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Train suicides in The Netherlands

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ABSTRACT

Background: Little is known about train suicide and factors influencing its prevalence. This study tests the hypotheses that railway density, railway transportation volume, familiarity with railway transportation and population density contribute to train suicide. It also tests the relationship between train suicide and general population suicide and examines the prevalence and the characteristics of high-risk locations and their contribution to the grand total of train suicides.

Methods: Trends in train suicides were compared with trends in railway track length, train kilometres, passenger kilometres and national suicide figures over the period 1950–2007. The geographical distribution over the national network over the period 1980–2007 was studied. Data were obtained from The Netherlands Railways, Prorail and Statistics Netherlands.

Results:

1. The incidence of train suicides is unrelated to railway parameters.
2. Being familiar with railway transportation as a passenger is not a contributory factor.
3. Train suicide rates are unrelated to regional population density.
4. The incidence of train suicides parallels that of general population suicides.
5. Half of the train suicides took place at a limited number of locations, the most important of which were situated within a village or town and were close to a psychiatric hospital.

Limitations: Most conclusions are based on correlational relationships between variables.

Conclusions:

1. Train suicide trends reflect trends in general population suicides.
2. Increased train transportation does not lead to more train suicides.
3. The prevention of train suicide at high-risk locations (HRLs) in built-up areas and near psychiatric hospitals deserves first priority.

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1. Introduction

Technological developments are often accompanied by undesirable side-effects. The development of rail transportation at the beginning of the nineteenth century led to the first officially recorded train suicide in England in 1852. At present, train suicides account for 10–14% of all suicides in the Netherlands, which is about twice as high as in Germany, Austria, England and Sweden (Van Houwelingen and Beersma,

2001; Symonds, 1985; Rådbo et al., 2005). Train suicides lead to high costs as a result of driver and bystander trauma, and delays to the service (O'Donnell et al., 1994), aspects that have been extensively reviewed elsewhere (Krysinska and De Leo, 2008; Ladwig et al., 2009).

It can be hypothesized that the number of train suicides depends upon:

- a. availability of railways and trains. This hypothesis was supported by the work done by Clarke (1994), who observed a positive correlation between the number of train suicides and track length. Contrary to this, Baumert

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- et al. (2005) observed that a reduction of track length was not followed by a reduction of train suicides. Subsequently, no time-trend related to mileage covered by trains was found in suicides aged 65 or under (Baumert et al., 2005).
- b. familiarity with trains as a means of suicide. Clarke's observation of a strong correlation between the number of train suicides and the number of railway passengers carried supports this hypothesis. He considered the number of passengers an indication of public familiarity with this suicide method (Clarke, 1994).
 - c. population density. In England, clusters of train suicides were found around major cities and towns, with a median distance of 1.8 km between residential location and place of death in 95% of the cases (Abbott et al., 2003). This combination of urban and proximity factors suggests that the most densely populated areas are at the highest risk.
 - d. the prevalence of general population suicides. The expectation that train suicides depend on the general suicide trend in a country was not supported by the study by Baumert, who found opposite trends: an increasing number of train suicides went together with a substantial decrease of suicides by all others means (Baumert et al., 2005).
 - e. the presence of high-risk populations near railways. Suicide risks of psychiatric inpatients have been described as being 30–40 times higher than those in the general population (Brunenberg et al., 1991). Several publications have indicated that high-risk locations (HRL) are found in the vicinity of psychiatric hospitals (Emmerson and Cantor, 1993; Erazo et al., 2004).

Accessibility and acceptability of the means of suicide may play complementary roles (Clarke and Lester, 1989). So far, these aspects of overground train suicides have not been systematically evaluated.

Studies on train suicide dealing with national population and railway variables are rare (Clarke, 1994; Baumert et al., 2005) and results are contradictory at times.

For this reason we set out to test hypotheses a–e in The Netherlands, a country with one of the most intensively used railway networks in the world and the highest percentage of train suicides. We were able to test the familiarity hypothesis in a natural experiment, as a spectacular increase of passengers (28.9%) and passenger kilometres (37.4%) was observed in 1991 after the introduction of free public transport for students aged 18 or over.

Although the existence of high-risk locations has been well-documented (Abbott et al., 2003; Emmerson and Cantor, 1993; Erazo et al., 2004) the proportional contribution of risk locations with varying degrees of severity is poorly understood. For this reason the frequencies at all risk locations were examined.

As male/female ratios of suicide methods may change over time (Centraal Bureau voor de Statistiek, 1995), the gender specificity of trends in the period 1980–2007 was investigated.

2. Methods

Demographic data and information regarding the location of suicidal behaviour in 1980–2007 was obtained from the Department of Corporate Communication of the *NV Nederlandse Spoorwegen* (The Netherlands Railways), who keep

records of all suicidal behaviour on the national railway network, with the exception of the underground, light rail and tram systems. Records are based on statutory investigations of every unnatural death by the local police and coroner.

The time window for this study was expanded to 58 years by adding the annual frequencies of transportation suicides (train and underground, unspecified) of 1950–1979, from *Centraal Bureau voor de Statistiek* (Statistics Netherlands). The component of underground suicides in this period is considered very small, as underground systems only started to function on a limited scale in two cities (Amsterdam and Rotterdam) in 1968 and 1977. Prorail and The Netherlands Railways provided data on the length of the national railway system, national and international passenger train and freight train kilometres as well as on passenger kilometres by all carriers on Dutch territory. Passenger kilometres by other companies were estimated by The Netherlands Railways and included in the dataset.

National suicide statistics and national population figures were obtained from Statistics Netherlands. Annual train suicide and general population suicide rates (per 100,000 inhabitants) were calculated over the period 1980–2007, based on the size of the population on January 1. Age was divided into 10-year bins.

Location coordinates were used to investigate geographical clustering and distribution of the suicides over 4 Dutch railway regions with different population densities: North East, Randstad North, Randstad South and South.

2.1. Statistical analysis

Chi-squared analysis for independence was used to assess the impact of free transport on the frequency of train suicides by youngsters.

3. Results

3.1. Characteristics of the 1980–2007 population

During this period, 5695 cases of suicidal behaviour were registered by The Netherlands Railways, comprising 5178 train suicides and 517 train suicide attempts, i.e. train contact with a non-fatal outcome. This makes the lethality of this suicide method 90.9%. The mean annual number of train suicides was 185 (SD = 18).

The train suicide/general population suicide proportion over the period 1980–2007 had a mean value of 11.5% (SD = 1.4, median 11.4, min 9.4–max 14.3).

The mean rate for train suicide is 1.21 per 100,000 inhabitants per year (SD = 0.13, median 1.17, min–max 0.99–1.55), for general population suicides 10.6 (SD = 1.3, median 10.3, min–max 8.3–13.2). The annual rates are shown in Table 1.

3.1.1. Age and gender

Information about age was missing in 271 cases (5.2%), information about gender in 125 cases (2.4%). Mean age = 40.0 (SD = 15.6, median 38, min–max 11–89). Maximum values for male train suicides were found in the age group 20–29, for female train suicides in the age group 30–39 (data not shown).

Table 1

Absolute numbers, rates (per 100,000 inhabitants) and M/F ratios of train suicides and general population suicides in The Netherlands in 1980–2007.

Year	Train suicides ^a (n)	General suicides (n)	Train/general suicides in %	Train suicide rate	General suicide rate	M/F ratio train suicides	M/F ratio general suicides
1980	155	1557	10.0	1.10	11.1	1.8	1.7
1981	157	1656	9.5	1.10	11.7	1.9	1.6
1982	166	1772	9.4	1.16	12.4	1.6	1.5
1983	187	1886	9.9	1.30	13.2	2.1	1.6
1984	189	1902	9.9	1.31	13.2	1.5	1.6
1985	175	1760	9.9	1.21	12.2	2.1	1.8
1986	197	1740	11.3	1.36	12.0	1.7	1.6
1987	198	1784	11.1	1.35	12.2	1.6	1.7
1988	196	1659	11.8	1.33	11.3	2.2	1.7
1989	231	1674	13.7	1.55	11.3	1.3	1.7
1990	178	1620	10.9	1.19	10.9	1.7	1.7
1991	183	1611	11.2	1.20	10.7	1.5	1.8
1992	219	1587	13.7	1.44	10.5	1.6	1.9
1993	182	1555	11.6	1.19	10.2	2.2	1.9
1994	216	1584	13.3	1.38	10.3	1.9	2.2
1995	180	1511	11.9	1.17	9.8	1.8	2.0
1996	156	1577	9.8	.99	10.2	2.2	2.0
1997	183	1570	11.5	1.16	10.1	2.1	2.0
1998	181	1519	11.8	1.14	9.7	2.1	1.9
1999	174	1517	11.2	1.08	9.6	2.5	2.0
2000	184	1500	12.1	1.14	9.5	2.1	2.0
2001	202	1473	13.7	1.26	9.2	2.1	2.2
2002	177	1567	11.2	1.09	9.7	2.2	2.1
2003	175	1500	11.5	1.07	9.3	1.9	2.1
2004	170	1514	11.2	1.05	9.3	2.1	2.1
2005	184	1572	11.7	1.13	9.6	2.4	2.2
2006	190	1524	12.5	1.16	9.3	2.4	2.2
2007	193	1353	14.3	1.18	8.3	3.6	2.3

^a Including suicides of non-residents (n = 31). Rates and ratios are exclusive of non-residents.

The proportion of train suicides of the general population suicides by age group revealed that almost a quarter of the suicides aged 10–19, boys (23.8%) and girls (23.9%), committed suicide by jumping before a train. The proportion of train suicides was seen to decrease steadily for both genders in subsequent age groups.

The M/F ratio over the years 1980–2007 was 3334/1719 (1.9). The M/F ratios of train suicides and general population suicides have both risen since the nineties of the previous century (Table 1).

3.2. Association with railway parameters

The number of train suicides started to rise significantly in 1970, kept increasing till 1989 and then gradually declined in the following years (Fig. 1).

Over the period 1950–2007 passenger kilometres and train kilometres (passenger and freight trains) showed an increase in railway mobility parallel to the national population growth, with the railway network remaining almost the same size (Fig. 1). Neither increase nor decrease of the numbers of train suicides would seem to bear any apparent relationship to the railway parameters presented.

The relationship between train suicide frequency and railway density was also examined by means of a cross-sectional analysis of train suicides in 4 railway regions. It appeared that regional train suicide rates did not correlate with regional railway densities (Table 2).

3.3. The association with familiarity

In order to study the impact of free transport for students, the frequencies of train suicides in the age group 18–25 and all other ages in two 5-year periods before and after the introduction of free transport for students in 1991 (1986–1990 and 1991–1995) were compared. Contrary to expectations it was found that in the age group 18–25 the number of

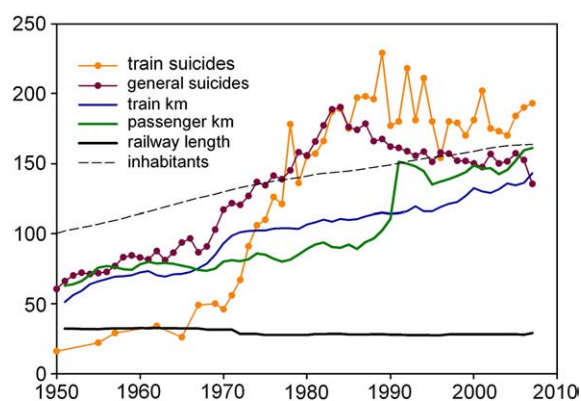


Fig. 1. Annual numbers of suicides and parameters of overground railway transportation in The Netherlands during 1950–2007. Includes: train suicides, general population suicides (divided by 10), train kilometres in millions, passenger kilometres in millions (divided by 100), length of the railway network (divided by 100) and the number of Dutch inhabitants (divided by 100,000). Train suicide data were incomplete in 1950–1969.

Table 2

Suicide statistics and other measures for 4 Dutch railway regions.

Region	Train suicides 1980–2007	Population density ^a	Train suicide rate ^b (n/100,000)	General suicide rate ^c (n/100,000)	Train rate/gen rate in %	Track-length in km	Rail density m/km ²	Train suicides 1980–2007 per km
NorthEast Rural	1587	275	1.28	10.34	12.4	1169	69	1.36
RndstdN Urban	1431	765	1.31	8.92	14.7	663	120	2.16
RndstdS Urban	626	1243	0.70	8.38	8.4	244	92	2.57
South Semi-rural	1482	425	1.31	10.44	12.5	600	61	2.47

^a On 1/1/2007.^b Average number of train suicides per year per 100,000 inhabitants of the railway region on 1/1/1997.^c Suicides per 100,000 inhabitants in 2005 of the provinces (roughly) matching the railway regions.**Table 3**

High-risk locations (HRL) of train suicides in The Netherlands over the period 1980–2007, stratified by categories of suicide frequency per kilometre.

HRL	Number of suicides per km	Number of locations ^a	Percentage of mean track length ^b	Number of suicides on all locations	Percentage of total number of train suicides, n = 4683 ^c
Category I	>=28	9	0.3	308	6.6
Category II	14–27	24	0.9	467	10.0
Category III	7–13	85	3.0	708	15.1
Category IV	4–6	223	8.0	1053	22.5
Category V	1–3	1427	51.0	2147	45.9
Category VI	0	1029	36.8	0	0
Total		2797	63.2	4683	100

^a Each location measures 1 km.^b Mean track length over period 1980–2007 is 2797 km.^c 495 train suicides of which the exact location could not be determined were not included.

train suicides had decreased slightly in the second period. These differences were significant for men and women taken together ($\chi^2 = 4.498$; $df = 1$; $P = 0.034$) and for men separately ($\chi^2 = 4.749$; $df = 1$; $P = 0.029$), but not for women ($\chi^2 = 0.499$; $df = 1$; $P = 0.48$).

3.4. The association with population density

In 1980–2007 similar rates of train suicides (1.3 per 100,000 inhabitants) were found in three railway regions with different population densities (Table 2). Remarkably enough, a much lower rate (0.7) was found in the most densely populated region, Randstad South.

3.5. The association with general population suicides

Fig. 1 shows trends in train suicides from 1970 to 2007. General population suicides showed a similar pattern, reaching a maximum in 1984. Train suicides, however, showed a much larger growth-rate in 1970–1984. In this period, general population suicides increased by 63%, whereas train suicides increased by 311%.

In order to understand the contribution of gender in the period of decline, rates differentiated by gender were calculated for the period 1980–2007 (Fig. 2). The decrease in general population suicides rates after 1984 is more pronounced in women, resulting in increased M/F ratios. Female train suicide rates decreased at a pace similar to that of female suicides in the general population. Male train suicide rates showed a large annual variation and no apparent downward trend.

3.6. High-risk locations (HRLs)

3.6.1. Geographical distribution

In 4683 out of 5178 train suicide cases, the exact location of the incident, expressed in kilometre and hectometre coordinates was either known or could be inferred (90.4%). A 1-kilometre resolution, corresponding to the railway grid, was chosen to analyse the geographical distribution. Below, every kilometre is referred to as a *location*.

All locations were divided into categories according to the number of train suicides taking place in 1980–2007. These categories range from very high: 28 or more suicides in 28 years (category I ($\geq 1/\text{km}/\text{yr}$)) to very low (1–3 cases in

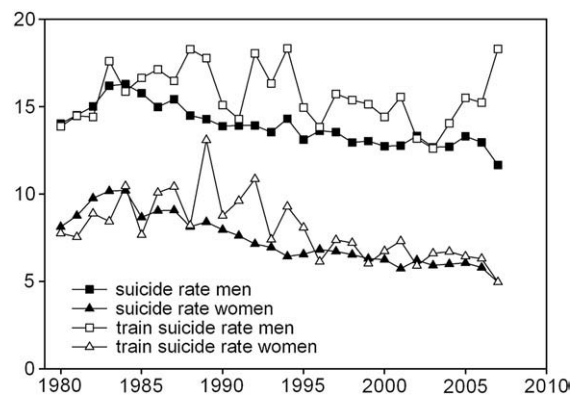


Fig. 2. Rates of train suicides (multiplied by 10) and general population suicides during the period 1980–2007 by gender (per 100,000 inhabitants).

28 years, category V) and ultimately to category VI with no incidents at all of fatal suicidal behaviour (Table 3).

It became evident that train suicides were clustered on relatively small sections of the national railway network. The majority of train suicides (54.2%) took place on 341 km (12.2%) of the network and, even more extremely, 16.6% took place on 1.2% of the tracks (categories I and II, Table 3). Furthermore, it was noted that a considerable number of suicides (45.9%) were spread over locations of very low frequency (category V, Table 3).

3.6.2. Location characteristics

A further investigation revealed that all locations of category I and 15 locations of category II were situated near 13 different psychiatric hospitals, which were within 800 meters' walking distance. All locations of category I and 20 of category II were situated within built-up areas.

3.6.3. Type of location

The totalized data over the years 2004–2007 showed the following distribution: platform 18.7%, level crossing 25.7% and open track 55.6%.

4. Discussion

4.1. Major findings

Train suicide frequency does not correlate with railway density or with the intensity of railway transportation. Familiarity with trains through travelling would not seem to be a contributing factor either. High population density in urban settings would not seem to contribute to the risk of train suicide. However, the prevalence of train suicides does correlate with that of general population suicides. About half of all train suicides are clustered on small sections of the railway network, the others take place at scattered locations.

4.2. Relationship with railway parameters

During the study period track length remained fairly stable, some tracks were lifted, some new ones were constructed. The observed rise and fall in train suicides did not depend on railway density. Nor did regional railway densities correlate with the corresponding train suicide rates. Therefore, the relationship between railway density and train suicide, as predicted by Durkheim (1897) and observed by Clarke (1994) in times of railway expansion, does not apply to The Netherlands.

No relationship was found between the number of train suicides and the number of train kilometres or passenger kilometres. Given the fact that train suicide is a feasible option for most Dutch inhabitants as 75% of them live within a 5-kilometre distance from a railway station (The Netherlands Railways, 2007, personal communication), this finding stands out. From this it can be inferred that it is unlikely that intensification of railway transportation in itself will lead to an increased number of train suicides.

4.3. Familiarity with railway transportation

In the present study, the hypothesis was tested that the more contact the public has with trains, the more train suicides will take place (Clarke, 1994). We did not find this

type of relationship after a massive increase of railway transport among students. This negative finding should be interpreted with some caution, as students may not be representative of all railway passengers.

4.4. Population density

Contrary to what was expected, population size (density) and train suicide rates were not related. Highly densely populated areas do not necessarily generate more train suicides. Since general population suicide rates do not depend strongly on urbanisation, the reduction in train suicides in the most highly urbanized region is not easily explained. Maybe this is because noise barriers and a high building density along tracks make overground tracks less easily accessible. While the lowest rate was found in the most urbanized region, the number of suicides per kilometre remained high, causing high levels of disturbance in areas with the highest traffic density.

4.5. Relationship with general population suicide figures

In the seventies, train suicides showed a disproportional increase compared to general population suicides. This was preceded by a decrease in domestic gas suicides from 24.5% to 0.5% due to the detoxification of gas (Clarke and Lester, 1989), which may have resulted in a shift towards train suicide. Furthermore, in the period 1970–1984, substantial decreases in self-poisoning and drowning and increases in hanging and jumping from a high place were observed (Centraal Bureau voor de Statistiek, 1995). It is possible that the strong increase of train suicides in the seventies is a reflection of a substitution of non-violent towards more violent means.

4.6. High-risk locations (HRLs)

Although regional population density does not contribute to train suicide, a relationship exists with communities on a local level. In 1980–2007 16.6% of the suicides took place on just 33 (1.2%) kilometres of the railway track. Most of these locations were within built-up areas of villages or towns and were close to psychiatric hospitals. Housing psychiatric patients near railways and the vicinity of infrastructural elements like railway stations and multiple level crossings, constitute a synergy of risk factors. The data of this study did not allow for differentiating between psychiatric patients and non-patients among the suicides. However, combined studies showed that 53% of train suicides received mental healthcare at the moment of suicide, with half of them being inpatients (Van Houwelingen and Kerkhof, 2008). These high-risk locations illustrate that collaboration between hospital staff, railway company and local authorities is needed in order to create appropriate solutions.

This study also demonstrated that during a 28-year period more than one-third of the national railway network has never been exposed to fatal suicidal behaviour. Therefore, if priorities have to be indicated, investments that make railway tracks less easily accessible for suicidal persons could be limited to selected areas with higher incidences.

4.7. Other findings

A remarkable finding is that male and female train suicide rates have diverged since around 1990. It would seem that the male population at risk for train suicide, for reasons we do not understand, does not benefit from factors causing the overall reduction of general population suicides and female train suicides.

A rather alarming finding is the high percentage of youngsters that make use of this violent method. This finding is in agreement with reports from Germany and Austria (Schmidtke, 1994; Deisenhammer et al., 1997). High levels of impulsivity at this age and not having access to alternative means, like medication, may play a role in the choice for this method.

4.8. Strengths and limitations

The strength of this study is that it is based on a very large, almost complete dataset, covering an entire national railway network. Data on age, gender and location characteristics were obtained over a period of 28 years, data regarding incidence, rail parameters and general population suicides cover 58 years. Therefore, the conclusions that railway parameters have little impact on train suicide frequency, that population density is not a major factor either, and that high-risk locations (HRLs) are situated within built-up areas, and near psychiatric hospitals, are quite strong.

A limitation of this study is that most conclusions are based on correlational relationships between variables.

4.9. Future research

In our study, easy access to the railway tracks could not be investigated as an independent variable. Our own observations throughout the country made it clear that the Dutch tracks were easily accessible during the period under study. On Jan. 1 2005 a new Railway Law, replacing a law dating from 1875, laid down that railway tracks must be inaccessible to the public (Staatsblad, 2003). Consequently, the construction of fences along the tracks has recently begun. The impact of this general intervention on the incidence of train suicides should be monitored carefully, including a possible shift towards railway-station platforms and level crossings.

4.10. Conclusion

The overall picture emerging from this study is that train suicide does not depend on the availability of or familiarity with trains. Undoubtedly, easy access to the tracks makes the railway system vulnerable to non-railway contributory factors such as the general suicide trend in a society. Consequently, the problem of train suicide could benefit from successful national

suicide prevention programs and long-term investments in rail systems that reduce the possibility of train-person collisions.

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None.

Conflict of interests

The authors declare no conflict of interests.

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