

**Predictors of using trains as a suicide method: findings from Victoria,  
Australia**

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## **Abstract**

This study aimed to investigate the factors associated with the choice of trains over other means of suicide. We performed a case-control study using data on all suicides in Victoria, Australia between 2009 and 2012. Cases were those who died by rail suicide and controls were those who died by suicide by any other means. A logistic regression model was used to estimate the association between the choice of trains and a range of individual-level and neighborhood-level factors. Individuals who were never married had double odds of using trains compared to individuals who were married. Those from areas with a higher proportion of people who travel to work by train also had greater odds of dying by railway suicide compared to those from areas with a relatively lower proportion of people who travel to work by train. Prevention efforts should consider limiting access to the railways and other evidence-based suicide prevention activities.

## **Keywords**

Suicide, railway, railroads, Australia

## **1. Introduction**

In Australia, hanging, poisoning by substances, and poisoning by carbon monoxide and other gases were the most frequent used methods of suicide in 2012 (Australian Bureau of Statistics, 2014). However, there is variation in the choice of suicide method across states and territories. For instance, the largest proportion of suicides by jumping in front of a train was found in Victoria, while hanging was more common in Northern Territory, and poisoning by carbon monoxide and other gases was particularly prevalent in Western Australia. The current study focused on suicide by train in Victoria, which accounted for approximately 7% of all suicides in the state (Australian Bureau of Statistics, 2014). This proportion was relatively moderate compared with the global proportion of suicide by train which ranged from 1% to 12% of all suicides (Krysinska and De Leo, 2008, Taylor et al., 2016). Although suicide by train is rare, it has been reported as the major cause of death on the rail network in Victoria (Too et al., 2015) and overseas (Mishara, 1999, Rådbo et al., 2005, Gershon et al., 2008, Sousa et al., 2015).

Suicides by train are highly distressing for train drivers and witnesses (Bardon and Mishara, 2015). They can also cause economic losses through the disruption of train services, driver absenteeism, and counseling required for affected individuals (Lukaschek et al., 2011, Mehnert et al., 2012, Silla et al., 2012).

Although suicides by train are a prominent problem within the railway sector, there is limited understanding of the factors associated with an individual's decision to use a train as a method to end one's life (as opposed to other methods). One study interviewed railway suicide survivors and found that nearly half chose trains because they knew of someone else who used this method. Some also perceived this method as quick, highly lethal, easily accessible and/or widely available (O'Donnell et al., 1996). Another study interviewed nine railway suicide survivors and found that the view that jumping in front of a train has a high

chance of dying and easy access to trains were their reasons for choosing trains (Chowdhury et al., 2000). This is consistent with a large body of work that shows that suicide by particular means is closely linked with the availability of that means (Ajdacic-Gross et al., 2008, Thomas et al., 2011, Yip et al., 2012).

Previous studies comparing suicides by train with suicides by other means have shown, in general, that suicides by train did not differ from suicides by other means in terms of gender, mental health, adverse life events, and local socioeconomic status (Emmerson and Cantor, 1993, Abbot et al., 2003, Silla and Luoma, 2012). However, in one study, nearly 40% of those who died by rail suicide were found to have some kind of connection with rail (e.g., living close to a railway line, past experience trespassing on rail tracks); whereas, only 7% suicides by other means had that same relationship (Abbot et al., 2003). There is also evidence that people who died by rail suicide were younger than those who used other suicide means (Emmerson and Cantor, 1993, Silla and Luoma, 2012). Mental health inpatients were more likely to use trains while outpatients were more likely to poison themselves to end their own lives (Huisman et al., 2010). Existing literature on suicides by train showed that the majority of the victims were male, young, never married or single, unemployed or not in the labour force, and have been diagnosed with a mental illness and admitted for mental health care (Mishara, 2007, Ratnayake et al., 2007, Kryszynska and De Leo, 2008, van Houwelingen and Kerkhof, 2008).

Because of the small amount of work previously done to uncover the factors associated with the choice of trains over other methods to suicide and none of them were conducted in Australia, this study seeks to examine the factors associated with the choice of a train as a suicide method using data from the country. Improved knowledge about these factors may be useful for informing intervention efforts. Based on the findings from previous research as indicated above, we hypothesized that people who died of suicide by train would

be different from those who died of suicide by other means on several factors. Those who died of suicide by train would be younger, never married or single, unemployed or not in the labour force, and have a history of mental illness and mental health hospitalization. We also hypothesized that these people would have easier access to trains. It is less clear what the association would be for other factors.

## **2. Methods**

### *2.1 Study setting and design*

Victoria is the second largest state in Australia. It has a population of approximately 5.7 million people. Most of the Victorians live in Melbourne, the state's capital with a population of 4.1 million. Melbourne is serviced by a metropolitan railway network consisting of 16 railway lines with 230 railway stations. Seventy percent of people from Melbourne who travel to work by public transport use train services (Bureau of Infrastructure Transport and Regional Economic, 2012). Victorian railway tracks are generally constructed at ground level and contain a large number of level crossings. About 90% of the tracks are unfenced.

We performed a case-control study using four years of coronial data from the state of Victoria, Australia. We compared individuals who died by suicide using a train (cases) to those who died from suicide using all other methods (controls) in order to identify factors associated with using a train as a means of suicide.

### *2.2 Suicide data*

We obtained data on deaths classified as intentional self-harm (ICD-10 code X60-X84) from the National Coronial Information System (NCIS). The NCIS is a national internet-based data storage and retrieval system of Australian coronial records. For each record, there are four full text reports: the police summary of circumstances, the autopsy report, the toxicology

report, and the coroner's findings. Each record also contains coded information such as age, sex, marital status, employment status, date of death, and usual residential address. NCIS is regarded as the primary data source for research in injury and death (Victorian State Government, 2015). It offers much more detailed information than the Australian Bureau of Statistics (ABS) and is regarded as a reliable source of suicide figures in Australia (Driscoll et al., 2003).

To overcome the possibility that cases could be missed because the coroners' investigation was complete but not yet uploaded into NCIS, the Coroners Court of Victoria (CCOV) cross-referenced records we identified in NCIS with their own records. As a result, an additional 40 cases for 12 years were identified from CCOV and included. These cases tended to be from more recent years.

We retrieved and reviewed all intentional self-harm deaths coded as X60-X84 (ICD-10) (World Health Organization, 2010). We categorised suicides coded as X81 or recorded "rail vehicle" as the object involved in the death as suicides by train and all other suicides as being due to other means, such as suicides by hanging, poisoning, jumping from height, firearm shooting, cutting and so forth.

### 2.3 *Inclusion and exclusion criteria*

We included all suicides that occurred from 1 January 2009 to 31 December 2012. We excluded cases and controls that: were still under investigation by the coroner on the date of data extraction (8 September 2015) (n = 21); had no certain year of death (n = 14); with residency outside Victoria (n = 22); and had missing information on usual residential postcode or did not have fixed home address (n = 11).

#### 2.4 *Exposure variables*

We assessed a number of individual variables in relation to using a train as a suicide means. These were age, sex, marital status, employment status, diagnosed mental illness, history of mental health hospitalisation, history of suicide attempt and blood alcohol concentration. We also included a range of neighbourhood variables in the analyses. They were social fragmentation, socioeconomic status, train-related variables, number of assaults, concentration of alcohol outlets, number of mental health services, and area remoteness. Train-related variables were categorised into three domains (e.g., availability of trains, accessibility to trains and familiarity with trains) based on how they are usually classified in the past literature (Too et al., 2014). All variables used to measure familiarity with trains were a proxy because we were not able to directly measure our sample on their familiarity with trains providing that they were deceased. These variables were selected because they showed some relationships with suicide by train or overall suicide in the existing literature (e.g., most rail suicide victims were male, young, never married, and/or unemployed; social fragmentation has been found as a strong predictor of suicide; neighbourhood socioeconomic deprivation has been associated with an increased risk of suicide in the population) (Kennedy et al., 1999, Taylor et al., 2005, Rehkopf and Buka, 2006, Mishara, 2007, Ratnayake et al., 2007, Kryszynska and De Leo, 2008, van Houwelingen and Kerkhof, 2008, Barth et al., 2011, Branas et al., 2011, Giotakos et al., 2012, Congdon, 2013, Mok et al., 2013).

We included all neighbourhood variables at the postcode level and merged them with the residential postcodes of all suicide cases. Based on the postcode-level data from the 2011 Census, the median population size covered by a postcode was 2,660, ranging from 0 to 77,756. The median geographical size of a postcode is 81.2 square kilometres, ranging from 0.2 to 11415.9. Table 1 shows the descriptions of all included variables, such as year(s) of availability, operational definition and source. The data of these variables were obtained from

the best possible sources. For examples, individual information about deceased from the NCIS and CCOV, social information from the ABS Census, and train-related information from the railway organisations who managed the relevant datasets.



Table 1. Details of individual and neighbourhood variables

<b>Variable</b>	<b>Year(s) of availability</b>	<b>Definition</b>	<b>Data source(s)</b>
<b>Individual-level</b>			
Sex	2009-2012	The biological sex of the deceased.	NCIS & CCOV
Age	2009-2012	The age of the deceased at time of death.	NCIS & CCOV
Marital status	2009-2012	The marital status of the deceased at time of death.	NCIS & CCOV
Employment status	2009-2012	The employment status of the deceased at time of death.	NCIS & CCOV
Mental illness	2009-2012	This was defined as the deceased having been diagnosed with a mental illness in the 12 months prior to the death. This information was based on coronial findings when the coronial investigation found evidence of a previously diagnosed mental illness. Mental illness was only recorded as present if it was diagnosed by an appropriately qualified medical professional.	NCIS & CCOV
Mental health hospitalisation	2009-2012	This was defined as based on the evidence that the deceased having been admitted to hospital for mental health treatment during 12 months before the death. This information was obtained from the deceased's medical records where available.	NCIS & CCOV
Previous suicide attempt	2009-2012	This was defined as the deceased having at least one suicide attempt prior to the death. This information was recorded in the coronial record, usually gathered from the deceased's closed family members, relatives, friends or medical professionals.	NCIS & CCOV
Blood alcohol concentration (g/100ml)	2009-2012	The amount of blood alcohol detected from toxicology in ante-mortem or post-mortem. Deceased had positive alcohol reading if blood alcohol concentration was detected $\geq 0.05$ g/100ml.	NCIS & CCOV
<b>Neighbourhood-level</b>			
Social fragmentation	2011	Congdon's measure of social fragmentation, which was calculated for all postcodes by summing the z-scores of the following four variables: % persons	ABS Census

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		living alone, % persons in rented accommodation, % unmarried persons and % persons resided in different address 1 year ago.	
Socioeconomic status			
Index of Relative Socio-economic Disadvantage (decile)	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)	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	2009-2012	Presence of railway tracks in each postcode. Railway tracks used for tourist and heritage purposes only were excluded.	Geoscience Australia (MapConnect), MTM, V/Line
Number of trains (per 10 trains)	2012	Average daily number of trains (passenger and freight trains) passing through the level crossing in each postcode.	VicTrack
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)	2009-2012	Number of surveillance unit installed at railway stations and carparks in each postcode.	PTV, MTM

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Number of level crossing	2014	Number of level crossing (including pedestrian and road crossing) in each postcode.	VicTrack
Number of stations	2009-2012	Number of railway station in each postcode.	PTV, V/Line
Familiarity with trains			
Proportion of people who travel to work by train	2011	% employed people aged 15 years and above who 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)	2009-12	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 environmental factors			
Number of assaults (per 100 assaults)	2009-2012	Number of assaults (including physical and family assaults) in each postcode.	Victoria Police Corporate Statistics
Number of alcohol outlets (per 10 outlets)	2009-2012	Number of active alcohol outlets with general, on-premises, packaged liquor or restaurant and café license in each postcode.	VCGLR
Number of mental health services	2014	Number of mental health services (including adult, child and adolescent, aged person, community support and inpatient services) in each postcode.	MHDR
Remoteness	2009-2012	Remoteness of a postcode area, classified based on Australian Statistical Geography Standard (ASGS) 2011.	ABS

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

## 2.5 *Statistical analysis*

Prior to undertaking our analysis we coded several train-related variables using a procedure recommended by Robertson and colleagues (Robertson et al., 1994). These variables typically had values of either zero (representing no exposure) or a positive number (representing, for example, average train frequency). We therefore entered these variables into the model using two parameters – a parameter to capture the effect when the exposure had a value of zero, and a parameter to capture the same exposure when it has a value greater than zero. This enabled simultaneous estimation of the relationship between the exposure and the outcome when there was no exposure, and estimation of a dose-response relationship between the exposure and the outcome among those who were exposed.

We utilised a logistic regression model to examine the effects of individual and neighbourhood variables on individual choice of a train as a suicide method. Our strategy was to fit a series of models to the data. In the first instance, all variables in Table 1 were individually entered into a model to estimate their association with the use of a train as a suicide method. Statistically significant variables ( $p < 0.05$ ) from these analyses were then introduced into a multivariate model, controlling for socioeconomic status (Steer Davies Gleave, 2011)). All coefficients were exponentiated and interpreted as odds ratios (ORs). All analyses were conducted in Stata 13.1.

## **3. Results**

### 3.1 *Demographic characteristics*

During the study period, 105 suicides by train (5%) and 1,856 suicides by other methods (95%) were available for inclusion in the study. Among suicides by train, 66% were by males and 34% by females, with a mean age of 37 years [standard deviation (SD) 16 years]. Of

those suicides by other methods, 77% were males and the mean age was 46 years (SD = 18 years).

### 3.2 *Factors associated with choice of method*

From the univariate analyses, the individual-level variables that were associated with the likelihood of choosing trains over other methods were age, sex and marital status (see Table 2). Males were less likely to die from suicide by train compared to females (OR 0.6, 95% CI 0.4, 0.9). Individuals who were younger than 35 years old were more likely to use trains to end their own lives compared to individuals who were 60 years and older (OR 3.0, 95% CI 1.6, 5.6). People who were never married had more than triple the odds of using trains to kill themselves compared to individuals who were married or in de facto relationship (OR 3.3, 95% CI 2.1, 5.3). All other individual-level variables were unrelated to individual choice of trains as a suicide method. These were employment status, mental illness, history of mental health hospitalisation, previous suicide attempt, and alcohol consumption prior to death.

With respect to the neighbourhood level variables, individuals who lived in an area with a presence of railway tracks were more likely to die by suicide on the railways than those who lived in an area without a presence of railway tracks (OR 1.9, 95% CI 1.1, 3.1, see Table 3). Those who lived in an area with higher frequency of train services also had greater odds of choosing trains to end their lives compared to those who lived in an area with relatively lower frequency of train services (OR 1.03, 95% CI 1.01, 1.06). A similar relationship was found for the number of railway stations. Those people who lived in an area with a higher number of railway stations had increased odds of selecting trains as their suicide method compared with those who lived in an area with relatively lower number of railway stations (OR 1.3, 95% CI 1.1, 1.5). People who were from an area with a higher proportion of people who travel to work by train had heightened odds of suicide by train (OR

1.04, 95% CI 1.02, 1.06). Lastly, those who lived in a city area had approximately triple the odds of killing themselves using trains compared to those who lived in a regional or remote area (OR 2.6, 95% CI 1.5, 4.5).

The variables associated with rail suicide in univariate analyses were subsequently assessed jointly in a multivariate model. We also controlled for socioeconomic status at this step. Because three of the variables from the univariate analysis were significantly correlated: (1) train frequency; (2) number of stations; and (3) proportion of people who travel to work by train, [ $r(1 \text{ \& } 2) = 0.6$ ,  $r(1 \text{ \& } 3) = 0.6$ , and  $r(2 \text{ \& } 3) = 0.7$ ], we used only the variable of proportion of people who travel to work by train in our analysis on the grounds that it had a stronger association with suicides by train and is a more direct measure of the use of rail services (i.e. the proportion of people who use train) than the other two variables.

Table 2. Descriptive and univariate results at individual level

<b>Variable</b>	<b>Cases n(%)</b>	<b>Controls n(%)</b>	<b>Unadjusted OR</b>	<b>95% CI</b>	<b>p-value</b>
Sex					0.010
Male	69 (65.7)	1,425 (76.8)	0.58	0.38-0.88	
Female*	36 (34.3)	431 (23.2)	1.00		
Age (years)					<0.001
≤34	55 (52.4)	544 (29.3)	3.02	1.63-5.60	
35-39	37 (35.2)	924 (49.8)	1.20	0.63-2.27	
≥60*	13 (12.4)	388 (20.9)	1.00		
Marital status					<0.001
Married (including de facto)*	33 (32.7)	636 (41.8)	1.00		
Never married	49 (48.5)	283 (18.6)	3.34	2.10-5.30	
Widowed	1 (1.0)	75 (4.9)	0.26	0.03-1.91	
Divorced	6 (5.9)	149 (9.8)	0.78	0.32-1.89	
Separated	12 (11.9)	377 (24.8)	0.61	0.31-1.20	
Employment status					0.933
Employed*	41 (43.2)	765 (41.7)	1.00		
Unemployed	22 (23.2)	454 (24.7)	0.90	0.53-1.54	
Not in the labour force	32 (33.7)	616 (33.6)	0.97	0.60-1.56	
Mental illness					0.116
No diagnosis*	42 (40.0)	889 (47.9)	1.00		
At least one diagnosis	63 (60.0)	967 (52.1)	1.38	0.92-2.06	
Mental health hospitalization					0.118
No*	79 (75.2)	1,511 (81.4)	1.00		
Yes	26 (24.8)	345 (18.6)	1.44	0.91-2.28	



Previous attempt						0.824
No*	65 (61.9)	1,169 (63.0)	1.00			
At least once	40 (38.1)	687 (37.0)	1.05	0.70-1.57		
Blood alcohol concentration (g/100ml)						0.069
No detected*	82 (78.1)	1,260 (67.9)	1.00			
< 0.05	7 (6.7)	129 (7.0)	0.83	0.38-1.84		
≥ 0.05	16 (15.2)	467 (25.2)	0.53	0.30-0.91		

\*Reference category. Marital status was missing for 17.3%, employment status for 1.6% of all suicides.

Table 3. Descriptive and univariate results at neighbourhood level

<b>Variable</b>	<b>Cases n(%)/mean(SD)</b>	<b>Controls n(%)/mean(SD)</b>	<b>Unadjusted OR</b>	<b>95% CI</b>	<b>p-value</b>
Social fragmentation (z-scores)	1.8 (3.1)	1.5 (3.0)	1.03	0.97-1.10	0.345
Socioeconomic status					
Index of Relative Socio-economic Disadvantage	6.5 (2.9)	5.9 (2.9)	1.07	1.00-1.15	0.057
Index of Economic Resources	5.3 (2.9)	5.1 (2.9)	1.03	0.96-1.10	0.370
Availability of trains					
Presence of railway tracks					0.020
Yes	87 (82.9)	1,313 (72.3)	1.85	1.10-3.10	
No*	18 (17.1)	502 (27.7)	1.00		
Number of trains (per 10 trains)	9.4 (8.8)	6.3 (8.4)	1.03	1.01-1.06	0.005
Train speed (km/hr)	62.1 (43.2)	56.3 (48.7)	1.00	0.99-1.00	0.518
Accessibility to trains					

Number of surveillance units (per 10 units)	2.4 (4.9)	1.9 (4.7)	1.00	0.96-1.04	0.884
Number of level crossings	4.2 (4.7)	3.9 (5.5)	0.99	0.95-1.03	0.652
Number of stations	1.5 (1.3)	1.0 (1.2)	1.27	1.06-1.51	0.008
Familiarity with trains					
Proportion of people who travel to work by train	16.3 (10.5)	11.2 (9.9)	1.04	1.02-1.06	<0.001
Number of station patronage (per 1000 persons)	2.1 (1.3)	1.6 (4.0)	1.01	0.96-1.06	0.768
Number of pedestrian (per 100 persons)	3.9 (5.8)	3.3 (6.1)	1.00	0.97-1.03	0.826
Other contextual variables					
Number of assaults (per 100 assaults)	2.1 (2.5)	2.0 (2.4)	1.01	0.94-1.10	0.735
Number of alcohol outlets (per 10 outlets)	4.6 (9.5)	4.3 (8.7)	1.00	0.98-1.02	0.736
Number of mental health services	2.0 (3.1)	1.8 (2.7)	1.03	0.96-1.10	0.394
Remoteness					
Urban	90 (85.7)	1,269 (69.9)	2.58	1.48-4.50	<0.001
Regional/remote*	15 (14.3)	546 (30.1)	1.00		

\*Reference category. The number of surveillance units was missing for 17.4%, the number of station patronage was missing for 20.4%, and other area variables were missing for less than 2.5% of all suicides.

The final model showed that only two variables remained associated with the choice of trains over other suicide means after adjustment for the other variables in the model (Table 4). Individuals who were never married had greater odds of suicides using trains over other suicide methods compared to individuals who were married or in de facto relationship (OR 2.4, 95% CI 1.4, 4.1). The odds of choosing trains as a suicide method were also higher in individuals from areas with a higher proportion of train commuters than those from areas with a relatively lower proportion of the measure (OR 1.03, 95% CI 1.00, 1.06).

Table 4. Multivariate results, controlling for local socioeconomic status

<b>Variable</b>	<b>Adjusted OR</b>	<b>95% CI</b>	<b>p-value</b>
<b>Individual-level</b>			
Sex			0.099
Male	0.68	0.43-1.07	
Female*	1.00		
Age (years)			0.191
≤34	1.62	0.79-3.29	
35-39	1.05	0.53-2.06	
≥60*	1.00		
Marital status			<0.001
Married (including de facto)*	1.00		
Never married	2.40	1.42-4.06	
Widowed	0.25	0.03-1.96	
Divorced	0.75	0.30-1.86	
Separated	0.60	0.30-1.20	
<b>Neighbourhood-level</b>			
Presence of railway tracks			0.221
Yes	1.46	0.79-2.70	
No*	1.00		
Proportion of people who travel to work by train	1.03	1.00-1.06	0.023
Remoteness			0.407
Urban	1.34	0.67-2.70	
Regional/remote*	1.00		

\*Reference category.

## **4. Discussion**

### *4.1 Main findings*

We found that being never married was a key factor for choosing trains over other suicide methods, while living in an area with high proportion of people who use train as the transport to work was an important neighbourhood factor associated with the choice of trains. As opposed to our hypothesis, age, sex, employment status, mental health-related variables, history of previous attempt, alcohol consumption, social and environmental variables, and other train-related variables (e.g. easy access to and high availability of trains) were not associated with the choice of trains as a means of suicide. Reasons for this are unclear, but the most likely explanation was a lack of statistical power. Suicide is a relatively rare event and suicide by train even more so.

### *4.2 Strengths and limitations of the study*

Our work is strengthened by including a wide range of individual- and neighbourhood-level factors that have not previously been investigated. However, our work has several limitations. First, under-reporting of suicides is possible due to coronial investigations still being open despite the long follow-up time (this is common in suicides which can be complex to investigate) and misclassification of suicides as undetermined intent or unintentional cause of death (Australian Bureau of Statistics, 2007). We have tried to minimise the first limitation by allowing a long follow-up time (three years) for cases to be closed; the other limitation is difficult to fix. Second, there was a small proportion of deceased persons ( $n = 5$ ) who have their temporary residence recorded as usual residence (e.g., psychiatric hospital). If the psychiatric hospital where the deceased provisionally resided was close to the railways, such inclusion may influence the effects of some train-related factors on the outcome measure; however, this is unlikely to have considerable impact on the key findings. Third, when area-

level data was not available for the whole study period, we used the data that closest to the year of death. For example, 2011 census data was used for suicides in 2009, 2010 and 2012. We assume these data stay constant across non-data years.

Fourth, because our sample comprised people who were deceased, we were unable to directly measure their familiarity with trains and thus used the proxy of this measure such as proportion of people who travel to work by train. As such, higher proportion of this variable does not necessarily infer that railway suicide deceased travelled to work by train and therefore were familiar with trains. Fifth, we did not have data on whether the deceased knew someone else who used trains to kill themselves. This exposure may be a key factor that affects the choice of a train as a suicide method. Finally, we excluded those who did not have fixed home address or were homeless. Due to these people may have their temporary shelter near to railway tracks and thus have easy access to the tracks, exclusion of these individuals may have weakened the relationships between some train-related factors and the odds of choosing trains to suicide.

#### *4.3 Interpretation*

In this study of people who had all died by suicide, our focus was to understand the factors associated with individual choice of trains over other suicide methods. Consistent with our hypothesis, our work shows that people who were never married were more likely to choose trains rather than other suicide methods. This is consistent with the past studies undertaken in the United States, Australia and Canada, indicating the majority of train suicide victims were never married at the time of death (Mishara, 1999, De Leo and Krysiniska, 2008, Berman et al., 2014). One possible interpretation could be people who are never married may be less likely to own a car and therefore more likely to use a train as their transport in day-to-day life compared with people who are married (especially those who have young children). For this

reason, people who are never married may be more familiar with trains (e.g., trains schedules and railway environments) than people who are married. Nevertheless, the mechanism for why individuals who were never married tended to choose trains over other suicide means is unknown.

The above interpretation is supported by another finding from this work. We found that many individuals who chose a train rather than other means as a suicide method were from areas where a high proportion of people who travel to work by train. This factor is a proxy indicator of familiarity with trains. We therefore argue that individuals who died from suicide by train may be more familiar with trains than those who died from suicides by other means. This argument is supported by one of Durkheim's propositions (Durkheim, 1858-1917/1951), that people are inclined to use the means of suicide that is made familiar to them by daily use. This is also supported by a previous study showing that individuals who died from suicide by train were more familiar with rail compared to those who died from suicide by other means (Abbot et al., 2003). So, it may be that those who chose trains as means to suicide may have been more familiar with trains (although we acknowledge that we did not have the data to examine this).

Our findings somewhat contradict the literature (Ajdacic-Gross et al., 2008, Yip et al., 2012) and our hypothesis in that we found no significant link between availability of/accessibility to trains and the choice of a train as a suicide means, after adjusting for other variables in the multivariate model. This suggests that familiarity with suicide method may be a stronger factor for the method choice compared to availability of/accessibility to suicide method. However, it seems to be impossible to decrease people's familiarity with trains because train is a known public transportation and it is difficult to directly measure this variable. The significant results of availability of/accessibility to trains from the univariate models indicated that these factors played some roles in the choice of trains, though with

weaker effects compared to familiarity with trains. Therefore, strategies to restrict means (i.e., limiting access to the railway tracks) should be considered because this intervention has been proven to effectively reduce suicides by train in countries like Hong Kong and Japan (Law et al., 2009, Ueda et al., 2015).

Apart from the abovementioned differences, our work shows that suicides by train and suicides by other methods did not significantly distinguish in many aspects of individual and neighbourhood characteristics, despite existing literature documented that individuals who died by train were predominantly with males, young adults, and people who had at least one diagnosed mental illness (Mishara, 2007, Ratnayake et al., 2007, Krysinska and De Leo, 2008, van Houwelingen and Kerkhof, 2008). Our findings are similar to the findings from a descriptive study conducted in England, where gender, mental health, adverse life events, and local socioeconomic status were not significantly different between suicides by train and suicides by other methods (Abbot et al., 2003). These findings might be a reflection of the fact that there were a small number of suicides by train and thus a lack of statistical power. We suggest that our study should be replicated in other countries to assess the robustness of our findings. Nevertheless, based on the similarities between the characteristics of suicides by train and those of suicides by other means, we propose that prevention efforts should also consider strategies that can reduce suicides by all means such as engaging key relevant stakeholders, raising awareness that suicides are preventable using public campaigns, and promoting help-seeking (World Health Organization, 2014) as this may lead to a decrease in suicides by train.

## **Conclusions**

This study shows that individual choice of trains over other suicide methods may be primarily determined by familiarity with trains. This factor has a stronger effect on suicide method

choice than availability of/accessibility to means. Prevention strategies should focus on limiting access to the railways as well as the efforts to reduce overall suicides because these may reduce the tragic events of suicides by train.



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## **Authors' contributions**

All authors participated in the design of the study. LST collected data with support from LB. LST performed the statistical analyses with input from MJS, AM and RM. LST prepared the first draft of the paper. All authors revised the draft and contributed to the final version of manuscript.

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## **Conflict of interest**

None.

**Ethical approval**

This study received full ethical approval from the Health Sciences Human Ethics Committee (the University of Melbourne) and the Justice Human Research Ethics Committee (State Government Victoria).

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