Individual and community factors for railway suicide: a matched case-control study in Victoria, Australia

Lay San Too¹, Matthew J. Spittal¹, Lyndal Bugeja², Roderick McClure³, Allison Milner^{4,5}

¹Centre for Mental Health, Melbourne School of Population and Global Health, The University of Melbourne, 207 Bouverie Street, Victoria, 3010, Australia

²Department of Forensic Medicine, School of Public Health and Preventive Medicine, Monash University, 65 Kavanagh Street, Southbank, Victoria, 3006, Australia

³Harvard Injury Control Research Center, Harvard School of Public Health, 677 Huntington Avenue, Boston, MA, 02115, USA

⁴Deakin Population Health SRC, School of Health and Social Development, Deakin University, 221 Burwood Highway, Burwood, Victoria, 3125, Australia

⁵Centre for Health Equity, Melbourne School of Population and Global Health, The University of Melbourne, 207 Bouverie Street, Victoria, 3010, Australia

Corresponding author:

Lay San Too

E-mail: tiffany.too@unimelb.edu.au

Tel: +61 3 8344 4000

Word count: 3554 (manuscript), 250 (abstract)

Acknowledgements

The authors acknowledge the Department of Justice and Regulation for granting access to the National Coronial Information System, the Coroners Court of Victoria for providing us railway suicide data for cross-referencing, and Ms Nadia Polikarpowski (NCIS Coder at the Coroners Court of Victoria) for her assistance in data collection. We also thank the Victorian railway regulators and operators (from the Department of Transport, Planning & Local Infrastructure, Public Transport Victoria, Victrack, Metro trains, V/Line, Australian Rail Track Corporation and Transport Safety Victoria), HILDA, the Australian Bureau of Statistic, Victorian Commission for Gambling and Liquor Regulation and the Victoria Police for providing data.

This study used unit record data from the HILDA Survey. The HILDA Project was initiated and is funded by the Australian Government Department of Families, Housing, Community Services and Indigenous Affairs (FaHCSIA) and is managed by the Melbourne Institute of Applied Economic and Social Research (Melbourne Institute). The findings and views reported in this paper, however, are those of the author and should not be attributed to either FaHCSIA or the Melbourne Institute.

Funding

None.

Abstract

Purpose: This study aims to simultaneously examine individual- and community-level factors associated with railway suicide.

Methods: We performed a case-control study in Victoria, Australia between 2001 and 2012. Data on cases of railway suicide were obtained from the National Coronial Information System (a database of coronial investigations). Controls were living individuals randomly selected from the *Household, Income and Labour Dynamics in Australia* study, matching to cases on age groups, sex and year of exposures. A conditional logistic regression model was used to assess the individual-level and community-level influences on individual odds of railway suicide, controlling for socioeconomic status.

Results: Individual-level diagnosed mental illness increased railway suicide odds by over six times [95% confidence interval (CI) 4.5, 9.2]. Community-level factors such as living in an area with a presence of railway tracks [odds ratio (OR) 1.8, 95% CI 1.2, 2.8], within a city (OR 3.2, 95% CI 1.9, 5.4), and with a higher overall suicide rate (OR 1.02, 95% CI 1.01, 1.04) were independently associated with greater individual odds of railway suicide compared to living in an area without a presence of railway tracks, outside a city, and with a relatively lower overall suicide rate.

Conclusions: The effects of mental illness and high incidence of overall suicides are prominent but not specific on railway suicide. The effects of presence of railway tracks and city residence suggest the importance of accessibility to the railways for individual risk of

railway suicide. Prevention efforts should focus on vulnerable people live in areas with easy access to the railways.

Keywords: Suicide, railroads, mental health, environment

Introduction

Although railway suicides are relatively rare, when they do occur, the event can be highly distressing for families and friends of the deceased, the person driving the train at the time, and any witnesses. Previous studies on railway suicide have largely focused on describing its epidemiology (prevalence, lethality and risk factors) at the individual level. In general, these studies show that people who die by railway suicide are predominantly male, young in age, single or never married, and unemployed or not in the labour force [1]. A prior diagnosis of a mental illness is common as is psychiatric treatment before suicide [2]. Alcohol and/or drug abuse prior to death has sometimes been identified as a factor [2]. Several studies have identified clusters of railway suicides and some studies have shown that these clusters tended to be located in the vicinity of mental health institutions [3-5].

However, despite knowing some of the environmental factors associated with railway suicides, few studies have explored railway suicide risk in relation to rail-specific risk factors (some of which may be highly modifiable). The available evidence is that high train frequency, high passenger volume, availability of fast trains, presence of drug users at stations, high drug-related crime rates in the station's surrounding, and presence of a wall dividing two sides of station platform were all associated with an increased risk of railway suicide [6, 7]. Irresponsible media reporting had a moderately strong impact on copycat behaviours, where railway suicide acts increased following detailed and extensive media reporting of a railway suicide [8, 9].

In a recent study of railway suicides in Victoria, Australia, we found that high-risk areas for railway suicide were characterized by high station density, high patronage volume and high train frequency [10]. However, this study used an ecological design and did not consider the effects of any individual-level factors beyond age and sex. In the present study,

we seek to extend this work by simultaneously examining the individual- and community-level factors associated with railway suicide. A case-control study was performed to compare those who died by railway suicide in Victoria, Australia between 2001 and 2012 to living controls.

Methods

Case selection

Information on railway suicides was obtained from the National Coronial Information System (NCIS). The NCIS is a national internet-based data storage and retrieval system of deaths reported to an Australian coroner. It contains four reports generated for coroners' death investigation. This includes the police summary of circumstances, the autopsy report, the toxicology report, and the coroners' findings. It also contains socio-demographic information (e.g., age, sex, marital status, and employment status), usual residential address and ICD-10 coding of the cause of death.

Deaths classified as intentional self-harm by railway vehicle (ICD-10 code X81) or involved "rail vehicle" were extracted from the NCIS and cross-referenced with railway suicides data provided by the Coroners Court of Victoria. We included data from 2001 to 2012 because the most complete data are available from the NCIS for these years. We excluded any cases that: (1) were still under investigation on the date of data extraction (11 August 2015) (n = 21); (2) had missing usual residential postcode (n = 6); (3) where the deceased usually resided outside Victoria (n = 2); or (4) were of a person aged under 15 years old (because no corresponding controls were available for people under the age of 15) (n = 4).

Control selection

Controls were a random sample of living subjects obtained from the *Household, Income and Labour Dynamics in Australia* (HILDA) Survey [11], who resided in Victoria during the study period. Living controls were selected because they were directly from the source population (or referred to as primary base) where the cases originated. The importance of sampling from the primary base has been emphasized by several researchers [12, 13] as this provides a better indication of the distribution of the exposures (e.g., unemployment and mental health) among the controls compared to sampling from a secondary base (used when sampling from the primary base is not possible). Using a secondary base (e.g., people who died from natural causes) introduces two key problems: (1) those who died by natural causes are, by definition, not at risk of suicide (and therefore not part of the source population), and (2) it may not be possible to gather comparable data on the exposures, thus lessening the ability to assess whether these exposures are the risk factors for cases.

HILDA is a nationally-representative, longitudinal study of Australian residents aged 15 years and over [11]. It has been conducted annually since 2001 and gathers information on a variety of factors, including demographic, social, economic and health measures using a combination of face-to-face interviews and a self-completion questionnaire. HILDA subjects have multiple observations (they are surveyed annually). To avoid including data from the same control subject more than once in the analyses, in our primary analysis we randomly selected data from each control only once. The use of a longitudinal cohort as the control population enabled us to match cases on year of exposures (i.e., the exposure information from cases in the year of death was matched to the exposure information for controls based on the year of interview), seven age categories and sex. This enabled us to match on average 1.9 controls for each case. Examination of the matches indicated that the groups where the ratio

of cases to controls fell below this level were for the older age groups (greater than 55 years). In these age groups, the match was ranged from 1.2:1 to 1.8:1.

Outcome and exposure variables

The outcome was a binary variable coded “1” if the individuals were a case (i.e., they had died by railway suicide) and “0” if they were a living control. Our exposure variables included individual-level variables – marital status at the time of death/interview, employment status at the time of death/interview, and diagnosed mental illness. These data were extracted from the NCIS for each case and from the HILDA for each control. They were available every year during the period of interest. In cases, diagnosed mental illness was defined as a coronial record of a diagnosed mental illness in the 12 months prior to the suicide. For controls, information on mental health was obtained through the five-item Mental Health Inventory (MHI-5) of Short Form 36 from the HILDA study. We used a cut-off score of 65 to screen whether a living control had a diagnosed mental illness. This cut-off was selected because an initial analysis showed that the estimate of diagnosed mental illness in our controls calculated using this score was closer to the estimate of 27% prevalence in the controls suggested in a recent systematic review on suicide [14]. This score has also been proposed by some researchers assessing the cut-off of the MHI-5 for any mental health diagnosis in the general population [15].

We also included a number of environmental measures, which were all captured at the postcode level. These included community-level social fragmentation, socioeconomic status, train-related measures, number of assaults, density of alcohol outlets, number of mental health services and overall suicide rate (see supplementary table for their details in terms of year(s) of availability, operational definition, and source). Nine measures related to trains were

categorised into availability of (e.g., train frequency), accessibility to (e.g., number of surveillance units) and familiarity with (e.g., volume of station patronage) trains.

Statistical analysis

We used a conditional logistic regression model to assess the effects of individual and community variables on individual risk of railway suicide. This model was selected because it allows matching controls with cases on potential confounders to eliminate their effects on the associations between exposure variables and outcome variable [16]. All coefficients were exponentiated and interpreted as odds ratios (ORs). As some of our train-related exposure variables had values of either zero (representing no exposure) or a positive number (representing, for example average train speed), we coded these variables using the procedure recommended by Robertson and his colleagues [17]. By doing this, the odds estimations of the dose-response for all these train-related variables were based solely on those who were exposed to railway tracks.

We commenced with univariate analyses to estimate unadjusted ORs for all variables. Variables that had a significant association (P value < 0.05) at this step were introduced in the multivariate models separately for individual-level and community-level. Statistically significant variables in these multivariate analyses were then carried forward and tested together in a final multilevel multivariate model, controlling for known confounders (a confounder that is known to influence the relationship between an exposure and an outcome, such as local socioeconomic status can distort the magnitude of the relationships between train-related factors and railway suicide as the socioeconomic status of an area where a train station is built is likely to be improved [18]). We also investigated possible interactions between individual and community variables. All analyses were conducted using Stata 13.1.

Sensitivity analysis

Given the growing interest in studying determinants of public health problems at multiple levels using multilevel model [19], we performed a sensitivity analysis to assess whether the estimates from the population averaged multilevel model were different from the estimations from the conditional logistic regression model. To conduct population averaged multilevel analysis, we reselected controls matching to cases only on year of exposures. This enabled us to obtain up to five controls for each case every year. We then performed the same analysis procedures when applying population averaged multilevel model as when using conditional logistic regression model (indicated above), but adjusting for age and sex in the model.

Results

Demographic characteristics

Three hundred and forty-three railway suicides occurring in Victoria from 2001 to 2012 were included in this study. Of these cases, 71% were male and 29% were female, with a mean age of 39 years [standard deviation (s.d.) 17 years]. A total of 652 living controls (70% males, 30% females) were selected from HILDA. Their mean age was 37 years (s.d. 16 years).

Missing data

We found missing data for five variables in cases and controls. These were marital status (cases: 35.9%, controls: 0.3%), employment status (cases: 20.4%, controls: 0%), diagnosed mental illness (cases: 15.2%, controls: 14.7%), the number of surveillance units (cases: 8.5%, controls: 12.6%) and patronage volume (cases: 11.4%, controls: 15.6%). Because there were substantial differences in the proportion of missing data between cases and controls for the

variables of marital status and employment status, we removed them from the multivariate analysis. We retained the other three variables.

Findings from the univariate analyses

Table 2 presents the results from the descriptive and univariate analyses for individual-level variables and Table 3 demonstrates the results for community-level variables. At individual-level, all included variables (e.g., marital status, employment condition and diagnosed mental illness) were significantly associated with the odds of railway suicide. At community level, presence of railway tracks, frequency of train services, station density and proportion of people travel to work by train were associated with the odds of railway suicide. Area remoteness and overall suicide rate were also a significant community-level factor for railway suicide.

(Table 1 here)

(Table 2 here)

Findings from the multivariate analysis

In the multivariate analysis for community level, presence of railway tracks, remoteness and overall suicide rate were significantly associated with the odds of railway suicide. We therefore entered these variables and individual-level mental illness simultaneously into the final multivariate model as shown in Table 4, along with socioeconomic status of the area to control for possible confounding effects.

The final model showed that all entered variables remained significant. People diagnosed with a mental illness had over sixfold increased odds of railway suicide compared to those had no diagnosed mental illness in the past 12 months before death [odds ratio (OR) 6.4, 95% confidence interval (CI) 4.5, 9.2]. In comparison with individuals lived in an area without a presence of railway tracks, those lived in an area with a presence of railway tracks had doubled the odds of railway suicide (OR 1.8, 95% CI 1.2, 2.8). People lived in an urban area also had elevated odds of railway suicide than those lived in a regional or remote area (OR 3.2, 95% CI 1.9, 5.4). There was higher odds of railway suicide among people lived in an area with rising general suicide rate (OR 1.02, 95% CI 1.01, 1.04). The effect of individual-level factor was greater than the effects of community-level factors on individual odds of railway suicide. There was no evidence of an interaction between individual-level mental illness and community-level number of mental health services.

(Table 3 here)

Findings from the sensitivity analysis

In the population averaged multilevel model, 343 cases and 1,715 living controls were included in the analysis. Table 4 shows that the odds estimated from the multivariate conditional logistic regression model were similar to the odds estimated from the population averaged multilevel model, but with slightly smaller magnitudes for all included variables.

Discussion

Main findings

The key factors for railway suicide included diagnosed mental illness at individual-level and living in an area with a presence of railway tracks, within a city, and with a high overall suicide rate at community-level. Individual-level factor had a stronger influence on railway suicide than community-level factors.

Strengths and limitations

This is the first study, to our knowledge, that simultaneously examined individual- and community-level factors on individual odds of railway suicide. The case control design is particularly suitable for the study on the determinants of railway suicide as a rare event. The controls were generally a representative sample of Victorian population. Their individual information are collected every year and this enabled matching to cases on age groups, sex and year of exposures and generating an average of 1.9 controls for each case every year. By doing so, we would be able to ensure same temporal period of reporting for cases and controls to minimize information bias and provide more accurate estimates of odds. Our choice of control was also enable us to ensure that cases and control arose from the same source population, thus reducing the likelihood of bias and following the best practice in epidemiology [12].

This study has some limitations. First, railway suicide data may be under-reported due to the frequency of active coronial investigations and misclassification of suicides as other causes of death (e.g., undetermined intent or unintentional) [20]. Second, as in other longitudinal studies, HILDA is subject to attrition bias (i.e., people dropping out as a result of refusal, death, or inability to locate them). Its attrition rates were 13.2% in 2002 and less than

10% in the following years [21]. We believe that such small attrition does not prominently affect the generalization of our findings. Third, approximately 8% of individuals who died by railway suicide were a psychiatric inpatient at the time of death and five of them have their psychiatric hospital (temporary residence) recorded as usual residence. This might have somewhat affected the results at community-level. Fourth, one variable (e.g., mental illness) with missing data were included in the final model. However, this is unlikely to have influenced the main findings because the proportions of missing data in cases and controls were fairly similar. Fifth, some area-level data are not available for the whole study period. These data were based on the data most closely to the year of exposures. However, our assumption that these data stay constant across non-data years is unlikely to have significantly changed the main findings. Sixth, our controls were sampled from the same population but different data source as the cases. Nevertheless, the bias induced from using different data source should be minimal because the controls were drawn proportional to the same year at risk as the cases and the individual-level estimates in our controls were similar to the estimates in general population such as the proportion of mental illness in our controls was close to the proportion found in a review on suicide (indicated above). Seventh, we excluded people who had missing usual residential postcode from our analyses, which may contain those who did not have fixed home address or were homeless. It is not uncommon that these people have their temporary shelter near to railway tracks and they may have high risk of suicide on the railways resulted from their accessibility to the tracks. Such exclusion may have weakened the relationships between some train-related factors and individual risk of railway suicide. Lastly, we included proxy measures for familiarity with trains (e.g., proportion of people travel to work by train). As such, higher proportion of this variable does

not infer that railway suicide victims used train as their transport to work and therefore were familiar with trains.

Interpretations

Our work shows that diagnosed mental illness was a relatively strong predictor of railway suicide. This is consistent with the previous studies, indicating there is a high prevalence of mental illness among people who died from railway suicide. For example, a review of five studies based on the United Kingdom, Denmark, Australia, and the Netherlands reported that nearly two-thirds of railway suicide deceased had a known history of mental illness [2]. A study in Canada found that 86% of individuals who ended their own lives on the railways had been diagnosed with a mental illness [22]. However, mental illness is also a well-known risk factor for suicide in general [23]. Therefore, the role of this factor is neither specific nor novel for railway suicide.

Our finding that individuals lived in an area where railway tracks were present had higher odds of railway suicide further strengthens the evidence of the availability of suicide method in relation to suicide risk [24]. For example, in England and Wales, the increased use of domestic coal gas was associated with an increase in suicides by gassing [25]. In the United States, some researchers interviewed the next of kin of persons who died from railway suicide reporting that over three-quarter of these persons had no access to a firearm at the time of suicide [26]. Despite firearm being the leading suicide method in America [27], the inaccessibility of this means and the close proximity of railway tracks to the persons' home seemed to increase the risk of railway suicide in these vulnerable persons [26]. We therefore suggest that limiting access to the railway tracks might avert the tragedies of railway suicide.

This intervention has been proven to reduce the number of suicides at suicide hotspots by 91% [28] and reduce over 59% of railway suicides in Hong Kong and Japan [29, 30].

We found significantly more individuals died by suicide on the railways lived in urban areas than in regional or remote areas. This supports the finding in Sweden, where railway suicides were often located in urban areas [31]. One of the plausible explanations for the impact of urban residence on railway suicide is the close distance between railway tracks and residences in that area. Urban residences are always located nearer to the railways compared to regional or remote residences. This finding again suggests that accessibility to the railways is an important risk factor for railway suicide.

Our work also indicates that an increase in community-level overall suicide rate was associated with elevated individual odds of railway suicide. This is likely to be explained by the effect of exposure to suicide (commonly referred as contagion effect – the process whereby one suicidal act in a community increases the probability of the others in the community imitating the act [32]). Past research revealed that young people are particularly vulnerable to suicide contagion [33]. Our cases were largely young people. Thus, we would argue that exposure to suicide in close proximity put them at increased odds of suicide and the contagion effect is likely to be evident on railway suicide where access to the means is also ready.

Despite previous literature having shown that mental health services play an important role in preventing suicide [34, 35], we found mental health services in a local area had no significant relationship with individual risk of railway suicide. It is possible that this variable is not a good proxy measure for individual utilization of mental health care as people who at risk of railway suicide may not seek mental health support. We suggest future research to assess service utilization at individual level where possible.

Conclusions

This study provides the first piece of evidence that mental illness, high local suicide rate, presence of railway tracks, and city residence were independently associated with an increased individual risk of railway suicide. Our findings strengthen the previous findings on railway suicide at both individual and community levels and show individual factor has a stronger impact on railway suicide compared to community factors. However, mental illness and high incidence of overall suicides are factors that are not specific for railway suicide. The effects of a presence of railway tracks and city residence suggest that accessibility to the railways plays a vital role on railway suicide. This work proposes that interventions to reduce the tragic events of railway suicide should focus on vulnerable people live in areas with easy access to the railways. Restricting access to the railway tracks is therefore a potential intervention to prevent railway suicides. This can be done by installing physical barriers along the railway tracks and increasing surveillance by railway staff and protective service officers in high-risk areas. Finally, this work shows local community connectivity, socioeconomic condition, physical and family violence, availability of mental health care and concentration of alcohol outlets have no significant impact on individual risk of railway suicide.

Authors' Contributions

All authors participated in the design of the study. LST collected data with support from LB and performed the statistical analyses with guidance from MJS, AM and RM. LST prepared the first draft of the paper. All authors read, commented and refined the draft. They all approved the submitted version of manuscript.

Conflict of Interests

The authors declare that they have no conflict of interest.

Ethical approval

This study was approved by the Health Sciences Human Ethics Committee (the University of Melbourne) and the Justice Human Research Ethics Committee (State Government Victoria) and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

References

1. Kryszyska K, De Leo D (2008) Suicide on railway networks: Epidemiology, risk factors and prevention. *The Australian and New Zealand journal of psychiatry* 42:763-71. 10.1080/00048670802277255
2. van Houwelingen CAJ, Kerkhof AJFM (2008) Mental healthcare status and psychiatric diagnoses of train suicides. *Journal of Affective Disorders* 107:281-4. 10.1016/j.jad.2007.08.024
3. Van Houwelingen CAJ, Kerkhof AJFM, Beersma DGM (2010) Train suicides in the Netherlands. *Journal of Affective Disorders* 127:281-6. 10.1016/j.jad.2010.06.005
4. Debbaut K, Kryszyska K, Andriessen K (2014) Characteristics of suicide hotspots on the Belgian railway network. *International Journal of Injury Control and Safety Promotion* 21:274-7. 10.1080/17457300.2013.825630
5. Andriessen K, Kryszyska K (2012) Railway suicide in Belgium 1998-2009: incidence and prevention. *Crisis: The Journal of Crisis Intervention and Suicide Prevention* 33:39-45. <http://dx.doi.org/10.1027/0227-5910/a000105>
6. Too LS, Milner A, Bugeja L, McClure R (2014) The socio-environmental determinants of railway suicide: a systematic review. *BMC Public Health* 14:1-10.
7. Uittenbogaard A, Ceccato V (2015) Temporal and spatial patterns of suicides in Stockholm's subway stations. *Accident; analysis and prevention* 81:96-106. 10.1016/j.aap.2015.03.043
8. Ladwig KH, Kunrath S, Lukaschek K, Baumert J (2012) The railway suicide death of a famous German football player: Impact on the subsequent frequency of railway suicide acts in Germany. *Journal of Affective Disorders* 136:194-8. 10.1016/j.jad.2011.09.044
9. Hegerl U, Koburger N, Rummel-Kluge C, Gravert C, Walden M, Mergl R (2013) One followed by many? Long-term effects of a celebrity suicide on the number of suicidal acts on the German railway net. *Journal of Affective Disorders* 146:39-44. <http://dx.doi.org/10.1016/j.jad.2012.08.032>
10. Too LS, Spittal MJ, Bugeja L, Milner A, Stevenson M, McClure R (2015) An investigation of neighborhood-level social, economic and physical factors for railway suicide in Victoria, Australia. *Journal of Affective Disorders* 183:142-8. 10.1016/j.jad.2015.05.006
11. Wilkins R (2012) Families, incomes and jobs, volume 8: a statistical report on waves 1 to 10 of the household, income and labour dynamics in Australia survey. Melbourne Institute of Applied Economic and Social Research, The University of Melbourne, Melbourne.
12. Rothman KJ, Greenland S, Lash TL. *Modern Epidemiology*, 3rd Edition. Chapter 8: Case-Control Studies. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2008.
13. Wacholder S, Silverman DT, McLaughlin JK, Mandel JS (1992) Selection of Controls in Case-Control Studies. *American Journal of Epidemiology* 135:1042-50.
14. Cavanagh JTO, Carson AJ, Sharpe M, Lawrie SM (2003) Psychological autopsy studies of suicide: a systematic review. *Psychological Medicine* 33:395-405.
15. Rumpf H-J, Meyer C, Hapke U, John U (2001) Screening for mental health: validity of the MHI-5 using DSM-IV Axis I psychiatric disorders as gold standard. *Psychiatry Research* 105:243-53.
16. Rose S, van der Laan MJ (2009) Why Match? Investigating Matched Case-Control Study Designs with Causal Effect Estimation. *The International Journal of Biostatistics* 5:1.
17. Robertson C, Boyle P, Hsieh CC, Macfarlane GJ, Maisonneuve P (1994) Some statistical considerations in the analysis of case-control studies when the exposure variables are continuous measurements. *Epidemiology* 5:164-70.
18. Steer Davies Gleave (2011) *The Value of Station Investment: Research on Regenerative Impacts*. Network Rail, London.
19. Diez-Roux AV (2000) Multilevel analysis in public health research. *Annual Review of Public Health* 21:171-92.

20. Australian Bureau of Statistics (2007) Information Paper: External Causes of Death, Data Quality, 2005. Cat. no. 3317.0.55.001. Australian Bureau of Statistics, Canberra.
21. Watson N, Wooden M (2006) Modelling Longitudinal Survey Response: The Experience of the HILDA Survey", HILDA Project Discussion Paper Series No. 2/06. Melbourne Institute of Applied Economic and Social Research, University of Melbourne., Melbourne.
22. Mishara BL (1999) Suicide in the Montreal subway system: Characteristics of the victims, antecedents, and implications for prevention. *Canadian Journal of Psychiatry* 44:690-6.
23. World Health Organization (2014) Preventing suicide: a global imperative. World Health Organization, Geneva.
24. Yip PSF, Caine E, Yousuf S, Chang S-S, Wu KC-C, Chen Y-Y (2012) Means restriction for suicide prevention. *The Lancet* 379:2393-9. [http://dx.doi.org/10.1016/S0140-6736\(12\)60521-2](http://dx.doi.org/10.1016/S0140-6736(12)60521-2)
25. Thomas K, Chang SS, Gunnell D (2011) Suicide epidemics: the impact of newly emerging methods on overall suicide rates—a time trends study. *BMC Public Health* 11:314.
26. Berman AL, Sundararaman R, Price A, Au JS (2014) Suicide on railroad rights-of-way: a psychological autopsy study. *Suicide & life-threatening behavior* 44:710-22. <http://dx.doi.org/10.1111/sltb.12107>
27. Miller M, Warren M, Hemenway D, Azrael D (2015) Firearms and suicide in US cities. *Injury Prevention* 21:e116-e9.
28. Pirkis J, Too LS, Spittal MJ, Krysinaka K, Robinson J, Cheung YTD (2015) Interventions to reduce suicides at suicide hotspots: a systematic review and meta-analysis. *Lancet Psychiatry*.
29. Ueda M, Sawada Y, Matsubayashi T (2015) The effectiveness of installing physical barriers for preventing railway suicides and accidents: Evidence from Japan. *Journal of Affective Disorders* 178:1-4. <http://dx.doi.org/10.1016/j.jad.2015.02.017>
30. Law CK, Yip PSF, Chan WSC, Fu KW, Wong PWC, Law YW (2009) Evaluating the effectiveness of barrier installation for preventing railway suicides in Hong Kong. *Journal of Affective Disorders* 114:254-62. 10.1016/j.jad.2008.07.021
31. Rådbo H, Andersson R (2012) Patterns of suicide and other trespassing fatalities on state-owned railways in greater Stockholm; implications for prevention. *Int J Environ Res Public Health* 9:772-80. 10.3390/ijerph9030772
32. Cheng Q, Li H, Silenzio V, Caine ED (2014) Suicide contagion: a systematic review of definitions and research utility. *PLoS One* 9.
33. Haw C, Hawton K, Niedzwiedz C, Platt S (2013) Suicide clusters: a review of risk factors and mechanisms. *Suicide & life-threatening behavior* 43:97-108.
34. Pirkola S, Sund R, Sailas E, Wahlbeck K (2009) Community mental-health services and suicide rate in Finland: a nationwide small-area analysis. *The Lancet* 373:147-53. [http://dx.doi.org/10.1016/S0140-6736\(08\)61848-6](http://dx.doi.org/10.1016/S0140-6736(08)61848-6)
35. Kapur N (2009) Health services and suicide prevention. *J Ment Health* 18:1-5.

Supplementary file. Details of community-level variables

Variable	Year(s) for which data were available	Variable description	Data source(s)
Social fragmentation	2001, 2006, 2011	Congdon's measure of social fragmentation, which was calculated for all postcodes by summing the z-scores of the following four variables: % persons living alone, % persons in rented accommodation, % unmarried persons and % persons resided in different address 1 year ago.	ABS Census
Socioeconomic status			
Index of Relative Socio-economic Disadvantage (decile)	2001, 2006, 2011	This index summarises the social and economic conditions of people and households in each postcode. High decile indicates a relative lack of disadvantage and low decile indicates a relative greater disadvantage.	ABS Census
Index of Economic Resources) (decile)	2001, 2006, 2011	This index reflects the financial aspects of relative socioeconomic advantage and disadvantage in each postcode. High decile indicates a relative greater access to economic resources and low decile indicates a relative lack of access to economic resources.	ABS Census
Train-related factors			
Availability of trains			
Presence of railway tracks	2001-2012	Presence of railway tracks in each postcode. Railway tracks used for tourist and heritage purposes only were excluded.	Geoscience Australia (MapConnect), MTM, V/Line
Train frequency (per 10	2012	Average daily number of trains (passenger and freight trains)	VicTrack

trains)		passing through the level crossing in each postcode.	
Train speed (km/hr)	2014	Average speed (kilometre per hour) which train is allowed to pass through the level crossing in each postcode.	VicTrack
Accessibility to trains			
Number of surveillance units (per 10 units)	2001-2012	Number of surveillance unit installed at railway stations and carparks in each postcode.	PTV, MTM
Number of level crossing	2014	Number of level crossing (including pedestrian and road crossing) in each postcode.	VicTrack
Number of stations	2001-2012	Number of railway station in each postcode.	PTV, V/Line
Familiarity with trains			
People travel to work by train (%)	2001, 2006, 2011	% employed people aged 15 years and above travel to work by train in each postcode. It was calculated as a ratio to the total employed persons.	ABS Census
Number of station patronage (per 1000 persons)	2008-12	Average daily number of station patronage in each postcode.	PTV, MTM
Number of pedestrian (per 100 persons)	2014	Average daily number of pedestrian passing through the level crossing in each postcode.	VicTrack
Other contextual factors			
Number of assaults (per 100 assaults)	2001-2012	Number of assaults (including physical and family assaults) in each postcode.	Corporate statistics (Victoria Police)
Alcohol outlets density (per 10 outlets)	2001-2012	Number of active alcohol outlets with general, on-premises, packaged liquor or restaurant and cafe license in each postcode.	VCGLR
Number of mental health	2014	Number of mental health services (including adult and inpatient	MHDR

services		services) in each postcode.	
Remoteness	2001-2012	Remoteness of a postcode area. This was classified based on Australian Statistical Geography Standard (ASGS) 2011.	ABS
General suicide rate	2001-2012	General suicide rate per 100 000 persons in each postcode. It was calculated as a ratio of total number of general suicide to the total population.	NCIS, ABS

Abbreviations: PTV, Public Transport Victoria; MTM, Metro Trains; VCGLR, Victorian Commission for Gambling and Liquor Regulation; MHDR, Mental Health, Drugs & Regions (division of the Victorian Government Department of Health).

Table 1. Descriptive and univariate results for individual-level factors from the conditional logistic regression model

Variable	Cases n(%) / mean(s.d.)	Controls n(%) / mean(s.d.)	Unadjusted OR	95% CI	P value
Individual-level					
Marital status					<0.001
Never married	89 (40.5)	198 (30.5)	2.79	1.77-4.38	
Widowed	5 (2.3)	13 (2.0)	0.95	0.24-3.68	
Divorced	10 (9.6)	31 (4.8)	1.22	0.54-2.74	
Separated	21 (9.6)	20 (3.1)	3.63	1.81-7.29	
Married (inc de facto) ^a	95 (43.2)	388 (59.7)	1.00		
Employment status					<0.001
Unemployed	54 (19.8)	43 (6.6)	4.59	2.92-7.21	
Not in the labour force ^b	110 (40.3)	182 (27.9)	2.50	1.74-3.61	
Employed ^a	109 (39.9)	427 (65.5)	1.00		
Mental illness					<0.001
At least one diagnosis	219 (75.3)	170 (30.6)	6.70	4.78-9.39	
No diagnosis ^a	72 (24.7)	386 (69.4)	1.00		

Abbreviations: CI, confidence interval; OR, odds ratio; s.d., standard deviation.

^aReferent.

^bThis includes student, housewife/husband, retired and disabled person.

Table 2. Descriptive and univariate results for community-level factors from the conditional logistic regression

Variable	Cases n(%) / mean(s.d.)	Controls n(%) / mean(s.d.)	Unadjusted OR	95% CI	P value
Community-level					
Social fragmentation	1.6 (2.7)	1.3 (2.9)	1.03	0.98-1.08	0.202
Socioeconomic status					
Index of Relative Socio-economic Disadvantage	6.0 (3.1)	6.1 (2.9)	0.99	0.95-1.04	0.772
Index of Economic Resources	6.0 (2.9)	5.9 (2.8)	1.01	0.97-1.06	0.601
Train-related factors					
Availability of trains					
Presence of railway tracks					<0.001
Yes	291 (84.8)	466 (71.5)	2.16	1.54-3.04	
No ^a	52 (15.2)	186 (28.5)	1.00		
Train frequency (per 10 trains)	10.9 (9.2)	7.0 (9.1)	1.04	1.02-1.05	<0.001
Train speed (km/hr)	65.1 (41.3)	54.1 (46.6)	1.00	0.99-1.00	0.866
Accessibility to trains					
Number of surveillance units (per 10 units)	2.0 (3.2)	1.6 (3.2)	1.00	0.96-1.05	0.857
Number of level crossings	4.1 (4.4)	3.7 (4.8)	0.99	0.95-1.02	0.369
Number of stations	1.6 (1.2)	1.2 (1.3)	1.15	1.02-1.30	0.023
Familiarity with trains					
People travel to work by train (%)	12.9 (8.7)	9.9 (9.7)	1.03	1.01-1.04	0.001
Number of station patronage (per 1000)	2.1 (3.4)	1.4 (3.1)	1.04	0.99-1.09	0.120

persons)					
Number of pedestrian (per 100 persons)	4.6 (5.6)	3.9 (7.9)	1.00	0.98-1.02	0.765
Other contextual variables					
Number of assaults (per 100 assaults)	1.7 (1.8)	1.5 (1.8)	1.05	0.97-1.13	0.203
Alcohol outlets density (per 10 outlets)	3.6 (6.4)	3.5 (5.9)	1.00	0.98-1.03	0.710
Number of mental health services	0.7 (1.3)	0.7 (1.2)	1.00	0.90-1.11	0.996
Remoteness					
Urban	308 (89.8)	463 (71.0)	3.72	2.50-5.53	<0.001
Regional/remote ^a	35 (10.2)	189 (29.0)	1.00		
General suicide rate	18.8 (31.8)	11.1 (20.7)	1.03	1.02-1.04	<0.001

Abbreviations: CI, confidence interval; OR, odds ratio; s.d., standard deviation.

^aReferent.

Table 3. Multivariate results from the conditional logistic regression model and the population averaged multilevel model.

Variable	Conditional logistic regression model			Population averaged multilevel model		
	Adjusted OR	95% CI	<i>P</i> value	Adjusted OR	95% CI	<i>P</i> value
Individual-level						
Mental illness			<0.001			<0.001
At least one diagnosis	6.40	4.48-9.15		7.22	5.30-9.84	
No diagnosis ^a	1.00			1.00		
Community-level						
Presence of railway tracks			0.007			<0.001
Yes	1.83	1.18-2.83		2.33	1.54-3.53	
No ^a	1.00			1.00		
Remoteness			<0.001			<0.001
Urban	3.24	1.94-5.40		4.52	2.69-7.59	
Regional/remote ^a	1.00		0.004	1.00		
General suicide rate	1.02	1.01-1.04		1.03	1.02-1.04	<0.001

Abbreviation: CI, confidence interval; OR, odds ratio. Socioeconomic status (index of economic resources) was controlled in both models. Age and sex were adjusted in the population averaged multilevel model.

^aReferent.

Minerva Access is the Institutional Repository of The University of Melbourne

Author/s:

Too, LS;Spittal, MJ;Bugeja, L;McClure, R;Milner, A

Title:

Individual and community factors for railway suicide: a matched case-control study in Victoria, Australia

Date:

2016-06-01

Citation:

Too, L. S., Spittal, M. J., Bugeja, L., McClure, R. & Milner, A. (2016). Individual and community factors for railway suicide: a matched case-control study in Victoria, Australia. SOCIAL PSYCHIATRY AND PSYCHIATRIC EPIDEMIOLOGY, 51 (6), pp.849-856. <https://doi.org/10.1007/s00127-016-1212-9>.

Persistent Link:

<http://hdl.handle.net/11343/118530>