Pedestrian Fatalities Resulting From Train–Person Collisions

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Received 12 March 2014, Accepted 8 April 2014

Objective: Train–person collisions have a significant impact in our society, due to their negative economic and psychological effects. This work aims to study fatalities resulting from train–person collisions in Portugal.

Methods: A retrospective study was conducted based on the analysis of autopsy reports related to train–person fatalities performed in the North Branch of the National Institute of Legal Medicine and Forensic Sciences.

Results: Suicide was responsible for most of the cases, and males were more often involved in train–person collisions than females. Victims, between 40 and 59 years old, were found to be involved in a high percentage (39%) of the cases, and people older than 65 accounted for a significant percentage (40%) of the accidents. No seasonality was observed in suicide cases, but a decrease in accident numbers was registered in summer. Regarding weekday and time of day, afternoon and non–rush hour were the times when most suicides were observed, whereas accidents did not showed a specific weekday or time of day, except for rush hour, during which they were more frequent. Alcohol-positive blood analysis accounting for 25% of the cases.

Conclusions: Differences from other European studies were found, which may be related to the different cultures of the countries/regions, as well as to the differences in the railway systems. More extensive studies must be performed in order to develop strategies to prevent train–person collisions.

Keywords: train–person collision, suicide, accident, toxicological results

Introduction

Train–person collisions have a significant impact in our society. In addition to the obvious economic impact resulting from the delays, there are the negative psychological effects on the people involved, namely, engine drivers, other railroad and rescue employees, and people who witness the event (Engelhard et al. 2001; Limosin et al. 2006; Radbo et al. 2005; Silla and Luoma 2012; van Houwelingen et al. 2010; Vatshelle and Moen 1997).

The study by Silla and Luoma (2012) in Finland showed that between 2005 and 2009, 85% of the pedestrians killed in train–pedestrian collisions were suicides, but they only represented 5% of the total suicides within that time period. Similar proportions of railway suicides have also been reported in other European countries; that is, 5% in England and Wales (Silla and Luoma 2012), 5% in Sweden (Radbo et al. 2005), and 5% in Belgium (Andriessen and Krysinska 2012). In Germany (Hegerl et al. 2013) and in The Netherlands (van Houwelingen et al. 2010), results revealed a slightly greater percentage, with train suicides accounting for 8% and 10–14%, respectively, of all suicides.

There is often a difficulty in determining whether a particular fatality is a result of an accident or a suicide, because in many cases the available information is not enough to make a definitive classification (Silla and Luoma 2012). However, determining the underlying intent of railway fatalities is overall simpler than other types of fatalities, like drowning or intoxication, because in these cases a witness (engine driver or bystanders) is nearly always present and can give valuable information regarding the behavior of the victim in the moments before the event (Reynders et al. 2011).
Several different factors can influence the train related suicide rates. Radbo and Andersson (2012) reported that about half of all victims were influenced by alcohol, medicines, and/or drugs and that suicides were most frequent from afternoon to night and accidents during the afternoon rush hours. Systematic daily variations in train-related suicide rates have also been described (van Houwelingen et al. 2010), related to the hour of the day and to light–dark cycle. Radbo and Andersson (2012) found that most train–pedestrian fatalities happened in densely populated areas, which is contrary to the findings of van Houwelingen et al. (2010), who concluded that, in The Netherlands, suicide rates are unrelated to regional population density. The latter authors also found that the vicinity to a psychiatric hospital increases the risk (van Houwelingen and Kerkhof 2008; van Houwelingen et al. 2010). Indeed, 53% of all victims of train-related suicides received psychiatric care at the time of suicide, with half of them being in-patients with severe psychopathology (van Houwelingen and Kerkhof 2008; van Houwelingen et al. 2010). Gorrie et al. (2008) observed that the cognitive decline associated with neurodegenerative diseases such as Alzheimer’s may put this population at greater risk of certain types of crashes, namely, accidental ones.

Measures have been proposed to reduce the number of train–person fatalities. Some are related to reducing accidents by 3 countermeasures (landscaping, building a fence, and prohibitive signs). Silla and Luoma (2011) showed a positive effect in reducing trespassing. Others studies (Lobb et al. 2001, 2003) found that educational interventions had less significant impact on illegal and unsafe crossing of the tracks than punishment (in young people) and access to preventive measures. Strategies have also been implemented to prevent suicide by train. Law et al. (2009) found that the use of screen doors is an effective measure to prevent railway suicides. Matsubayashi et al. (2013) suggested the placement of blue lights on train platforms as a cost-effective method for suicide prevention. However, authors advise caution in interpretation of their results. Indeed, they concluded that the placement of the mentioned lights could be effective in discouraging people from committing suicide at a particular place but may not necessarily be a way to reduce the overall suicide rate. A list of 20 independent preventive strategies aiming to reduce perceived attractiveness and availability, influence accessibility to track areas and the potential of collision, mitigate consequences of collision and medical survival and recovery strategies was recently proposed (Radbo and Andersson 2012).

Even though, as aforementioned, there are some studies that describe the epidemiology and etiology of train–pedestrian collisions in some European countries, their validity for different countries can be questioned, because there are differences between the railroad systems, which can affect the prevention strategies that can be implemented (Radbo et al. 2005). Therefore, this work aims to study fatalities resulting from train–person collisions by characterizing the victims, etiology of the cases, and predisposing factors such as drug exposure in order to develop preventive measures that best fit to this reality.

Material and Methods

A retrospective study was conducted based on the analysis of autopsy reports related to train–person fatalities registered in the northern region of Portugal during 2008–2012. Data were obtained from the database of the North Branch of the National Institute of Legal Medicine and Forensic Sciences, which contains the autopsy reports from the northern region of Portugal.

A specifically customized data collection form was used and applied by the same investigator, who was previously trained, to guarantee data repeatability and reproducibility. Data regarding the etiology, gender, age, time of occurrence, and toxicological results were obtained. Age groups were divided in 10-year intervals, as well as 65 or younger or older than 65 years old. Concerning time of occurrence, both unintentional (accidental) and intentional (suicides) cases were grouped by season, time of week (week/weekend), time of day, and hour (rush hour/not rush hour). The time of day was divided in morning (5 a.m.–1 p.m.), afternoon (1 p.m.–8 p.m.), and night (8 p.m.–5 a.m.). Rush hour was considered from 6 a.m. to 10 a.m. and from 5 p.m. to 9 p.m. taking into account the period of moving to/from work. Toxicological results of the victims were classified according to the drug classes tested, namely, alcohol, opioids, cocaine/metabolites, cannabinoids, amphetamines, methamphetamines, and medicines according to the current Portuguese law (Dinis-Oliveira et al. 2010c). Due to the retrospective nature of the study, from the 105 cases registered within the time period of the study, the information needed was available only for 97 of the cases (corresponding to approximately 1% of the total autopsies performed).

Statistical analyses were performed using the Statistical Package for Social Sciences (Ver. 22; IBM, Portugal). The main results are presented in frequency tables and chi-square test was performed to assess independence between 2 variables. All P values were considered statistically significant if <.05.

Results and Discussion

Characterization of the Etiology

The etiology the train–pedestrian fatalities was defined by the forensic doctor after taking into consideration the circumstances of death, social and police information, and the results of the forensic autopsy. Thus, 60.8% were classified as suicide, 30.9% as accidental, and 8.2% as undetermined (Table 1). Although the majority of the cases of cases were related to suicidal behavior, these only represented 3.8% of the suicides registered in northern Portugal from 2008 to 2012. This percentage varied significantly (P < .05) throughout the 5-year period, decreasing from 6.5% in 2008 to 1.4% in 2011, but a slight increase, to 2.7%, was registered in 2012. The total number of train–person fatalities also significantly varied (P < .05) throughout the study, exhibiting an important decrease after 2009. There is no absolute explanation for this decrease. Nevertheless, in 2009 an advertising campaign was launched on Portuguese public television to reduce...
train–person fatalities. Also aiming to take preventive measures to reduce suicide events, some authors (Pompili et al. 2010; Pompili et al. 2010) have suggested the great importance of psychological autopsy to characterize the psychological background of the victims.

Characterization of Victims

Results presented in Table A1 (see online supplement) showed that the etiology did not depend on gender ($P > .05$). Most victims were found to be males (62%), which accounted for 56% of the suicides, 67% of the accidents, and 87.5% of the cases classified as undetermined. The male : female ratios were 1.3:1 for suicide and 2:1 for accidents. In other studies performed in Sweden (Radbo and Andersson 2012; Radbo et al. 2005) and Finland (Silla and Luoma 2012) it was also showed that male victims are more common than female but the ratios were higher. Suicide was the leading manner of death, representing 55% of the fatalities for males and 70% for females. Accidents accounted for 33% of fatalities for males and 27% for females.

Regarding victims’ age, a dependence between etiology and age interval was found ($P < .05$). In accordance with the findings of Radbo and Andersson (2012), fatalities were mostly registered for the age groups 40–49 and 50–59. In Finland, the proportion of suicide victims under 40 years old was reported to be 58.7% (Silla and Luoma 2012), though we found it to be only 27.1%. Another study, performed in The Netherlands (van Houwelingen et al. 2010), found that for males the most suicides occurred in the 20–29 age group and for females in the 30–39 age group. Our results differ from those, with the 40–49 age group encompassing 33.3% of the male suicides and the 50–59 group accounting for 30.8% of suicides among females.

No dependence ($P > .05$) was found between etiology and being older than 65 years (Table A2, see online supplement). Although older people represented only 27% of the total fatalities, they were involved in 40% of the accidental cases. As proposed by Gorrie et al. (2008), the cognitive decline associated with dementia disorders can lead to behaviors that put this population at greater risk than the average person.

Time of Occurrence

Any dependence was found between etiology and season (Table A3, see online supplement). These results were somewhat similar to the results found in several other studies (Radbo and Andersson 2012; Radbo et al. 2005; Silla and Luoma 2012; van Houwelingen and Beersma 2001), where weak seasonal variations were reported. In the study performed by Radbo and Andersson (2012), there was no significant difference ($P > .05$) between spring and winter; summer presented a significantly ($P < .05$) lower percentage and autumn had the lowest. In 2005, a slightly elevated mean frequency was observed in the warmer seasons (spring and summer). Silla and Luoma (2012) also reported similar seasonal results in Finland, with the only season that considerably differed from the others being winter, which presented the lowest percentage of suicides. In The Netherlands, van Houwelingen and Beersma (2001) also found no pronounced seasonal dependence for train suicides.

However, when we look at suicides throughout the different years (Fig. 1), we see a different scenario. Spring showed a significant ($P < .05$) decrease in suicide percentage from 2008 to 2009, but a significant ($P < .05$) increase was registered in 2011, when it was the season when most suicides took place. In 2012, the observed percentage returned to the previous ones. Summer presented no significant variation ($P > .05$) throughout the years, except for 2011, when no suicides were registered in this season. In the first 2 years, autumn showed a significant increase ($P < .05$), with the most suicides in 2009. However, from 2010 to 2012, no suicides were reported in this season. In the third and fourth years of the study, winter presented a significant ($P < .05$) increase compared to the first 2 years, and in the last year (2012) it reached the highest percentage (62.5%) and was the season during which the most suicides were registered.

Seasonal overall results showed winter to be the season when most accidents were reported, followed by both spring and autumn; summer had the fewest. These results can possibly be explained by the fact that in Portugal, trains are usually utilized by people who live outside the metropolitan areas as a mean of transportation to get to work. Hence, because summer is a time when most of the population goes on vacation, movement surrounding the railways is diminished, which lowers the probability of accidental train–person fatalities. Yearly results (data not shown) showed similar percentages between seasons, except for spring, in 2012, where it was the only season where accidents were reported ($n = 2$), and for winter (2010) and summer (2008 and 2011), with no accidental fatalities.

For the relationship between etiology and weekday, time of day, or hour (Table A4, see online supplement), no statistical significance were observed ($P > .05$). Suicides occur more frequently during the weekdays, mainly during the afternoon (44.2%) and not during rush hour (55.8%). Accidents were evenly distributed throughout the week, with a very slight difference between morning and afternoon and, as expected, more frequently during rush hour (66.7%), because there are more people surrounding the railways. In accordance data provided by Silla and Luoma (2012), we found that afternoon rush hour was the time of day during which most accidents happened, accounting for 40.7%. Analyzing day of the week, Silla and Luoma (2012) observed that suicides and accidents were more frequent at the end of the week (49.2 and 65.7%)
Train–Person Collisions

Fig. 1. Suicides by train–person collision, throughout 2008 to 2012, in spring (◇), summer (◇), autumn (◇), and winter (■).

from Friday to Sunday, which was not the case in our study where, for both etiologies, only 40% of the fatalities were registered in that time period. In contrast, both studies performed by Radbo (Radbo and Andersson 2012; Radbo et al. 2005) reported that suicides occur proportionally more often during weekdays, which is in accordance with our findings. The studies also found afternoon to be the time of day when suicide was the highest, and accidents occur primarily in the evening/at night time.

Toxicological Results

Blood for toxicological analysis was collected accordingly to Dinis-Oliveira and colleagues (Dinis-Oliveira et al. 2010; Dinis-Oliveira and Magalhaes 2013). Toxicological results were not possible in 19 cases (16.9%), due to the lack of enough blood to perform the analysis as a result of significant destruction of the body (Table 2). No dependence was observed (\( P > .05 \)) between the toxicological results and the etiology of the fatality. The results showed that 50% of the victims were under the influence of some type of substance. These results are in agreement with the findings of Silla and Luoma (2012), who found that 50.5% of victims were under the influence of any type of substance. Alcohol was the substance mostly detected, accounting for 50% of the samples that tested positive (25.6% of the total), and suicide was the etiology with the highest percentage. In 60% of the cases where alcohol was detected suicide was considered to be the etiology of the fatality. Medicines were detected in 30.8% of the positive cases (15.4% of the total), and in 75% of the cases they were considered to be implicated in the suicide event. Several substances (medicines and illegal drugs) were utilized in 7.7% of the cases, and cannabinoids were only detected in one case (accident).

Statistical differences (\( P < .05 \)) were observed between gender and intoxication. Among the male victims, 61% were found to be under the influence of some type of substance, which represented 69% of victims under the influence. Among females, only 35% had consumed any kind of substance, and this group accounted for 31% of the total positive toxicological results. Silla and Luoma (2012) found similar percentages, with males being more frequently under the influence than females, representing 55.5 and 37.3%, respectively.

The results pertaining to being under the influence of alcohol at the moment of the event can be explained (in the case of suicides) by the need for the victim to gain courage, or become more uninhibited, to attempt suicide (Dinis-Oliveira et al. 2010a; Dinis-Oliveira et al. 2014). In 58% of the accidents, alcohol was detected, which can be an indication of some kind of inappropriate/unsafe behavior of the victim that led to the event. Regarding medicines, results were positive for 18.5% of the males and 58.3% of the females. In Silla and Luoma’s (2012) study, female suicide victims were reported to suffer from mental health problems more frequently (58.4%) than males (31.2%). Therefore, the existence of a psychiatric or psychological pathology can explain the positive analyses for medicines.

In conclusion, like in other European countries, suicide was the main etiology of the train–person fatalities, but this suicide method only represented a small percentage of the total suicides registered in the region. Being under influence of alcohol or drugs was found to have a considerable impact in these cases, especially in suicides. More extensive studies must be performed in order to understand this phenomenon and to develop strategies to prevent train–person collisions.

Ethical Approval

This study was carried out in accordance with ethical rules. It was not submitted for ethical approval because it is a retrospective study based on medical reports and identification of the individuals was not given.

| Substance | Suicide | Accident | Undetermined | Total |
|-----------|---------|----------|--------------|-------|
| Alcohol   | 12      | 7        | 1            | 20    |
| Cannabinoids | 0     | 1        | 0            | 1     |
| Medicines | 9       | 2        | 1            | 12    |
| Several   | 3       | 2        | 1            | 6     |
| None      | 24      | 12       | 3            | 39    |
| Total     | 48      | 24       | 6            | 78    |
Funding

Ricardo Dinis-Oliveira acknowledges Fundação para a Ciência e a Tecnologia (FCT) for his Investigator Grant (IF/01147/2013).

Supplemental Materials

Supplemental data for this article can be accessed on the publisher’s website.

References

Andriessen K, Krysinska K. Railway suicide in Belgium 1998–2009: incidence and prevention. Crisis. 2012;33:39–45.

Dinis-Oliveira RJ, Carvalho F, Duarte JA, et al. Suicide by hanging under the influence of ketamine and ethanol. Forensic Sci Int. 2010;202:e23–e27.

Dinis-Oliveira RJ, Carvalho F, Duarte JA, et al. Collection of biological samples in forensic toxicology. Toxicol Mech Methods. 2010;20:363–414.

Dinis-Oliveira RJ, Magalhaes T. Forensic toxicology in drug-facilitated sexual assault. Toxicol Mech Methods. 2013;23:471–478.

Dinis-Oliveira RJ, Magalhaes T, Moreira R, et al. Clinical and forensic signs related to ethanol abuse: a mechanistic approach. Toxicol Mech Methods. 2014;24(2):81–110.

Dinis-Oliveira RJ, Nunes R, Carvalho F, et al. Ethical, technical and legal procedures of the medical doctor responsibility to accomplish the road enforcement law about driving under the influence of alcohol and psychotropic substances. Acta Med Port. 2010;23:1059–1082.

Engelhard IM, Macklin ML, McNally RJ, van den Hout MA, Arntz A. Emotion- and intrusion-based reasoning in Vietnam veterans with and without chronic posttraumatic stress disorder. Behav Res Ther. 2001;39:1339–1348.

Gorrie CA, Brown J, Waite PM. Crash characteristics of older pedestrian fatalities: dementia pathology may be related to “at risk” traffic situations. Accid Anal Prev. 2008;40:912–919.

Hegerl U, Koburger N, Rummel-Kluge C, et al. One followed by many?—long-term effects of a celebrity suicide on the number of suicidal acts on the German railway net. J Affect Disord. 2013;146:39–44.

Law CK, Yip PS, Chan WS, et al. Evaluating the effectiveness of barrier installation for preventing railway suicides in Hong Kong. J Affect Disord. 2009;114:254–262.

Limosin F, Loze JY, Cotherneau C, et al. A prospective study of the psychological effects of “person under train” incidents on drivers. J Psychiatr Res. 2006;40:755–761.

Lobb B, Harre N, Süddendorf T. An evaluation of a suburban railway pedestrian crossing safety programme. Accid Anal Prev. 2001;33(2):157–165.

Lobb B, Harre N, Terry N. An evaluation of four types of railway pedestrian crossing safety intervention. Accid Anal Prev. 2003;35:487–494.

Matsubayashi T, Sawada Y, Ueda M. Does the installation of blue lights on train platforms prevent suicide? A before-and-after observational study from Japan. J Affect Disord. 2013;147:385–388.

Pompili M. Exploring the phenomenology of suicide. Suicide Life Threat Behav. 2010;40:234–244.

Pompili M, Innamorati M, Vichi M, et al. Suicide prevention among youths. Systematic review of available evidence-based interventions and implications for Italy. Minerva Pediatr. 2010;62:507–535.

Radbo H, Andersson R. Patterns of suicide and other trespassing fatalities on state-owned railways in greater Stockholm; implications for prevention. Int J Environ Res Public Health. 2012;9:772–780.

Radbo H, Svedung I, Andersson R. Suicides and other fatalities from train–person collisions on Swedish railroads: a descriptive epidemiologic analysis as a basis for systems-oriented prevention. J Safety Res. 2005;36:423–428.

Reyners A, Scheerder G, Van Audenhove C. The reliability of suicide rates: an analysis of railway suicides from two sources in fifteen European countries. J Affect Disord. 2011;131:120–127.

Silla A, Luoma J. Effect of three countermeasures against the illegal crossing of railway tracks. Accid Anal Prev. 2011;43:1089–1094.

Silla A, Luoma J. Main characteristics of train–pedestrian fatalities on Finnish railroads. Accid Anal Prev. 2012;45:61–66.

van Houwelingen CA, Beersma DG. Seasonal changes in 24-h patterns of suicide rates: a study on train suicides in The Netherlands. J Affect Disord. 2001;66:215–223.

van Houwelingen CA, Beersma DG. Seasonal changes in 24-h patterns of suicide rates: a study on train suicides in The Netherlands. J Affect Disord. 2008;10:281–284.

van Houwelingen CA, Kerkhof AJ. Mental healthcare status and psychiatric diagnoses of train suicides. J Affect Disord. 2010;127:281–286.

Vatshelle A, Moen BE. Serious on-the-track accidents experienced by train drivers: psychological reactions and long-term health effects. J Psychosom Res. 1997;42:43–52.