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Summary

Train suicides by jumping, standing, or lying in front of a moving train or by deliberately crashing with a vehicle against it, constitute a minority among all suicides, yet the impact of these suicides in terms of human suffering and disturbance of public life is great. The studies in this thesis investigated factors that influence this type of suicidal behaviour in order to understand better which kind of preventive action is worth pursuing.

In **Chapter 1** the themes of the thesis are positioned in the context of the relatively small body of international research findings on train suicide. Issues that had not or had insufficiently been examined are discussed as an introduction to the research questions in the following chapters. The history of train suicide research in the Netherlands is briefly outlined, highlighting the importance of a longitudinal database on incidents of train suicidal behaviour.

In **Chapter 2** the epidemiology of train suicide in the Netherlands is presented. Over the period 1980–2007 the mean annual number of train suicides was 185. The lethality of suicide-related train-person collision was 90.9 %. The proportion of train suicides to the total number of suicides had a mean value of 11.5 %. The M/F ratio was 1.9. Maximum values for male train suicides were found in the age group 20–29 and for female train suicides in the age-group 30–39. When train suicide frequencies were investigated over a much larger time window of 1950–2007, frequencies of < 50 cases per year were found in the period 1950–1970, followed by an increase of up to 231 cases in 1989 and a slight decrease in the years afterwards. This decrease can be attributed to a decrease in female train suicides. Overall the trend in train suicides paralleled that of general suicides. The increase and later decrease of train suicides did not seem to bear any relationship with the steady growth in train kilometres and passenger kilometres, nor with the length of the railway network. Familiarity with rail transport as a passenger did not seem to contribute either. A sudden increase of passenger transport in 1991 after the introduction of free public transport for students did not result in more train suicides. An important finding was the skewed distribution of train suicides on the railway network in 1980–2007: 6.6 % of all suicides happened on 0.3 % of the network on locations with high numbers of suicides ($\geq 1/\text{km}/\text{yr}$), while 45.9 % of the suicides took place scattered on half of the network at locations with a very low incidence. 36.8 % of the total network was free from fatal suicidal behaviour in this period. High-risk locations were located within villages or towns and were close to psychiatric hospitals. Especially these locations deserve first priority when making railway tracks less accessible for suicidal persons.

Chapter 3 describes the results of the matching of 57 train suicides residing in the province of Drenthe with cases from the Groningen Psychiatric Case-Register. This provided insight into the mental healthcare history and psychiatric diagnoses made when healthcare was received. A substantial proportion (63%) of this group of train suicides received mental healthcare at the time of the suicide. The data of this part of the study were combined with data from studies from four other countries. The combination of these five studies showed that half of the train suicides received mental healthcare at the time of suicide, of which half were

inpatients. These proportions are much higher than found in general suicide populations. In the combined populations of the five studies the proportion of affective disorders (including bipolar disorders) in train suicides appeared to be similar to that of general suicides. Non-affective psychotic disorders were over-represented.

The study presented in **Chapter 4** examined the association of suicide methods with psychiatric diagnoses, treatment status and gender, in a sample of suicides reported to the Netherlands Health Care Inspectorate. Compared to suicides by hanging, train suicides were more likely to have a bipolar disorder or a psychotic disorder and more likely to be inpatient. While male patients hanged themselves more often and female patients chose self-poisoning more frequently as suicide method, no association was found between gender and train suicide in the examined population. Other findings were that psychotic disorders were associated with jumping from heights and substance-related disorders with self-poisoning. Depressive disorders were not associated with any particular method. That might imply that these patients could easier switch to other methods if one method were to become less available.

In **Chapter 5** a study on temporal patterns in train suicidal behaviour is presented. The research question was whether 24-h patterns of train suicide rates can be identified, and if so, whether they change in the course of the calendar year. At first, when train suicides were related to time of year no seasonal pattern could be identified. When the data were analyzed as a function of clock time, a pronounced pattern emerged with 10 times higher values between 10:00 h and midnight than between 02:00–06:00 h. However, more interesting was the finding that train suicide was associated with the time of sunrise and sunset. An 80 % increase of train suicides was noticed at about 1.5–2 h after sunset, when after twilight, it becomes really dark in the Netherlands. When data were plotted in a two-dimensional way, as a function of clock-time and as a function of the time of year simultaneously, the observed peak was visible as an oscillating band parallel to the times of sunset throughout the year, both in men and women. This pattern suggests a strong environmental influence on train suicidal behaviour. Probably a subgroup of train suicides wait until complete darkness, perhaps in order to be less visible to passers-by and train drivers.

Chapter 6 explores which factors contribute to the fact that the proportion of train suicides to the total number of suicides is 1.6 times higher in the Netherlands than in Germany. It was investigated whether this difference is related to differences in availability of a railway system. Two components of availability were studied: a. railway density and b. train traffic intensity. Also, the impact of familiarity of the public with rail transport and the impact of population density was assessed. It was found that train traffic intensity and population density contributed significantly to the observed difference in train suicide between the Netherlands and Germany. Railway density and familiarity with rail transport, in terms of number of train kilometers traveled per inhabitant, appeared to have no contributory role. The conclusion

was that the availability of trains, in terms of the number of trains passing at a certain location, influences the number of train suicides. Shorter intervals between trains would appeal to the impulsivity that characterizes many train suicide cases. If train traffic intensity increases this will result in more train suicides. As population density and train traffic intensity are highly correlated, it is difficult to assess which of the two is more important. Either way, since population density is not easily influenced, in both cases it is important to concentrate on the availability of trains in order to prevent suicides.

This finding of the influence of train traffic intensity inspired us to re-examine the data of the longitudinal study described in Chapter 2. In **Chapter 7** we tested the newly-formulated hypothesis that the combination of general suicide rates and train traffic intensity might predict the observed train suicide rates during the 58-year study period better than these variables separately. A series of regression analyses confirmed that the product of the general suicide rate and train traffic intensity provided the best fitting model, for all train suicides as well as for men and women separately. This study disclosed a synergistic effect of general suicide rate and train traffic intensity. In line with the main finding of Chapter 6 we expect train suicides to rise on railway lines with growing train frequency. This effect may be toned down or boosted by developments in society that change general suicide rates.

In **Chapter 8** the main results of the thesis are summarized and possibilities for train suicide prevention are discussed accordingly. The studies of the thesis demonstrated that train suicide is not an autonomous problem. It is an exponent of public health and related suicide figures, socio-economic developments that influence mobility, the organization of mental healthcare and the infrastructure of the railway network. This asks for a vision that embraces a wide array of complementary preventive measures in multiple domains. We propose: 1. interventions related to the railway system; 2. interventions aimed at identified high-risk populations and 3. interventions in society aimed at the reduction of suicide risk in general and influencing contextual variables.

1. Railway-related interventions are reducing the frequencies of trains and reducing the accessibility of the tracks. As it is expected that mobility by rail will increase in the near future, the reduction of access to the tracks is of paramount importance. The open track situated at high-risk locations or running through built-up areas or areas with a nearby psychiatric hospital, need to be fenced-off with fences designed to prevent desperately suicidal people entering the tracks. Level crossings should be replaced with viaducts or tunnels and on remaining locations sophisticated technology should be applied to detect anomalous behaviour. Railway tracks away from platforms should allow through-trains to pass local stations without passing platforms with waiting commuters. On the platforms, transparent intermittent fences, which do not obstruct boarding and getting off the train, can mark a no-standing area on the platform until a train has stopped and create a psychological barrier. Ideal would be if platforms could be closed off at the edges by a

flexible system of sliding panels. Other measures are improvement of lighting conditions on platforms, closing off remote parts and eliminating structures on platforms people can hide behind and closing the end of platforms to prevent people from easily entering the open track. Communication poles with instructions create possibilities for suicidal persons to contact a suicide prevention service like www.113online.nl. Increasing the clearance between the train and the body by deepening the space between the rails, creating so-called *suicide pits*, was an effective measure in the London Underground. As a subgroup of suicidal persons prefer the dark hours of the day, lamps can be installed on high-risk locations like level-crossings, that switch on automatically when people start walking along the tracks.

2. The high proportion of train suicides that was receiving psychiatric care illustrates that Mental Health Services have a pivotal role in train suicide prevention. Talking regularly with high-risk clients about their suicidal ideation while explaining the disadvantages a train suicide has for others involved, are important steps to be taken. Mental Health Services need to take care that on their grounds and within a radius of 5 kilometres from their grounds access to railway tracks is reduced in liaison with the other stakeholders in society. Mental Health Services need to inform ProRail about the accommodation of high-risk populations and to discuss every case of train suicide with them in order to learn from each incident.
3. At a societal-level a number of interventions are conceivable to address a wider population at risk for suicide. The new online suicide prevention service www.113online.nl is highly informative for everyone and reaches out to suicidal persons outside professional care. For the continuation of this service the financing of care provided on an anonymous basis should become possible.

As the subject of train suicide easily draws print media and television attention there is the risk of being over-represented in the media which leads to a distorted image of suicide in society. An even more serious aspect is that media coverage of jumping, i.e., jumping in front of moving objects or from great heights, in particular, has been associated with subsequent increases in suicide. The dilemma between the task of the media to inform and the risk of inducing copycat behaviour demands a sensible approach. Sensationalist coverage and the use of images representing high-risk locations should be avoided. Providing background information on psychiatric illnesses, like depression and substance abuse, and related treatment options, can contribute to a better understanding of the suicide problem and ways to prevent it. Reports on persons who have suicidal ideation, but who succeed not to attempt suicide, proved to have a suicide-protective or so-called Papageno effect. Such reports can be employed when media coverage of train suicides is appropriate.

The way the Netherlands Railways inform travellers on delays due to incidents of train suicide with the wording: "*Vertraging door aanrijding met een persoon*" [Delay because of collision with a person] may be considered a form of unintentional continuous education of the public at large, including the suicide-prone among them, about the method of train suicide. It is recommended that these messages are replaced by announcements that give information about the delay and are at the same time neutral about the nature of the incident. For example: "*Vanwege een ongeval rijden er geen treinen...*" [Delay because of an accident].

Summarized we recognize the need for preventive action on a societal level, within the domain of Mental Healthcare and that of the railway system. This thesis demonstrated that besides the easy access to the tracks the intensity of the railway traffic contributes to the number of train suicides. The proposed measures that reduce access to the tracks are therefore also aimed at neutralizing the impact of availability of trains in modern high-frequency railway systems. We might say that the new Railway Law, which became operative on Jan.1 2005 and laid down that railway tracks must be inaccessible to the public, has anticipated the findings of this thesis.

