The epidemiology of the railway related casualties

Demiryolu taşımacılığı ile ilişkili ölüm ve yaralanmaların epidemiyolojisi

Mehmet ÖZDOĞAN,[1] Sami ÇAKAR,[2] Fatih AĞALAR,[3] Mehmet ERYILMAZ,[4]
Bülent AYTAÇ,[5] Kuzey AYDINURAZ[3]

BACKGROUND

Railway related accidents and incidents account for 150-200 deaths per 100 million passengers annually in Turkey. The aim of this study was to evaluate the epidemiological aspects of these casualties.

METHODS

The data about railway related casualties between January 1997 and December 2003 were retrospectively analyzed in Turkey.

RESULTS

Railway related accidents and incidents resulted in 213,3 deaths per year per 100 million passengers during the study period. Train-pedestrian accidents caused highest number of mortality and level crossing accidents caused highest numbers of casualty. Furthermore, suicide attempts had highest mortality ratio in railway related accidents. The majority of the fatalities and injuries occured in males for every type of incident and most of the injuries have taken place in the 25-60 age group. Summer time was the season with the highest number of fatalities and injuries.

CONCLUSION

Measures should be taken to improve railway safety. These include prevention of direct exposure of pedestrians to the railway tracts and conditioning the level crossings.

Key Words: Accidents; railroads; retrospective studies; suicide; wounds and injuries/epidemiology.

AMAÇ

Türkiye'de demiryolu taşımacılığı ile ilişkili kazalar sonucunda, yılda taşınan 100 milyon yolcu başına 150-200 ölüm gerçekleşmektedir. Bu çalışmada amacı demiryolu taşımacılığı sırasında gerçekleşen ölüm ve yaralanmaların epidemiyolojik analizi yapıldı.

GEREÇ VE YÖNTEM

Türkiye'de Ocak 1997-Aralık 2003 tarihleri arasında gerçekleşen yaralanma ve ölümlü demiryolu kazalarına ait bilgiler geriye dönük olarak incelendi.

BULGULAR

Demiryolu ile ilişkili kaza ve olaylar yıllık 100 milyon yolcu başına 213,3 ölüme neden olmaktadır. Tren-yaya çarpışmaları en fazla sayıda mortaliteye, hemzemin geçit kazaları en fazla sayıda yaralanmaya neden olmuştur. İntihar amacı ile tren yollarının kullanılması demiryollarında en yüksek mortalite oranına sahip olaylardır. Ölüm ve yaralanmaların büyük çoğunluğu erkek cinsiyette ve 25-60 yaş grubunda görülmüştür. En fazla ölüm ve yaralanma yaz döneminde meydana gelmiştir.

SONUÇ

Demiryolu taşımacılığında güvenliği arttırıcı önlemlerin alınması gerekmektedir. Bu önlemlerin başında yayaların demiryoluna girmemesini sağlayacak önlemler ve hemzemin geçitlerin durumunun iyileştirilmesi gelmektedir.

Anahtar Sözcükler: Kazalar; trenyolu; retrospektif çalışma; intihar; yaralar ve yaralanma/epidemiyoloji.

[1]3rd Department of General Surgery, Atatürk Training and Research Hospital, [2]Department of General Surgery, Gazi Hospital, Ankara; [3]Department of General Surgery, Medicine Faculty of Kırıkkale University, Kırıkkale; [4]Department of Emergency Surgery GATA, [5]Department of General Surgery, Medicine Faculty of Gazi University, Ankara, Turkey.

[1]Atatürk Eğitim ve Araştırma Hastanesi, 3. Genel Cerrahi Kliniği, [2]Gazi Hastanesi, Genel Cerrahi Kliniği, Ankara; [3]Kırıkkale Üniversitesi Tıp Fakültesi, Genel Cerrahi Anabilim Dalı, Kırıkkale; [4]Gülhane Askeri Tıp Akademisi, Acil Tıp Anabilim Dalı, [5]Gazi Üniversitesi Tıp Fakültesi, Genel Cerrahi Ana Bilim Dalı, Ankara.

Correspondence (*İletişim*): Mehmet Özdoğan, M.D. Mertler Sok., No: 41 / 7, 06510 Beştepe, Ankara, Turkey.
Tel: +90 - 312 - 291 25 25 / 4303   Fax (*Faks*): +90 - 312 - 291 27 05   e-mail (*e-posta*): mehmetozdogan01@superonline.com

Turkish railway carries about 100 million passengers every year through a total tract length of more than 10.000 km. Approximately 150 to 200 deaths and several times injuries are caused by train accidents and railway-related incidents in Turkey;[1] but this raw data has not been analyzed before. The aim of this study was to evaluate the epidemiological aspects of these casualties in Turkey.

MATERIALS AND METHODS

Railway related casualties between January 1997 and December 2003 were retrospectively analyzed considering the demographic data, and risk factors related to the accidents and incidents. The data was obtained from the accident-incident forms of the Turkish State Railways. These forms are composed of official records of the Accident and Incident Office of Turkish State Railways which are regularly completed for every railroad related incident. The forms are, unfortunately, not on a computerized database system and they were manually searched for the variables of interest during the entire study. This was a limiting factor in expanding the study beyond the seven-year study period.

Railway related casualties occur in different ways: Level-crossing accidents (LCA), train-pedestrian accidents (TPA), falls from trains, suicide attempts, violence and others. Level-crossing accidents included crashes between trains and all types of other motorized and non-motorized transportation vehicles. Casualties due to TPA and falls from train in which a letter of suicide has been left behind, accurate eyewitness have existed according to official police records or in the presence of a personal confession have existed, were categorized as suicides or suicide attempts when appropriate. Train-train crashes, derailments, electricity accidents and other rare incidents were categorized as "Others". This categorization of the incidents depends on the classification system used in the official reports of the Accident and Incident Office of Turkish State Railways. We have unfortunately not detailed medical records about the injured organs or autopsy records. Therefore, detailed medical analysis of railway related casualties has not been included in this study.

Turkish State Railways designated seven geographically different administrative regions in Turkey. We used these official divisions to evaluate the fatalities due to LCA and suicides in Tables 3 and 4. Centers of Railway Administrative Regions and their populations are as follows:

1. Istanbul (Trace and Marmara Region, population: 12.409 million),

2. Ankara (Capital, Central Anatolia Region, population: 6.283 million),

3. Izmir (Western Anatolian Region, population: 7.841 million),

4. Sivas (Eastern Anatolian Region, population: 3.724 million),

5. Malatya (South-eastern Anatolian Region, population: 4.120 million),

6. Adana (Southern Anatolian Region, population: 6.528 million),

7. Afyon (Internal Eastern Anatolian Region, population: 4.457 million).

RESULTS

The distribution of railway related fatalities and injuries between January 1997 and December 2003 according to the accident and incident types and sex are shown in Table 1. Railway related accidents and incidents resulted in 213,3 deaths per year per 100 million passengers during the study period. Train-pedestrian accidents were the most common cause of deaths followed by LCA and suicides. Suicides were the third leading cause of death but had the highest mortality ratio (82,5%) followed by TPA (60,5%).

The fatality and injury rates per year per one million population for all age groups were shown in Fig. 1 and 2. The majority of the fatalities and injuries were males (77% and 76% respectively) for every type of incident and most of injuries occurred in 25-60 age group. Train-pedestrian accidents were the most common cause of fatalities for all age groups. The exception was 25-60 age group, for which LCA were the most common cause of death (37,6%, n=330). Level-crossing accidents were the most common cause of injuries for all age groups and had highest fatality rate for 25-60 age intervals. Train-pedestrian accidents and suicides had highest fatality rate in >60 age group (Fig. 1). Level-crossing accidents had highest injury rate in 25-60 age groups and falls had highest injury rate in 15-24 age groups (Fig. 2).

Majority of the casualties occurred between 09:00 and 21:00, and most of them were within 09:00-17:00 period during which the maximum security measures should have been taken (Table 2). Most of the violence victims were assaulted within 17:00-21:00 period. Summer time was the season with the highest number of fatalities and injuries (Fig. 3).

First administrative region had the highest suicide fatality rate per year per one million population (Table 3). This region includes Istanbul, the biggest metropolitan of Turkey and Marmara region which has the highest economic income compared with the other regions of Turkey. Second and third administrative regions represent also developed regions of Turkey and had higher sui-

Table 1. Distribution of the railway related casualties according to the types of the incidents and sex

Types of accidents and incidents	Fatalities		Injured		Total casualties		Mortality ratio (%) (Fatalities/Total casualties)
	n	%	n	%	n	%	
Level-crossing accidents	419	28,1	1333	49,3	1752	41,8	23,9
Train-pedestrian accidents	633	42,4	413	15,3	1046	24,9	60,5
Falling from trains	88	5,9	643	23,8	731	17,4	12,0
Suicide or suicide attempts	326	21,8	69	2,6	395	9,4	82,5
Violence	5	0,3	149	5,5	154	3,7	3,2
Others	22	1,5	95	3,5	117	2,8	18,8
Total	1493	100	2702	100	4195	100	35,6

Table 2. Time distributions of casualties during the time periods of the days

	Casualties						
Hours	LCA	TPA	F	S or SA	V	O	*Total*
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
05-09	316 (18,0%)	154 (14,7%)	89 (12,2%)	74 (18,7%)	9 (5,8%)	16 (13,7%)	658 (15,7%)
09-17	684 (39,0%)	516 (49,3%)	299 (40,9%)	162 (41,0%)	44 (28,6%)	60 (51,3%)	1765 (42,1%)
17-21	448 (25,6%)	251 (24,0%)	195 (26,7%)	75 (19,0%)	65 (42,2%)	18 (15,4%)	1052 (25,1%)
21-05	304 (17,4%)	125 (12,0%)	148 (20,2%)	84 (21,3%)	36 (23,4%)	23 (19,6%)	720 (17,1%)
Total	1752 (100%)	1046 (100%)	731 (100%)	395 (100%)	154 (100%)	117 (100%)	4195 (100%)

LCA: Level-crossing accidents; TPA: Train-pedestrian accidents; F: Falls from trains; SA: Suicide attempts; S: Suicide; V: Violence; O: Others.

Table 3. Distributions of fatalities due to suicides within the administrative regions of the Turkish State Railways

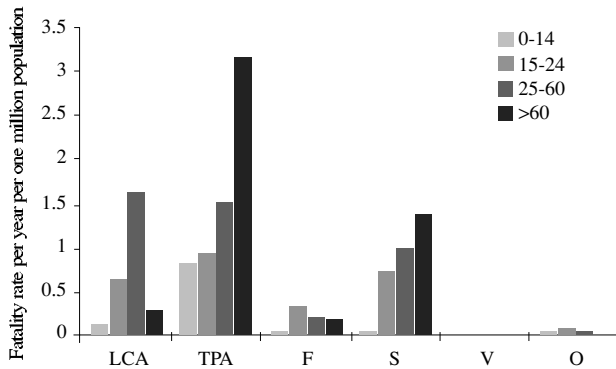| Regions	Number of fatalities in first 5 years (rates/year/million population)	Number of fatalities in second 2 years (rates/year/million population)	Total number of fatalities (rates/year/million population)	%
1	113 (1,82)	69 (2,78)	182 (2,10)	55,8
2	36 (1,15)	18 (1,43)	54 (1,23)	16,6
3	38 (0,97)	13 (0,83)	51 (0,93)	15,6
4	3 (0,16)	2 (0,27)	5 (0,19)	1,5
5	2 (0,10)	2 (0,24)	4 (0,14)	1,2
6	18 (0,55)	6 (0,46)	24 (0,53)	7,4
7	3 (0,14)	3 (0,34)	6 (0,19)	1,9
Total	213 (0,94)	113 (1,25)	326 (1,03)	100

Fig. 1. The graphics of the fatalities according to the age groups and accident/incident types. (LCA: Level-crossing accidents; TPA: Train-pedestrian accidents; F: Falls from trains; S: Suicide; V: Violence; O: Others.)
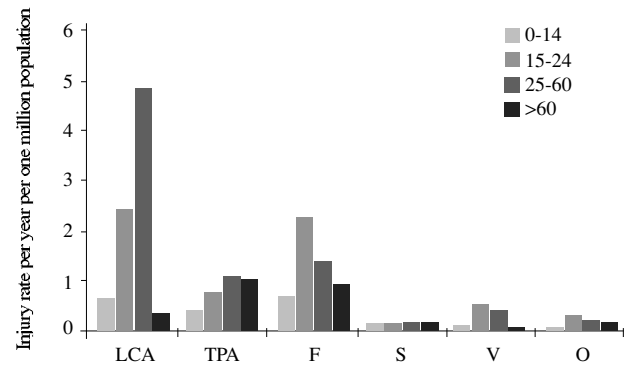

Fig. 2. The graphics of the injured according to the age groups and accident/incident types. (LCA: Level-crossing accidents; TPA: Train-pedestrian accidents; F: Falls from trains; S: Suicide; V: Violence; O: Others.)

cide fatality numbers than the rest of the country. During the last two years of the study period, a trend toward an increase in the suicide fatality in the railways was observed, and this was especially prominent for the 1st and 2nd regions.

Administrative regions 3, 6 and 7 had the highest fatality rates due to level-crossing accidents (Table 4). These three regions have wide agriculture plants and especially regions 3 and 6 do imports lots of seasonal part-time workers in summer time.

DISCUSSION

Transportation by railway is cheap and safe.[2] Turkey has a widespread railway network although it is questionable whether this cheap and secure

way of transportation is being used functionally, effectively and safely. In this study we aimed to analyze the epidemiology of railway related casualties through a medical point of view.

This study carries some short-comings. First of all, data was on separate files of sheets and it must have been searched manually.

This kind of a method in searching such a big load of data might have caused to overlook some data. Another drawback was the absence of autopsy records of the fatalities and of detailed medical records about the injured organs in injured cases. Therefore, medical analysis of railway related casualties could not been included in this study.

Table 4. Distributions of fatalities due to level-crossing accidents within the administrative regions of the Turkish State Railways

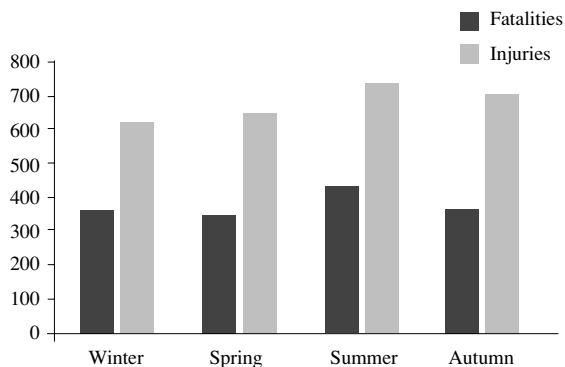| Regions	Number of fatalities (rates/year/million population)	%	Number of injuries (rates/year/million population)	%
1	59 (0,68)	14,1	185 (2,13)	13,9
2	57 (1,30)	13,6	191 (4,34)	14,3
3	105 (1,91)	25,1	325 (5,92)	24,4
4	29 (1,11)	6,9	113 (4,33)	8,5
5	21 (0,73)	5,0	129 (4,47)	9,7
6	83 (1,82)	19,8	256 (5,60)	19,2
7	65 (2,08)	15,5	134 (4,30)	10,0
Total	419 (1,32)	100	1333 (4,20)	100

Fig. 3. Distribution of the casualties according to the seasonal variations. (Winter: December, January, February; Spring: March, April, May; Summer: June, July, August; Autumn: September, October, November.

The data source, on the other hand, is official and absolutely reliable and this adds to the power of the study.

Railway related accidents result in 18000 injuries and 1200 fatalities every year in USA.[3] Fatality rates per 100 million passengers are 60 in South Africa and 150 in India where train is the most preferred mode of transport.[4,5] Approximate annual fatality rate of 200 per 100 million passengers in Turkey seems to be too much when compared with developed and other developing countries. Railway related casualties in developed countries do generally occur in undergrounds and suburban train systems and are mainly composed of suicide attempts.[6,7] The spectrum is wider in Turkey.

The kinetic energy transferred by a moving train to a pedestrian is proportional to the mass and velocity of the train (Kinetic Energy=1/2 mV^2). Therefore an enormous amount of energy is transferred to the body of a person when crashed by the train, resulting in massive injuries and high mortality rate. It has been previously reported that TPA had a high mortality.[8-10] Train-pedestrian accidents were the leading cause of death and were responsible from the 42,4% of all fatalities with a 60,5% mortality ratio in this study. Considerable amount of population live in outskirts of big cities in Turkey, usually located near to the railway roads. This results in increased incidences of accidents and fatalities due to passing across on the lines in the absence of accurate protec-

tion, pedestrian subways and bridges in rural, suburban and even in urban areas.

Level-crossing accidents were the leading cause of total casualties and injuries, and the second most common cause of mortality in this study. There are 4693 level-crossings in Turkey by the year 2000, and 91,2% of them are inappropriately conditioned, regarding barrier and signalization systems.[11] Level-crossing accidents had the highest fatality rate in region 7 which is the most underdeveloped region of Turkey. Level-crossing accidents have been reported to be a major cause of death in railway related accidents in developed countries too. In United States of America where more than 170.000 level crossings exist, 4400 accidents occur every year[12] with a mortality ratio between 15-25%.[13,14] Inappropriate physical conditions of level crossings, insufficient warnings to drivers, and motor-vehicle driver related factors, such as drunk driving, are all risk factors. It has been estimated that a level crossing with automatic barriers and signalization would cost nearly 25000 USD.[15] Considering this high cost, authorities must be informed that conditioning the level crossings with automatic barriers and electronic signalization was reported not only to decrease the accidents, but also the severity of the injuries resulting from them.[2]

Suicides in railways had the highest mortality ratio (82,5%) and constituted third leading cause of all deaths in this study. The proportions of suicide attempts in railway related casualties vary from 12% to 89% and mostly occur in undergrounds and urban railway systems.[16-18]

In this study it was found that they occurred more commonly during 09:00-17:00 day time in Turkey. In previous studies, it has been reported that suicide attempts occurred more commonly in the early morning hours.[19,20] In a study from Turkey performed by the members of this study group evaluating the TPA in a specific region[8] also found that nearly half of the suicide attempts occurred in the early morning hours. Present study analyzed the nation-wide occurrence of suicides and the difference in findings between a specific region, namely Ankara, the capital of Turkey, and whole country needs to be investigated in a psychological aspect. Majority of the fatalities due to suicides occurred in economically developed

regions of the country. One interesting finding is that during the last two years of the study period, a trend toward an increase in the suicide fatality in the railways was observed, which was especially true for the biggest city (Istanbul) of Turkey and its near periphery. This finding is in accordance with the increase trend in crude suicide rate for entire country and particularly for the first administrative region. Total crude suicide rate in Turkey increased from 2,80 to 3,77 and the figure increased from 2,97 to 4,20 per 100.000 population in the above mentioned region.[21] An economical crisis which stroked Turkey in the year 2.000 might possibly have caused this trend.

Falling from trains was found to be the third leading cause of casualties following LCA and TPA. It has a lower mortality ratio than the other types of accidents. Falls accounted for the 5,9% of the fatalities although it is responsible from 23,8% of all injuries. Falls from trains have been found to be the most common type of the train-related injuries in some studies,[10,17] whereas it caused no mortality in others.[8]

Falls occurred during attempts of train surfing, premature boarding on the train, escaping from train inspectors and so forth. Majority of these falls happened when the train were still in the stations or had not accelerated yet, explaining the relatively low mortality ratio of this type of accidents.

Railway related casualties occurred throughout the year but more frequently in summer. It was also found that level-crossing accidents caused higher fatality rates in agriculture regions which import lots of seasonal part-time workers especially in summer time. Tractors and open trucks are usually used to transport these seasonal farm workers. Considering these facts together, level crossings which are unmanned and technically inadequate should be supposed to be a major threat for public health especially in rural areas.

CONCLUSION

Train-pedestrian accidents cause highest number of mortality, LCA cause highest numbers of total casualty and suicide attempts have highest mortality ratio in railway related accidents. Authorities, especially in under-developed and developing countries, should be informed and forced to take measures to improve railway safety.

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