Research paper

Characteristics and circumstances of rail suicides in England 2019–2021: A cluster analysis and autopsy study

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ABSTRACT

Background: Around 4 % of all suicide deaths in Great Britain occur on the railways. This exploratory study was designed to increase understanding of the individuals that take their lives in this way, and the circumstances of their death.

Method: Data were obtained from fatality investigation files compiled by the British Transport Police (BTP) relating to suspected suicides on the mainline railway in England from April 2019 to March 2021. Cluster analysis was carried out to identify grouped associations of characteristics and circumstances relating to rail suicide.

Results: A total of 436 files were analysed, representing 93 % of all suspected railway suicides during this period. Cluster analysis identified four groups of almost equal size, distinguished principally by age, living arrangements, employment status and location of death. The study is novel in the way it integrates individual characteristics and circumstances of death. The identified clusters may provide a multidimensional way of conceptualising suicide risk that could inform more targeted interventions at rail locations.

Limitations: A high proportion of missing data means that the findings need to be interpreted with caution. It also restricted the multivariate analysis to those categories of information for which sufficient information was available.

Conclusion: The characteristics and circumstances of suicide deaths on the railways are complex and multifaceted. The typology identified in this study may help to target preventative strategies prior to the incident as well as at different location types.

1. Introduction

In the year to April 2023, 236 people died by suspected suicide on the mainline railways in Great Britain, constituting approximately 4 % of the total number of suspected suicide deaths (Rail Safety and Standards Board [RSSB], 2023). As such, railways suicides in Britain comprise a lower proportion of all suicide deaths than in some European countries, such as Germany (7.3 % in 2020, Moritz et al. (2023)) and the Netherlands (10.8 % in 2018, van Houwelingen et al. (2022)). In contrast, in North America and Australia, railway suicides have tended to represent a lower proportion of all suicide deaths (Mishara and Bardon, 2016). However, even in those countries where rail suicide is relatively rare as a method, it has a wide and costly impact. In addition

to the tragic loss of life and the effect on friends and family, such deaths may cause distress to the train driver, other rail staff, passengers or witnesses (Bardon and Mishara, 2015). Suicidal behaviour also causes disruption to the operation of the rail network. In 2014 the cost of each suicide to the railway industry in the UK was estimated to be £140,000 (RSSB, 2014) in addition to the £1.7mn estimated cost of each suicide to the economy (Knapp et al., 2011).

Suicide prevention measures, particularly those that restrict access to the track, can be effective in reducing rail suicides, without apparent displacement to other methods (Barker et al., 2017). For example, following the installation of platform screen draws on the Hong Kong metro system, suicides decreased by 60 %, against a rise in the general suicide rate over the same period of 27 % (Law et al., 2009). Such

measures can, however, be expensive and difficult to implement across a large network. In order to target prevention activities effectively, therefore, it is important to increase understanding of the characteristics and circumstances of rail suicides.

A review of the international literature concluded that people who die by suicide on the rails shared many of the characteristics of people who died by other methods of suicide (Mishara and Bardon, 2016). The main exception was that people who died on the railways tended to be younger in age. Railway suicides, like other suicide deaths, were associated with poor mental and physical health and lower socioeconomic status. The review identified some differences between countries, particularly with regard to the location of death. Nearly all railway suicides (98 %) in the USA, for example, occurred on open track, while in Sweden 53 % of railway deaths occurred at stations. Such differences are likely to reflect distinctions in both population densities and in the nature and use of national rail systems, and underline the need for research to examine the circumstances specific to individual countries.

In the UK, the RSSB publish annual suicide rates (RSSB, 2023) but no detailed information about rail suicides is routinely available. A time series analysis of data from 2000 to 2013 confirmed that, consistent with all suicide deaths, about three-quarters of rail suicides in England and Wales were men (ranging from 74 % to 82 % between 2000 and 2013; Taylor et al., 2016). The highest suicide rates for both sexes were in the age range 35–64 years (Taylor et al., 2016).

A detailed analysis of 257 suicide deaths at or near 51 British stations over a period of 20 years showed that by combining data from various sources it was possible to identify additional information such as the location of death, access to the track, time spent at the location prior to death and further characteristics of the deceased (Ryan, 2017). However, because the data in Ryan (2017) related to a subset of railway suicides, it is not possible to know whether the profile of deaths would be the same in all cases. To date, therefore, there exists no comprehensive picture of the characteristics and circumstances of rail suicides in England.

The British Transport Police (BTP) investigate all deaths on the railway, and their reports contribute to the Coroner's inquiry. These fatality investigation files contain information about the deceased and the circumstances of their death, and as such are a rich resource to increase understanding of railway suicides. The aim of this study was to use the BTP files to determine the characteristics of people who died by suicide on the railways in England between April 2019 and March 2021 and the circumstances of their death.

This time period spans the start of the Covid-19 pandemic, and the lockdowns that were put in place in England and Wales, during which time rail traffic was reduced and individual freedoms to travel outside the house were curtailed. At this time there was considerable anxiety as to whether the restrictions on individual freedoms and particularly social interaction would lead to an increase in suicide (Marzano et al., 2023), leading to a large effort by the academic community to measure effects in real time (John et al., 2021; Odd et al., 2021). As a result, a secondary aim of this study was to explore whether the Covid pandemic impacted on the characteristics or circumstances of rail suicides in the study period.

2. Method

2.1. Dataset

The dataset for this project was derived from the fatality investigation files compiled by BTP for suspected suicides on the mainline railway in England from April 2019 to the end of March 2021. Suicides on urban transit systems, such as the London Underground, were excluded because of their differences in operation and infrastructure. Cases were excluded if the death occurred away from the tracks (e.g. a person jumped from a rail bridge onto another piece of land); if the method of death was not specific to the railways (i.e. being hit by a train or

electrocuted on the live tracks were included but hanging from rail infrastructure was excluded); or if the death was known to have been recorded as an accident by the Coroner. An accident is deemed to be a death following an event over which there is no human control.

The BTP investigation files contain information relating to the death (such as the location, time of day, behaviours preceding the incident) and to the individual (e.g. demographic, medical, employment, life circumstances). In addition to the BTP summary report to the Coroner, the file may contain any or none of the following: statements by attending officers, train drivers, witnesses or next of kin; suicide notes or other documents belonging to the deceased; social media extracts; identifying documents; location inspections; still images of the location before or after the incident; CCTV footage; medical information noted by the police. It does not routinely include medical records, post-mortem or toxicology reports which tend to be sent directly to the Coroner.

2.2. Procedure

2.2.1. Ethical approval

Ethical approval for this study was obtained from Middlesex University Psychology Department Research Ethics Committee (reference 17711).

2.2.2. Database development

Decisions on what data should be extracted from the files were taken in consultation with the Stakeholder Advisory Group and in the light of the academic literature on suicide in public places. A data extraction database was created in Excel. Fields relating to the deceased included: personal demographic characteristics; life events, such as evidence of mental and physical ill health, prior suicide attempts and police contact, as well as notable events occurring in the six months and 48 hours before death. In addition, data were collated relating to the circumstances of death, such as the date, location and time of day, behaviours at the scene; presence of other people and evidence of intent, such as a suicide note or prior communication.

2.2.3. Data collection

Data collection was carried out by three members of the research team (HN, SB, SMH) between May and November 2021. Data extraction for each case was carried out by a single researcher. The database was tested during the first two weeks of data collection, and in a small number of cases, the same file was coded by all three researchers in order to check the consistency of coding. The coding was refined as required, following discussion among the team.

2.3. Analysis

An analysis of missing data was carried out by field and also by individual case. Descriptive results were then prepared using Excel and SPSS v28. *t*-Tests were used to compare means across different groups for variables such as age. In other cases, chi-square was used as a test of statistical association.

A cluster analysis was conducted to identify groups of closely related cases, using the k-medoids clustering procedure, which is appropriate for situations where not all variables are numeric (Jin and Han, 2010). Because the data contains a mix of categorical and numeric variables, the Gower distance measure was used to determine the similarity between cases (Gower, 1971). Only those variables where fewer than 20 % of values were missing were included in the cluster analysis (Ngugi, 2022). Missing categorical values were replaced by a constant value, so were treated as a 'missing data' category. In addition, highly correlated variables were eliminated. The analysis was conducted using the kmed package within the R system. To determine the most effective number of clusters, the k-medoids procedure was applied for k values in the range $2 \leq k \leq 20$, and the mean silhouette index (Rousseeuw, 1987), a measure of cluster 'tightness', calculated for each k.

3. Results

3.1. Overview of the dataset

A total of 436 files were included in the dataset. This represents 93 % of all deaths suspected to be suicides by BTP ($N = 467$), which occurred on the mainline railways in England in the period from April 2019 to the end of March 2021. Of the remaining 7 % of files ($N = 31$), four concerned deaths by hanging, three involved deaths which occurred away from the rail infrastructure and seven were not available or contained too little information. In a further 17 cases, the Coroner returned a verdict of accident. The Coroner's verdict was only known in about a third of cases and therefore there may have been other instances where the Coroner determined the death was an accident rather than suicide. However, in the judgment of the research team, no files were included where there was strong evidence that the death was accidental.

3.2. Missing data

Some information is routinely recorded by BTP and is therefore available for every case. For example, the sex and age of the deceased and the location of death were available in all cases and their last known address recorded in 99 % of cases. However, other information is not collected consistently by BTP. This is either because it is not known, or not relevant to the individual, or because the person making the statement (witness, train driver, next of kin) might not mention it. For example, the files contained, in general, very little information about individuals' childhoods.

In the current study, descriptive statistics are presented with the denominator N to indicate whether N represents the total sample, or the proportion of the sample for which the information was known, depending on which is more meaningful.

The cluster analysis was based on those fields which had <20 % missing data.

Of the 436 individual cases, 37.4 % ($N = 163$) had no missing data across the set of cluster analysis fields. In total, 70.4 % were missing 10 % or less. Using cross-tabs we assessed whether there was anything distinctive about the cases that were missing over 10 % of data. There was a significant association with sex ($\chi^2 = 8.338$, df = 1, $p = .004$) with a higher proportion of men missing over 10 % of fields. There was also a significant association with ethnicity ($\chi^2 = 17.678$, df = 5, $p = .003$) where a higher proportion of Asian and Black people had over 10 % missing data, and nationality ($\chi^2 = 6.623$, df = 2, $p = .036$) where a higher proportion of people from outside the UK had over 10 % of missing data. Lastly, there was a significant association with employment status ($\chi^2 = 9.736$, df = 4, $p = .045$), which was due to a disproportionate number of retired people having >10 % missing data. There was no significant association between the overall proportion of missing data and index of deprivation, living arrangements, relationship status, having children or criminal history and no significant difference in age. Taken together this analysis indicates that the data were not missing at random.

3.3. Characteristics of the deceased

The characteristics of people who died by suicide on the railways in England in the study period are set out in Table 1. Seventy-eight percent of individuals were men and the median age was 41 (range 13 to 89). Notably, 20 % of individuals were under the age of 25.

One hundred and sixty-six people (38 %, $N = 166/436$) were known to have made a previous suicide attempt, or to have previously attended a rail location with suicidal intent. Of these individuals, 36 % ($N = 60/166$) were known to have made the attempt within the month prior to their death.

Fifty-nine people (14 %, $N = 59/436$) were known to have made a previous suicide attempt on the railways, or to have previously gone to the railways with suicidal intent. In most of these incidents, the individual went to a rail location with suicidal intent, but either changed their mind (22 %, $N = 13/59$) or were stopped (66 %, $N = 39/59$).

Thirty-seven percent of individuals were known to have left a suicide note ($N = 161/436$). There was positive evidence in 106 (24 %, $N = 106/436$) cases that individuals had expressed either suicidal thoughts (19 %, $N = 84/436$) or intent (7 %, $N = 32/436$) in the week before their death. The suicide was described as unexpected by next of kin in 83 of the 319 cases where next of kin statements were available (26 %, $N = 83/319$).

There was positive evidence that 12 % ($N = 53/436$) of the deceased were known to be suspected or convicted of a crime at the time of their death (of which 25 % were sexual offences, in 10 cases against a minor). In addition, 37 % ($N = 163/436$) of the deceased had an entry in the Police National Computer relating to historic offences.

Where information on recent life events was available, for children and young adults it tended to refer to bullying or abuse, relationship or interpersonal difficulties, and problems at work or school (Fig. 1). Middle aged adults tended to have had work or financial problems, and physical health concerns were most prevalent among older adults. Worsening mental health problems were evident across the age bands.

3.4. Circumstances of death

Information about the circumstances of death are summarised in Table 2. With regard to the 47 % ($N = 205/436$) of suicides that occurred at or from stations, 55 % ($N = 113/205$) were at stations that were normally staffed at the time of death (although staffing may have been affected during lockdown), and 60 % ($N = 123/205$) were at smaller stations with only one or two platforms. Of the people who died at a station, 69 (37 %, $N = 69/189$) jumped or climbed on to the track from the middle of the platform, while 71 (38 %, $N = 71/189$) jumped or climbed onto the track from the near (17 %, $N = 33/189$) or far end (20 %, $N = 38/189$) of the platform (in 26 % of cases the exact location was not known).

There was a significant association between sex and the type of location ($\chi^2 = 14.97$, df = 6, $p = .020$). Women were proportionately more likely than men to take their lives at a station, while men were more likely than women to take their lives at a track location.

The distance between the individual's home address and the location of the suicide ranged from 0.01 mile to 207 miles (Mdn = 2.1 miles, $N = 424$). A total of 254 individuals (77 %, $N = 254/330$) were known to have travelled from their home address to the location of their death. Twenty individuals left hospital or secure or supervised accommodation (including five who were under section) and went directly to the railway. The median distance from the last known location to the site of death was 1.5 miles (range 0.01 to 233 miles).

Suicides occurred most frequently on Mondays, Tuesdays and Fridays, although the pattern was different between the two years of the study sample (pre and during Covid-19, Fig. 2). Around two-thirds (63 %, $N = 268/426$) of deaths occurred during the day (6 am to 6 pm), and 53 % ($N = 230/432$) occurred in broad daylight.

There was positive evidence in 10 % of cases ($N = 44/436$) that the individual had interacted with another person at the location prior to their death. Most commonly (52 %, N = 23/44) this was with members of the public, followed by railway staff (36 %, $N = 16/44$), people known to the deceased (16 %, $N = 7/44$) and police (9 %, N = 4/44). Interactions, where they were known to have occurred, were more likely to have taken place at stations with more than two platforms than at stations with only one or two platforms ($\chi^2 = 15.09$, df = 1, $p < .001$) and at staffed stations, compared with stations that were unstaffed at the time of death ($\chi^2 = 26.22$, df = 1, p < .001). In 39 % of cases ($N = 17/44$), the interaction was routine (e.g. asking for information), whereas in the remaining cases the interaction occurred because the deceased was behaving unusually (18 %, $N = 8/44$) or putting themselves in danger (43 %, $N = 19/44$).

Table 1
Summary of demographic characteristics.

Category		N	% of total cases (N = 436)	% of cases for which information is available for this category	Cases for which information is available for this category	
					N	% of total cases
Sex	Male	340	78 %	78 %	436	100
	Female	96	22 %	22 %		
Age	13–17	25	6 %	6 %	436	100
	18–24	64	15 %	15 %		
	25–34	81	19 %	19 %		
	35–44	73	17 %	17 %		
	45–54	79	18 %	18 %		
	55–64	54	12 %	12 %		
	65–74	44	10 %	10 %		
	75 and over	16	4 %	4 %		
Ethnicity	White	361	83 %	85 %	424	97 %
	Asian or Asian British	33	8 %	8 %		
	Black or Black British	20	5 %	5 %		
	Mixed/Multiple Ethic Groups	5	1 %	1 %		
	Other	5	1 %	1 %		
Nationality	British	354	81 %	86 %	414	95 %
	Other European	31	7 %	7 %		
	Rest of the World	29	7 %	7 %		
Relationship Status	Single	242	56 %	59 %	407	93 %
	In a relationship	165	38 %	41 %		
Children	Any children	190	44 %	48 %	392	90 %
Of which	Adult children only	95	22 %	54 %	175	
	Children under 18 only	66	15 %	38 %		
	Children over and under 18	12	3 %	7 %		
	Any deceased children	8	2 %	5 %		
	Children under 18 living with deceased	55	13 %	15 %	368	84 %
Living Arrangements	With friends or family	249	57 %	63 %	398	91 %
	Alone	91	21 %	23 %		
	With strangers	24	6 %	6 %		
	In hospital, care home or hostel	20	5 %	5 %		
	Homeless	14	3 %	4 %		
Index of Deprivation decile (home address)	1–3 (most deprived)	123	28 %	29 %	422	97 %
	4–7	178	41 %	42 %		
	8–10 (least deprived)	121	28 %	29 %		
Employment	In paid work	151	35 %	42 %	362	83 %
	Unemployed	88	20 %	24 %		
	Unable to work or caring	41	9 %	11 %		
	Retired	49	11 %	14 %		
	Student	33	8 %	9 %		
Known current criminal conviction or investigation		53	12 %	*		
Historic offences recorded on the Police National Computer		163	37 %	37 %	436	100 %
Known current use of drugs or alcohol		123	28 %	*		
Mental ill health	Diagnosed and/or on medication	248	57 %	67 %	370	85 %
	Suspected	88	20 %	24 %	370	85 %
	None	66	15 %	18 %		
Evidence of mental health condition (diagnosed or suspected)	Depression	250	57 %	68 %		
	Anxiety	111	25 %	30 %		
	Psychosis or schizophrenia	74	17 %	20 %		
	Other mental illness	37	8 %	10 %		
Known previous suicide attempt or attending railway with suicide intent		166	38 %	*		
Known physical ill health		126	29 %	*		
Known to have left a suicide note		161	37 %	*		
Events within 48 h of death (mentioned by friends/family)	Mental health event	90	*			
	Relationship/interpersonal problems	58	*			
	Consumed drink/drugs	48	*			
	Criminal/police contact/court date	22	5 %	*		
	School/work/financial problems	21	5 %	*		
	Physical illness/injury	20	5 %	*		
	Loss event e.g. anniversary of a death	10	2 %	*		
	Family states there was nothing unusual	59	14 %	*		

*For these categories, we recorded any positive information that was available in the file. However, there were very few cases in which the counterfactual was explicitly mentioned (e.g. they had never made a previous suicide attempt). Therefore, it would be misleading to express the data in these categories as anything other than a percentage of the total number of cases.
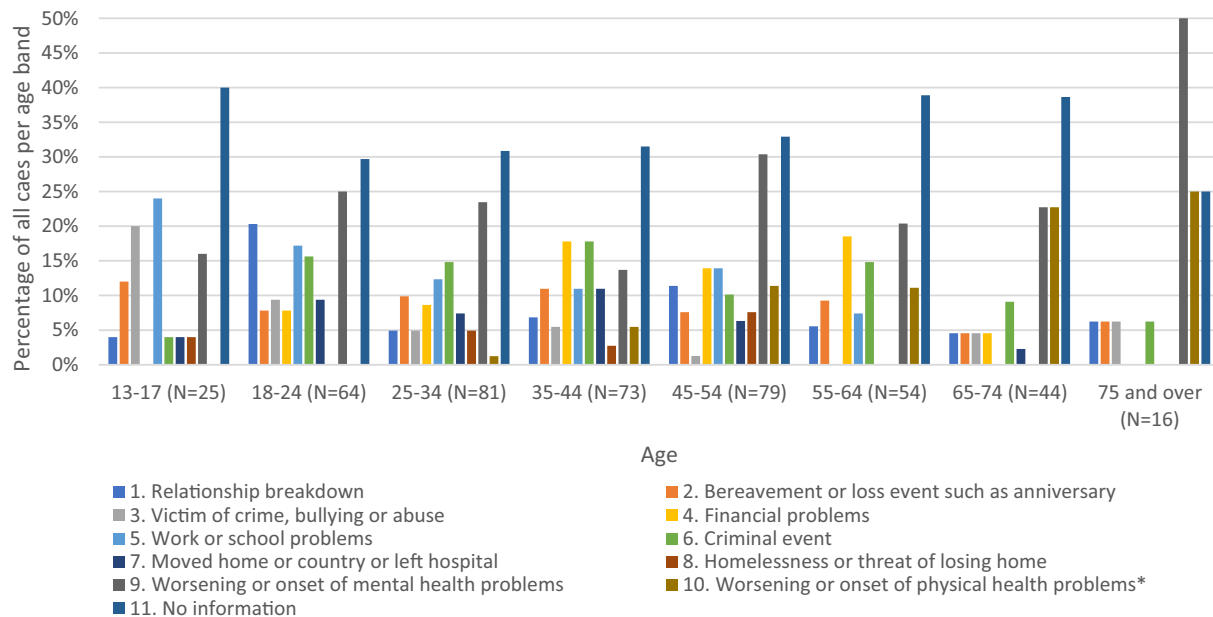

Fig. 1. Recent life events, occurring within six months of death, by age.

3.5. Effect of Covid-19

There were 235 suicide deaths on the railways in England in the year from April 2019 to end March 2020 falling to 201 in the year from April 2020. The decrease was due to a fall in suicides among men (from 183 to 157) while suicides among women remained constant across both years. The number of suicides averaged 18 per month (Fig. 3). Although March 2020 saw the highest number of suicides in a month, the subsequent three months saw below average numbers of deaths, coinciding with the initial restrictions imposed in response to the Covid-19 pandemic (Institute for Government, 2022).

The characteristics and circumstances of rail suicides listed in Tables 1 and 2 (with the exception of past life events) were tested to explore whether there was any difference between the profile of deaths prior to the announcement of the Covid 19 lockdown (April 2019 to March 23, 2020) compared with the Covid period of the sample (24 March 2020 to 31 March 2021). The median age of people who died in the pre-Covid-19 period (Mdn = 43, range 14 to 83) was significantly higher than the median age of people who died during the Covid-19 period (24 March 2020 to end March 2021; mdn = 39, range 13 to 89, U = 20,977.5, $p = .039$). There was a significant association between having children and deaths pre and during Covid-19 (respectively 54 % compared with 43 %, $\chi^2 = 4.602$, df = 1, $p = .032$). No other significant differences were found.

3.6. Cluster analysis of the characteristics and circumstances of railway suicides

The final set of variables used for the cluster analysis following exclusions for missing data and high correlations is listed in Table 3. The k-medoid analysis found that the four cluster solution produced the highest silhouette value, and therefore the 'tightest' clustering. The four clusters were of similar size (n = 103, 127, 103, 103). Cluster 1 (24 % of the sample) consisted of younger individuals in work or study, living with friends or family with no children. They were likely to die at a station location. Cluster 2 (29 %) was made up of older people, working

or retired, in a relationship with children and more likely than average to have physical health problems. Cluster 3 (24 %), like Cluster 1, were younger and working with no children, but were more likely to be living alone. This group tended to die at away from stations. Finally, Cluster 4 (24 %) comprised middle aged men, living alone in less affluent areas, more likely than average to be unemployed and to have a history of police contact and suicide attempts. They tended to die in the evening, away from stations. More detail of the characteristics of the four clusters is provided in Table 3.

4. Discussion

This study provides a comprehensive picture of rail suicides in England. It builds on the limited publicly available data to examine details of the characteristics of the individuals who died, and circumstances of death.

Placing the data in context, rail suicides comprised approximately 4 % of all suicide deaths in England in each year of the study period (Office for National Statistics [ONS], 2022). The fall in registered suicides in England and Wales in 2020, driven by a decrease in suicides among men at the start of the Covid-19 pandemic (ONS, 2021) is mirrored in the current data.

The proportion of individuals who died by suicide on the railway aged 10 to 24 was higher (20 %) than among people who died by suicide in the general population (10 %, ONS, 2022). Clearly, a longer time series would be needed to draw firm conclusions; however, the finding is consistent with a systematic review of the international literature, which found that individuals who die by suicide on the railways tend to be younger than all suicides (Mishara and Bardon, 2016). Railway suicide is a method that is relatively accessible and requires limited preparation, and as such may lend itself to impulsive acts, to which younger people may be more vulnerable (Beckman et al., 2019; Rimkeviciene et al., 2015). Previous research suggests that around a third of suicide attempts on the railways may be impulsive (Marzano et al., 2019).

The current data indicate that people who died by suicide on the railways share many of the known characteristics of people who die by

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Table 2
Circumstances of death.

Category		N	% of total cases (N = 436)	% of cases for which information is available for this category	Cases for which information is available for this category	
					N	% of total cases
Location type	Station platform	189	43 %	43 %	436	100 %
	Track away from station	148	34 %	34 %		
	Foot crossing	36	8 %	8 %		
	Level crossing	30	7 %	7 %		
	Road/footbridge over track	17	4 %	4 %		
	Track accessed from station	16	4 %	4 %		
Day of the week	Monday	76	17 %	17 %	436	100 %
	Tuesday	74	17 %	17 %		
	Wednesday	60	14 %	14 %		
	Thursday	62	14 %	14 %		
	Friday	77	18 %	18 %		
	Saturday	52	12 %	12 %		
	Sunday	35	8 %	8 %		
Time of day	6 am – 12 pm	125	29 %	29 %	426	98 %
	12 pm – 6 pm	143	33 %	34 %		
	6 pm – 12 am	118	27 %	28 %		
	12 am – 6 am	40	9 %	9 %		
Other people known to be at location	Yes	138	32 %	36 %	380	87 %
	No	242	56 %	65 %		
Of whom:	Adult public	117		85 %		
	Child public	14		10 %		
	Rail staff	35		35 %		
	Police	5		4 %		
	Known to deceased	9		7 %		
Witnessed	By driver	357	82 %	82 %	436	100 %
	By other people	105	24 %	24 %		
	No witnesses	72	17 %	17 %		
Evidence of interaction prior to death	Yes	44	10 %	–	–	–
	No	136	31 %	39 %		
Transport to scene	Walking only	160	37 %	51 %	314	72 %
	Car	87	20 %	28 %		
	Train	44	10 %	14 %		
	Bicycle	13	3 %	4 %		
	Other public transport	8	2 %	3 %		

	N	Mean	SD	Median	Min	Max
Distance from home (miles)	424	7.4	19.2	2.1	0.01	207
Distance from last known location (miles)	330	5.5	19.8	1.5	0.01	233
Time spent at the location prior to death (minutes)	153	33	67.4	12	<1	11 h

suicide by other methods. This includes being male and middle-aged, with poor mental health (Windfuhr and Kapur, 2011). In addition, in common with other methods of suicides and in comparison with the general population, people who died on the railways were more likely to be single, unemployed, living alone, have prior self-harm and/or a history of police contact (Knipe et al., 2022). These characteristics described Cluster 4 in the current analysis. It suggests that such individuals may have had contact, not just with health services, but also with social services or the police prior to their death, which might provide additional opportunities for 'upstream' intervention. Much attention has been focused on individuals' contact with health services before suicide in the UK (Appleby et al., 2014; John et al., 2020; Leavey et al., 2016) and elsewhere (Park et al., 2022; Schou Pedersen et al., 2019; Stene-Larsen and Reneflot, 2019). There is also corroboratory evidence concerning the elevated risk of suicide following police contact or arrest (Bryson et al., 2021; Chidgey et al., 2022). Training of police has been shown to be effective in improving awareness of suicide and confidence in intervening (Marzano et al., 2016; Osteen et al., 2021). Further work could usefully draw together key lessons for improved communication within and across the different agencies coming into contact with people at risk of suicide.

However, the results of the cluster analysis are a reminder that not everyone who takes their own life falls into this category. For example, Cluster 2 comprised an older than average group of working or retired people, living with others in relatively affluent areas, and in a relationship. The only characteristic of this cluster that is a known risk factor for suicide is the higher incidence of physical health problems (Ahmedani et al., 2017).

The two remaining Clusters (1 and 3) both consisted of younger people, in work or study. Cluster 1 were more likely to be in a relationship and living with others, while Cluster 3 tended to be single and living alone. Cluster 1 were more likely than average not to have left a suicide note and to die at a station location; Cluster 3 in contrast were more likely to choose a track location away from a station and to leave a suicide note. This appears to be consistent with a large scale study which found no significant association between personal characteristics and circumstances of death between people who did or did not leave suicide notes (Cerel et al., 2015).

The results of the cluster analysis may enable services to be alert to different potential profiles of people at risk of suicide. However,
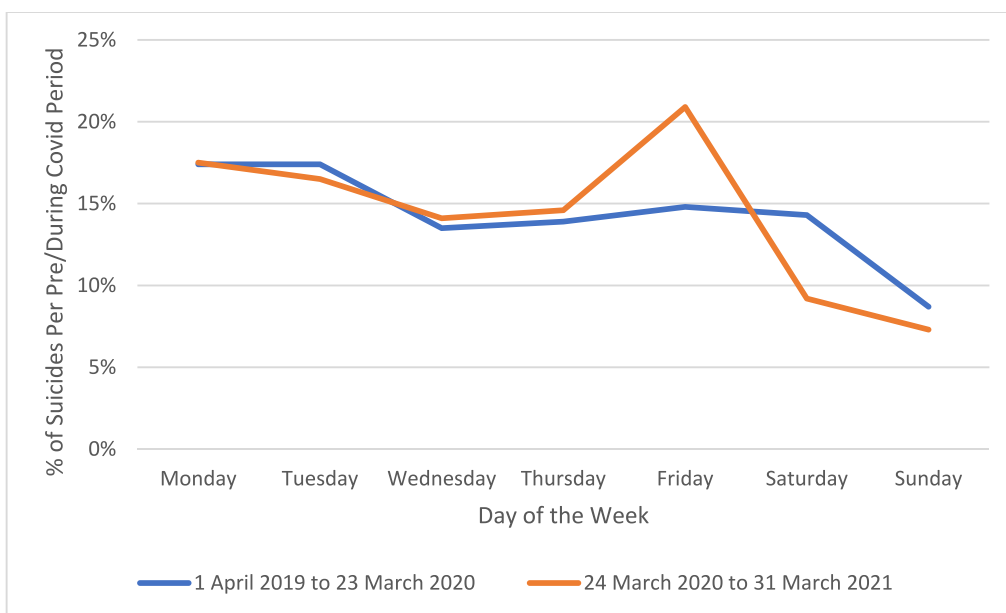
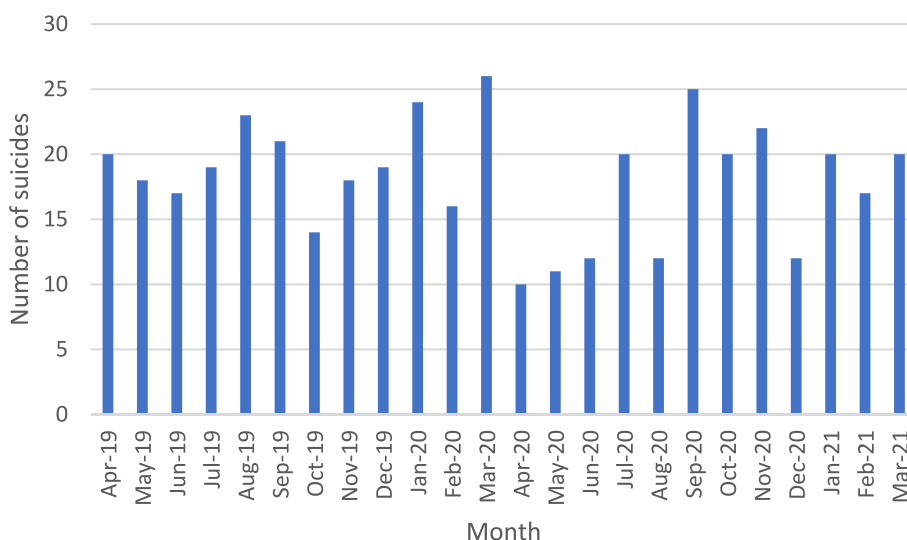**Fig. 2.** Percentage of rail suicides by day of the week pre and during covid-19.

Fig. 3. Rail suicides in England by month April 2019 to March 2021.

extensive research into risk factors has had a limited impact on our ability to predict suicide at an individual level (Franklin et al., 2017). It is important, then, to assess whether there may be opportunities to interrupt suicidal ideation or behaviour in the period immediately prior to an attempt. The window for intervention at a rail location appears to be relatively small (averaging at 12 minutes in the current study). Restricting access to the track using physical barriers has been found to be effective at reducing suicides at high risk locations (Barker et al., 2017). The fact that nearly half of deaths occurred at station locations should increase the possibility of human intervention, although the recent proposal to close some staffed ticket offices is worrying in this regard (Rail Delivery Group, n.d.). The study shows that the presence of bystanders is not always a sufficient deterrent to suicides on the railways, and 10 % of deaths in the current sample were known to have occurred despite a bystander interaction or intervention. However, this should be considered in the context of the much larger number of successful, live-saving interventions recorded on the railway network (approximately 1800 per year, Network Rail, n.d.). Research into the

efficacy of different kinds of interaction prior to suicide could strengthen initiatives to encourage bystander interventions (Katsampa et al., 2022). The finding that around a third of deaths occurred in the presence of other people, and 83 % were witnessed, mostly by the driver, but also by members of the public, highlights the importance of appropriate postvention support for witnesses and bystanders. Previous studies have highlighted the fact that the proportion of railway suicides that occur at stations is higher in England (43 % in the study period) than elsewhere, particularly compared with less densely populated countries such as Australia, the US and Canada (De Leo and Krysinska, 2008; Mishara and Bardon, 2016), but also with other European countries such as the Netherlands (Van Houwelingen et al., 2010) and Sweden (Rådbo et al., 2005). In addition, the current analysis indicates that nearly two thirds of station deaths occurred at small stations with only one or two platforms. This contrasts with a study in Japan, which found that larger stations (by numbers of passengers per day) and those with passing fast trains were associated with a greater proportion of railway suicides (Sueki, 2022). Future studies could usefully assess whether fast trains

Table 3
Characteristics of the statistical clusters of people who died by suspected suicide on the railways in England, 2019–2021.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	All cases
Number of People	103	127	103	103	436
Summary	Younger, working people, living with others	Older, more affluent people, with children	Younger, working single people, living alone	Older, unemployed with history of police contact	
	%	%	%	%	%
Median age	28	52	32	43	41
Sex					
Male	79.6	70.9	80.6	82.5	78.0
Female	20.4	29.1	19.4	17.5	22.0
Ethnicity					
White	73.8	88.2	83.5	84.5	82.8
Asian	8.7	4.7	12.6	4.9	7.6
Black	7.8	3.1	1.9	5.8	4.6
Mixed/Multiple	2.9	0	0	1.9	1.1
Other ethnicity	2.9	0.8	1.0	0.0	1.1
Not known	3.9	3.1	1.0	2.9	2.8
Nationality					
British	77.7	83.5	77.7	85.4	81.2
Other European	8.7	4.7	8.7	6.8	7.1
Rest of World	8.7	4.7	7.8	5.8	6.7
Not known	4.9	7.1	5.8	1.9	5.0
Have children*					
Yes	2.9	87.4	17.5	56.3	43.6
No	83.5	3.1	75.7	33	46.3
Not known	13.6	9.4	6.8	10.7	10.1
In a relationship*					
Yes	39.8	76.4	10.7	15.5	37.8
No	47.6	21.3	79.6	81.6	55.5
Not known	12.6	2.4	9.7	2.9	6.7
Living arrangements*					
Living alone	7.8	12.6	29.1	35.9	20.9
In shared accommodation or institution	4.9	2.4	18.4	16.5	10.1
With friends or family	77.6	75.6	39.8	28.2	57.1
Homeless	0	0.8	3.9	8.7	3.2
Not known	9.7	6.3	8.7	10.7	8.7

	%	%	%	%	%
Index of multiple deprivation for home address					
1 to 3 (most deprived)	26.2	18.1	27.3	43.7	28.2
4 to 7	45.6	42.5	43.7	31.1	40.8
8 to 10 (least deprived)	26.2	37	26.2	19.4	27.8
Not known	2.0	2.4	2.9	5.8	3.2
Employment status*					
Working	41.7	38.6	43.7	13.6	34.6
Unable to work	6.8	10.2	4.9	15.5	9.4
Retired	1.9	20.5	9.7	10.7	11.2
Student	17.5	0	12.6	1.9	7.6
Unemployed	16.5	14.2	20.4	31.1	20.2
Not known	15.5	16.5	8.7	27.2	17.0
Entry on the police national computer (historic offence)					
Yes	25.2	32.3	25.2	74.8	39.0
No	73.8	65.4	74.8	23.3	59.6
Not known	1.0	0	1.9	1.4	1.4
Evidence of current police investigation*					
Yes	9.7	12.6	6.8	19.4	12.2
No	90.3	87.4	93.2	80.6	87.8
Previous suicide attempt*					
Yes	29.1	33.1	23.3	68.9	38.1
No evidence	70.9	66.9	77.7	31.1	61.9
Diagnosed or suspected mental ill health					
Yes	75.7	77.2	69.9	85.4	77.1
No	10.7	7.1	11.7	1.9	7.8
No evidence	13.6	15.7	18.4	12.6	15.1
Specific mental health issues diagnosed or suspected					
Depression	50.5	64.6	47.6	65.0	57.3
Anxiety	28.2	26.8	26.2	20.4	25.5
Psychosis or schizophrenia*	19.4	10.2	13.6	26.2	17.0
Other mental ill health	8.7	3.1	11.7	11.7	8.5
Evidence of physical ill health*					
Yes	25.2	45.7	24.3	36.9	33.7
No evidence	74.8	54.3	75.7	63.1	66.3

(continued on next page)

Table 3 (*continued*)

	%	%	%	%	%
Left suicide note*					
Yes	24.3	31.5	68.0	25.2	36.9
None found	75.7	68.5	32.0	74.8	63.1
Location of death*					
Station (or accessed track from station)	70.9	48.0	29.1	39.8	47.0
Trackside away from station	29.1	52.0	70.9	60.2	53.0
Time of death*					
Early morning (midnight to 6 am)	8.7	5.5	11.7	11.7	9.2
Morning (6 to 12 pm)	34	33.1	25.2	21.4	28.7
Afternoon (12 to 6 pm)	29.1	37.8	44.7	18.4	32.8
Evening (6 pm to midnight)	26.2	21.3	16.5	45.6	27.1
Not known	1.9	2.4	1.9	2.9	2.3
Other people present*					
Yes	41.7	37.0	24.3	22.3	31.7
No	48.5	52.8	64.1	57.3	55.5
Not known	9.7	10.2	11.7	20.4	12.8
Number of known witnesses	1.4	1.2	1.2	1.2	1.3
Median distance from home to location	1.85 miles	2.8 miles	2.1 miles	2 miles	2.1 miles
Range	(0.1 to 207)	(0.1 to 123)	(0.01 to 200)	(0.06 to 38)	(0.01 to 207)

* Significant association between the variable and cluster allocation ($p < .05$).

are more likely to pass through small stations in England, increasing both ease of access and lethality of method. Previous research suggests that these are key motivating factors among individuals who have attempted or contemplated suicide by train (Marsh et al., 2021; Marzano et al., 2019), and by other methods (Marzano et al., 2021; Norman et al., 2023).

5. Limitations

This study benefitted from access to a unique dataset that has not previously been explored systematically to enhance understanding of rail suicides in England. However, the dataset itself had limitations. There was significant variation in the amount of data available in each case, resulting in a large amount of missing data for some categories. Perhaps most notably, very few files contained medical or toxicology reports, which resulted in an important gap in our knowledge about the deceased.

While the coding book was discussed extensively within the research team, and regularly updated and refined on the basis of such discussions, differences in interpretation and observation remain a possibility. The amount of missing data for some categories makes extrapolation to the wider sample difficult, and thus limits the conclusions that can be drawn. In addition, the results of the cluster analysis should be interpreted with some caution, as the analysis showed these groupings to be relatively close to one another (particularly clusters 1 to 3), which limits their statistical power. Furthermore, clustering is highly sensitive to the variables used and the choice of variables was limited by the degree of missing data.

The current study was by design exploratory and descriptive. Future research would benefit from comparative analysis between the characteristics of railway suicide and other suicide methods, or with non-fatal suicidal behaviour at railway locations. Alternatively, a case control method could usefully compare suspected suicides with accidental deaths on the railways, or with living controls (e.g McMahon et al., 2022).

6. Conclusion

This is the first case series study of railways suicides in England. Consistent with the wider suicide literature, the findings highlight the complexity and heterogeneity of suicide risk even in selected subgroups, and how difficult it can be to 'predict' such deaths, even against a common backdrop of adversity, isolation and physical and mental health challenges.

Nonetheless, the findings also point to some important opportunities

for prevention and intervention, both at rail locations and further 'upstream' in the pathways that lead to suicide. In particular, they underscore the need for preventative measures to restrict access to means and delay or interrupt impulsive behaviour (both at stations and elsewhere on the network), as part of or alongside local partnership approaches for upstream suicide prevention.

Consent to participate and publish

Since the analysis was conducted on files relating to deceased individuals, no consent to participate was required or sought.

CRediT authorship contribution statement

Hilary Norman: Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Lisa Marzano:** Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Supervision, Validation, Writing – review & editing. **Bob Fields:** Formal analysis, Investigation, Methodology, Validation, Writing – review & editing. **Sophie Brown:** Data curation, Methodology, Writing – review & editing. **Steven MacDonald Hart:** Data curation, Methodology, Writing – review & editing. **Ian Kruger:** Investigation, Visualization, Writing – review & editing.

Declaration of competing interest

The authors have no relevant financial or non-financial interests to declare.

Data availability

Due to the sensitive nature of this research, supporting data is not available.

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