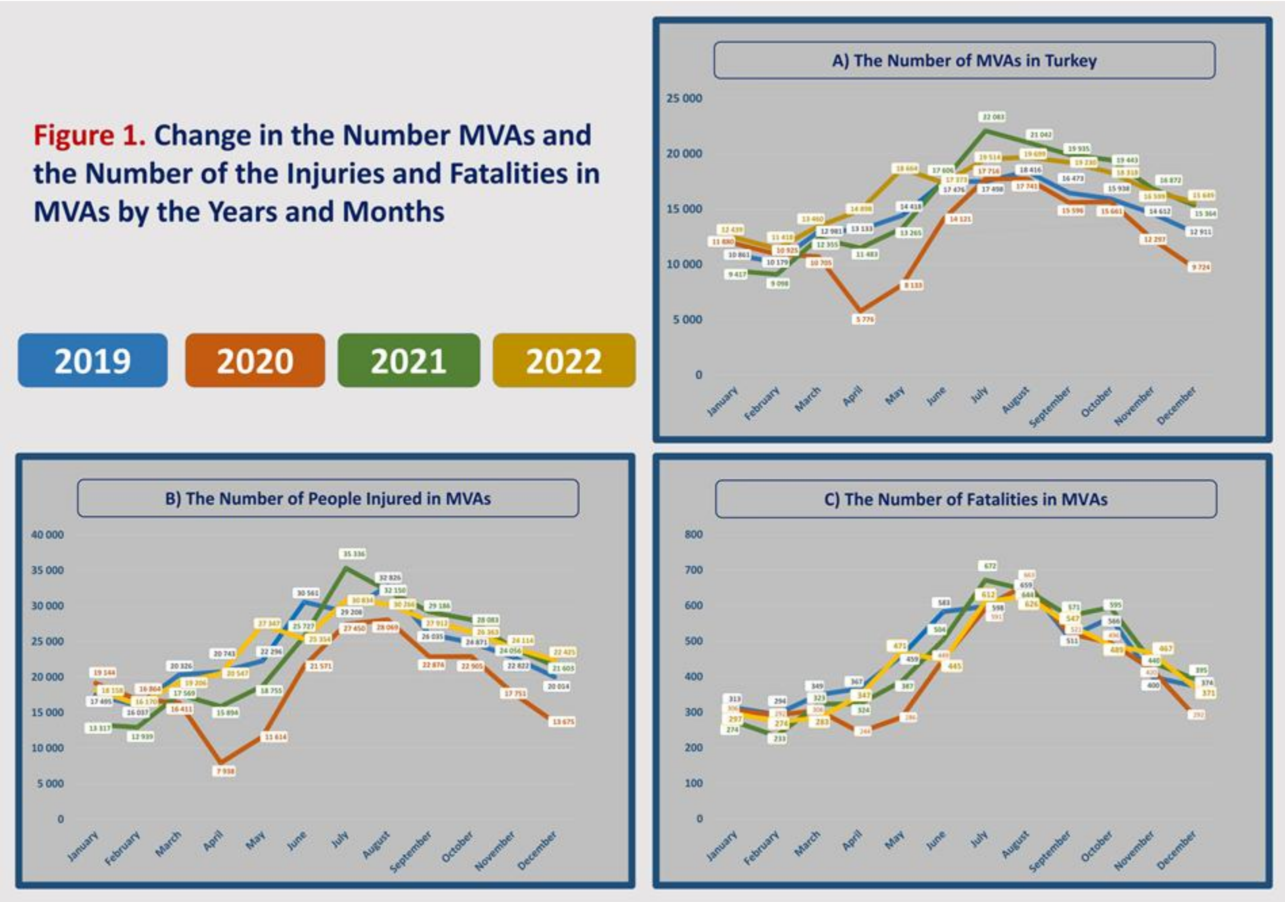

Fig.1. Change in the number of MVAs and the number of injuries and fatalities in MVAs by the years and months

MVAs in rural areas. According to a similar study conducted in the US, MVAs in rural areas had a fatality risk that was almost six times higher than that in urban areas (17). The roads in Spain with the highest fatality rate were the rural roads that connect interurban and urban traffic (18). MVA death rates were found to be 14/100,000 in urban areas and 22/100,000 in rural areas in a Wisconsin (US) study (19). The following factors have been reported as the causes of the greater death rate in rural areas: 1) speeding on major roads and highways that cross rural villages; 2) a higher incidence of traffic infractions (such as drivers under the influence of alcohol or drug, drivers without a license, and seat belt infractions of drivers and/or passengers) as a result of the relative lack of road-side traffic controls; and 3) the more widespread use of older vehicle models without airbags and other safety measures in rural areas (14,18,19). The longer time it takes to get injured people from remote areas to hospitals could be another factor contributing to the higher death rate in MVAs in rural areas.

Males accounted for 69.4% of the injuries in the MVAs and 76.9% of fatalities in the MVAs in Turkey during the ten years between 2013 and 2022 (Table 2). Likewise, WHO research found that 73% of the injured victims in MVAs were young males (2), while UNECE information collected in 2019 indicated that 74% of the dead victims in MVAs in 40 member countries were males (9). The gender disparity in mortality has been linked to male drivers' higher-risk behaviors, such as driving longer distances or when drunk (9). Previous studies indicated that male drivers are more likely to commit violations of traffic laws and to participate in more serious MVAs (3,20,21). In the current study, males suffered more serious injuries than females, with a higher male mortality rate (23%) compared to a female death rate (16%) for every 1,000 people injured in MVAs (Table 2). Drivers were responsible for the majority of MVA injuries and fatalities (44.3% and 43.9%, respectively). Nonetheless, the rate of injured passengers (44.2%) was nearly equal to that of injured drivers, associated with the rise in injuries among female passengers. This can be attributed to the fact that MVAs involving vehicles carrying many passengers, particularly buses, minibuses, and tractor-trailers, result in more injuries and fewer deaths. Most males who suffered injuries (59.0%) and died (55.7%) in the MVAs this study looked at were drivers, whereas most females who were injured (72.5%) and died (65.3%) were passengers (Table 2). The above condition may be indicative of 71.8% of Turkey's drivers are male based on 2021 TUIK data. The results of the present study showed that males had higher rates of injuries (55.7%) and fatalities (68.3%) among pedestrians. These results contradict Herrero-Fernandez et al.'s result that male pedestrians were less exposed to MVAs than female pedestrians [22], while was compatible with the NHTSA report that males accounted for 70% of pedestrian fatalities in MVAs in the US in 2019 (23). According to the current study, pedestrians (38‰) had the highest fatality rate per 1,000 injured people in MVAs, whereas driver (22‰) and passenger (15‰) fatalities were relatively low (Table 2). Numerous factors have been defined that impact the rates of injuries and fatalities experienced by drivers, passengers, and pedestrians. The type of vehicle involved in the MVAs, the vehicle's speed at the moment of the accident, the damaged part and durability of the vehicle, the position of pedestrians and/or passengers about the vehicle, whether or not the drivers and/or pedestrians were intoxicated, whether drivers and passengers use seat belts and safety gear, and the road conditions where the collision occurred are some of these factors (23-25).

According to the WHO, MVA injuries rank among the top causes of death for kids and young adults between the ages of 5 and 29 years (2). The adult population in France between the ages of 24 and 44 years was the most affected by MVAs (26). In Spain, 53% of those hurt in motor vehicle accidents were in the 26–64 age range (18). While 74% of MVA-related deaths in Mexico occurred between the ages of 15 and 64 (4), 51.9% of MVA-related deaths in Pakistan happened between the ages of 25 and 64 years (27). In Poland, the age group between 45 and 64 years old had the highest standardized death rates for MVAs (11). The age group of 35 to 49 years old was found to have the greatest death rate related to MVAs in Guinea (29.7 per 100,000 people) (28). The age groups of 15 to 20 years old had the highest rates of pedestrian injuries in the US (33 per 100,000 people), whereas the age groups of 55 to 59 and 60 to 64 years old had the highest rates of pedestrian fatalities (3.01 and 2.67 for every 100,000 pedestrians, respectively) [23]. Most injuries (55.9%) and fatalities (57.7%) in MVAs in the current study occurred among adults aged 25 to 64. Injury rates per 100,000 persons that were standardized increased dramatically between the ages of 10 and 24 (450), with the highest standardized death rate (65) occurring among those 65 years and older. The 65 years and older age group had the highest fatality rate (59.5%) among those injured in MVAs (Table 3).

A study conducted in India revealed that the number of MVAs increased between June and August, with most MVAs occurring in July (29). A different investigation conducted in 2012 on MVAs in India found that the month of May had the highest incidence of MVAs (8.8%), with April and January coming in second and third, respectively, with 8.74% and 8.72% (27). In the above research, it was reported that September had the lowest MVA rate (27). Ten of China's eleven major MVAs involving big buses and commercial trucks carrying dangerous substances occurred between May and August (30). The upward trend in MVAs during the summer was attributed to a rise in traveling that started during the school break, as well as the negative impact of rising temperatures on drivers (30). In the current study, most of the MVA-related injuries and fatalities in Turkey were in the summer, especially in August, when the injury and death rate per 1,000 MVAs peaked (Table 4).

UNECE's "Statistics of Road Traffic Accidents in Europe and North America" report states that lockdowns during the pandemic and other measures taken by member states in response to the COVID-19 pandemic generally decreased vehicle traffic, which in turn caused MVA rates to rise by an average of 8% in 15 out of 22 countries (9). According to the Road Safety Annual Report 2021, the COVID-19 pandemic caused most of the countries to go into quarantine, and the countries' traffic volumes decreased in 2020, especially in dropped to the lowest level in April and May and had decreased significantly during the second pandemic wave during the year-end (31). A comparable study conducted in Italy found that during the COVID-19 lockdown period in 2020, there was a considerable reduction in the frequency of MVAs. This reduction ranged from 70% to 80%, with the most notable time occurring in March and April (32). The results of the present study showed that the number of MVAs, injuries, and deaths declined from 2020 through 2021 COVID-19 pandemic. This diminished was evident in lockdown periods in Turkey between 22nd March 2020 and 30th June 2020, and between 25th November 2020 and 1st March 2021. In April 2020, the number of MVAs decreased by 50%, the number of injuries by 40%, and the number of fatalities by 45% compared to April 2019 (Figure 1).

Previous studies reported that Fridays (22.9% and 17%) were the day when MVA occurred most frequently in Russia in 2016 (13) and China during 2006-2010 (3). This was reported as Saturdays (19%) in India in 2016-2017 (29). The present study reveals that MVAs mostly occurred on Fridays (15.0%), whilst the injuries in MVAs on Sundays (15.4%) and the deaths in MVAs on Saturdays (15.7%) (Table 4).

Although the number of MVAs occurring at night is less than the number of MVAs occurring during the daytime due to less traffic, MVAs occurring at night are more damaging and cause more serious consequences (33). The risk of death is higher in accidents that occur at night and the victims injured in the night MVAs are more likely to die at the scene or upon arrival at the emergency room (34,35). Most MVA-related injuries and deaths (67.3%) happened during the day, according to the current study. Contrary to other studies, twilight hours had the highest rates of injuries and fatalities per 1000 MVAs (1,672 and 43). MVAs occurring at night were in second place (1,654 and 40) (Table 4).

Chen et al.'s study reported that most incidents involved two vehicles, with single-vehicle collisions inflicting less serious bodily harm on drivers (36). Wu et al. found that although the number of single-vehicle accidents was smaller, they were more serious and deadly, and they also highlighted the higher likelihood of serious injury to drivers in single-vehicle MVAs (37). The highest number of two-vehicle accidents in the current study was consistent with the results of the first study above, and the high death rates in single-vehicle accidents were consistent with the results of the second study.

The NHTSA reported in 2018 that most driver fatalities on urban roads (35.8%) occurred in passenger-transporting vehicles, whereas most driver fatalities on rural roads (41.4%) occurred in light commercial trucks (14).

In the current study, it was determined that 51.2% of the vehicles involved in MVAs occurring in Turkey were automobiles, the highest injury rate per 1,000 MVAs was in accidents involving motorcycles (862‰), and the highest death rate was in accidents involving tractor-trailers (60‰) (Table 5). The high rates of motorcycle injuries can be related to an increase in the number of motorcycle couriers, especially during the pandemic period (38). Also, the high rates of tractor and tractor-trailer fatalities in Turkey may be explained by the use by the aim of passenger transportation of tractors and tractor-trailers, although they were manufactured for goods transportation and farming purposes and had no protective measures for passengers.

Data from China in 1997 showed that personal faults contributed to 92.9% of MVAs; 88% of MVAs were caused by faults of the drivers of motorized and non-motorized vehicles, and 4.9% were caused by faults of the passengers and pedestrians (39). In 96% of MVAs in the US (40) and 80% of MVAs in Ethiopia, driver fault was in the foreground (41). Most MVAs (88.5%) were caused by drivers, according to the findings of the study. Pedestrian faults came in second with 8.6%, followed by vehicle faults (1.3%), passenger faults (0.9%), and road and environmental conditions (0.6%) (Table 6). Environmental conditions including inadequate street illumination, slippery or wet road conditions, and rough road surfaces can have a big impact on the frequency and severity of MVAs, according to Fararouei et al (42). Although the fault rates attributed to road and environmental conditions were defined as very low in the current study and many previous studies, the high rate of fault attributed to drivers for "not adjusting the vehicle speed according to road, weather, and traffic conditions" was evaluated as an indicator that traffic experts primarily consider personal faults.

Limitations of the Study: The authors were unable to evaluate several elements due to the data used in the current study is restricted to the content found on the TUIK website. These included the combined effects of gender and age groups, correlations between accident hours and the days and seasons, the effects of the weather and the kind of road, etc.

Despite the construction of new roads and upgrades to existing ones, Turkey still has a high number of MVAs, and fatalities and injuries from them. The UN General Assembly set a fifty percent decrease as the target for fatal and injury MVAs as part of its 10-year plan of action. This target is still considerably far from the rates defined in MVAs in Turkey.

Achieving the WHO General Assembly's target in Turkey requires an emergency action plan for safe road vehicle traffic. To create this plan, a road safety committee must be established with broad participation from scientists from other fields and members of the public across the country. This committee should conduct a thorough re-evaluation of the major components of traffic, including road structure, traffic flow, the number of vehicles and their characteristics, driver characteristics, and many driver-related issues, particularly driver training methods and psychological evaluations.

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