

Cluster Suicides Among Unemployed Persons in Australia Over the Period 2001–2013

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Abstract There has been no research on whether particularly vulnerable people such as the unemployed are prone to being in a suicide cluster (defined as an unusually high number of suicides occurring in a defined geographical area and/or over a relatively brief period of time). We investigated the presence of unemployed suicide clusters in Australia over the period 2001–2013 using a Poisson discrete scan statistic approach. Spatial, temporal and spatial/temporal clusters comprised 13.4, 4.4 and 1.7% of all unemployed suicides respectively. These results suggest the importance of targeting preventative efforts in where large numbers of unemployed persons who have died by suicide resided before death.

Keywords Unemployment · Suicide · Cluster · Temporal · Spatial · Job loss

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1 Background

Suicide clusters have been defined as an unusually high number of suicides occurring in a defined geographical area and/or over a relatively brief period of time (Joiner 1999). There have been several different typologies of suicide clusters discussed in past research. Mass clusters are those suicides that occur within a specific time period and have been linked to media-related publishing of suicide (Haw et al. 2013). Point clusters occur close to each other in time and/or space (Joiner 1999). Specific locations such as psychiatric hospitals (Haw 1994), schools and universities (Askland et al. 2003), prisons (Cox and Skegg 1993), and isolated rural communities (Wilkie et al. 1998) may be particularly prone to this type of clustering. Other studies have identified suicide clusters as being more likely to occur in lower socio-economic status areas (Haw et al. 2013). Individual factors that have been associated with greater risk of being in a suicide cluster include being of younger age, being male, having employment difficulties, and having problems with families and life events (Haw et al. 2013). Thus, research suggests that risk factors for suicide clusters represent both individual as well as environmental elements.

There are several methodological and conceptual gaps in past research on suicide clusters. Methodologically, much of the work on suicide clusters have used case series designs (e.g., Haw 1994; Brent et al. 1989). These approaches are useful, but are limited by either the ad-hoc nature of the rules that define a cluster, or by the subjectivity that comes from trying to establish relationship after the fact. An alternative approach to identifying clusters is based on statistical criteria. Such studies have used Poisson hierarchical regression models and the Markov chain Monte Carlo methods (Chang et al. 2010; Congdon 1997, 2000; Middleton et al. 2008; Pirkola et al. 2009; Álvaro-Meca et al. 2013) combined with geographical information system (GIS) tools (Qi et al. 2009, 2010) to investigate the presence of suicide clusters. These approaches advance the methodological quality of studies in this area as they are based on a priori statistical rules, rather than post hoc assessments.

Conceptually, most research has focused on the potential clustering of specific suicide methods (Ngamini Nguai et al. 2014; Niedzwiedz et al. 2014; Jones et al. 2013) or suicide generally (Álvaro-Meca et al. 2013; Chang et al. 2010; Congdon 1997, 2000; Middleton et al. 2008; Pirkola et al. 2009; Qi et al. 2009, 2010). For example, previous Australian research has demonstrated that about 2.1% of suicide cases in Australia occur in a cluster (Cheung et al. 2013). The largest clusters were located in the Northern Territory and northern Queensland, areas with a large indigenous populations. These cluster are apparent even after considering that there has been a decline in the Australian suicide rates over the last 10 years (Cheung et al. 2013).

There has been limited research on whether suicide clusters according to specific risk factors, such as unemployment. We would argue that a group like the unemployed is likely to be at risk of being in a suicide cluster because, as a group, they tend to have a higher risk of suicide (Milner et al. 2014) and mental health problems (Paul and Moser 2009), both of which are risk factors for being in a suicide cluster. There is also some evidence that suicide among unemployed persons is sensitive to the wider economic environment (Crawford and Prince 1999; Ahs and Westerling 2006; Milner et al. 2013), which may suggest that they are at risk of being in a temporal suicide cluster. Identifying whether suicide clusters occur in this specific at-risk group could be helpful in terms of prevention, as this would provide a specific target for suicide prevention and intervention services.

In the present study we employed the scan statistic to examine whether there was evidence that suicides cluster in space and/or time among the unemployed. We use data

from Australia between 2001 and 2013. The scan statistic is useful because it simultaneously accounts for the population size and the underlying rate of the condition or event of interest. It has been commonly used to detect clusters of communicable diseases, and is increasingly being used in suicide cluster research (Niedzwiedz et al. 2014; Kulldorff and Nagarwalla 1995). Our aim was to identify the presence of three types of clusters: spatial-temporal clusters; spatial-only clusters and temporal-only clusters.

2 Method

2.1 Ascertainment of Suicide Deaths

We identified coroner determined suicide cases using the National Coroners Information System (NCIS). NCIS is a national internet-based data storage and retrieval system used by coroners, government agencies, and researchers to identify cases for death investigation and to monitor external causes of death in Australia (Bugeja et al. 2010; Daking and Dodds 2007). It captures all reportable deaths in the country. NCIS provides basic demographic information, as well as employment status and occupation at the time of death, collected from coronial files.

The quality and completeness of NCIS data is variable between cases, particularly for the early years of the scheme (prior to 2001), and intentional self-harm deaths may be under-reported due to differences in how suicide is determined between coroners and between states. (De Leo et al. 2010) In addition, there is a significant time lag in reporting of deaths in NCIS due to the lengthy coronial process. As a consequence, 2013 was the final year for which reliable suicide data is available; 2001 was the first year included in the analysis.

2.2 Classification of Study Group

We included any suicide where the deceased was unemployed at the time of their death ($n = 6616$). We excluded cases with missing information on date of death ($n = 210$), and residential postcode ($n = 86$) and those that were younger than 15 years or older than 64 years ($n = 69$) so as to represent the working age population. As a result, a total of 6251 suicides by unemployed persons were included in our analysis. Over the time period of the study, there were 36,130 suicides in Australia (ABS, 2008, 2016a).

2.3 Population and Geographic Data

Population estimates of unemployed people aged between 15 and 64 years for all postcodes were obtained from the 2006 census data (the mid-point of the study) collected by the Australian Bureau of Statistics (ABS) (ABS 2006). Because official population data on the unemployed excludes those persons who have not looked for work in the past 4 weeks, we also included those persons who were classified as “not in the labour force” (ABS 2006). The population data thus provides an indication of the short and long term unemployed and matches data from NCIS. We computed the geographical coordinates of the centroids for all postcodes using the ArcGIS software. The digital map of all postcodes in Australia was obtained from the ABS for the same year and used in this computation. We calculated the unemployed suicide rates for population described above by sex, age, marital status, jurisdiction and year of death using the 2006 Census data.

2.4 Analytic Approach

We investigated the presence of three types of clusters of unemployed suicides: temporal, spatial, and spatial–temporal clusters. In our attempt to detect these clusters, we performed Poisson discrete scan statistic using SaTScan v9.4.1 (Kulldorff 2015).

We first aggregated the number of unemployed suicides by month of the death and residential postcode and then imported this information with population estimates and area coordinates into SaTScan. Following this, we pre-specified the sizes of the spatial and temporal scan windows. The spatial window is only pre-specified for detecting spatial clusters and temporal window is only pre-specified for detecting temporal clusters. Both windows are pre-specified for detecting spatial–temporal clusters. Therefore, to set the spatial window, we calculated the incidence rates of unemployed suicides for all postcodes and obtained a maximum rate of 0.0549 among the population of interest. Based on past research (Chen et al. 2008), we set the size of any unemployed suicide cluster to not larger than an area with 5.49% of the total population at risk. We chose the circular shape as the shape of the spatial scan window (Tango and Takahashi 2005a, b). We then set the temporal window from a minimum of 1 month to a maximum of 12 months, as suggested by a recent systematic review on suicide clusters (Larkin and Beautrais 2012). These settings mean that, when used in combination, a set of cylinders was used to scan regions in the spatial–temporal analysis, with the circular base representing the area of the potential cluster and its height corresponding to its time. Our analysis was based at the state/territory level, meaning a separate spatial–temporal, spatial-only and temporal-only scan was undertaken for each state/territory. The SaTScan software identifies a number of potential clusters. Therefore, to identify those clusters where the observed number of suicides significantly exceeded the expected number, we followed the standard approach and used Monte Carlo stimulation (Kulldorff 1997). Clusters were considered to be significant if their p value was <0.05 . All suicides by unemployed people that occurred within the significant clusters were categorised as cluster suicides; all others were categorised as non-cluster suicides.

A potential limitation of SaTScan is that it does not identify non-circular shapes. Because of this, we used FleXScan to identify irregular shaped clusters occurring closer in space as a sensitivity analysis (Tango and Takahashi 2005a, b). We used the same case, population, and coordinates information as those used in SaTScan and created the matrix definition data using GeoDa. We scanned clusters with high rates using the Binomial model and set the log likelihood ratio with restriction. The restricted likelihood ratio scans the postcode areas with elevated risk (Tango 2008). We selected flexible scan and set the type of random number as binomial. The maximum spatial cluster size was set at 15 (default number).

3 Results

3.1 Unemployed Suicides in Australia

Unemployed suicides in Australia were predominantly among males (26.8 per 100,000 unemployed persons) and persons aged between 20 and 49 years old (22.1 per 100,000 for 20–34 years and 21.5 per 100,000 for 35–49 years) (Table 1). Forty-one per 100,000 unemployed people who died by suicide were separated. The Northern Territory had the

highest annual rate of unemployed suicides (50 cases per 100,000 persons). This was followed by Western Australia (24 cases per 100,000 persons) and Queensland (18 cases per 100,000 persons). Unemployed suicide peaked in 2012 (15.6 per 100,000) and was lowest in 2006 (10.3 per 100,000). This is in comparison to suicide among the general population, where rates ranged between 10 per 100,000 and 12.7 per 100,000 (Footnote, Table 1).

3.2 Spatial–Temporal Cluster Detection

We detected ten spatial–temporal clusters of unemployed suicides in Australia. They comprised 106 unemployed suicides, which represented 1.7% of all unemployed suicides. The cluster size ranged from 5 to 22 unemployed suicides. Five of the clusters were located in Victoria (4.2% of all Victorian unemployed suicides), two were in Western Australia (2.9%), and one each occurred in New South Wales (1%), South Australia (1.2%) and Queensland (0.6%) (Table 2; Fig. 1). Three clusters in Victoria and one cluster in New South Wales occurred in urban areas while the other clusters in other states/territories occurred in regional and/or remote areas. No spatial–temporal cluster among unemployed people was found in Northern Territory, Tasmania and Australian Capital Territory. Five of the clusters were detected in the month of January 2010, with three of them were located in Victoria. The other clusters were either found within 6, 9, 11 or 12 months.

3.3 Spatial Cluster Detection

For the 13-year period, we identified 12 spatial clusters of among unemployed people ($n = 840$). The cluster cases accounted for 13.4% of all unemployed suicides. The minimum number of cases in a spatial cluster was ten while the maximum number was 122. As shown in Table 3, New South Wales had the highest proportion of unemployed suicides clustered in space (3 clusters and 22.4% of all unemployed suicides in New South Wales). The other spatial clusters were found in Western Australia (3, 16.6%), Victoria (3, 11.6%), Queensland (2, 11.7%), Western Australia (3, 16.6%) and South Australia (1, 2.3%). Six of these clusters took place in city areas and the remaining occurred in regional and/or remote areas. We identified no spatial cluster in Northern Territory, Tasmania and Australian Capital Territory. Detected spatial clusters were mapped in Fig. 2. Although, we acknowledge a small number of postcodes detected that do not meet the criteria to be the cluster. These can be seen in white in Figs. 1 and 2.

3.4 Temporal Cluster Detection

The temporal cluster detection identified seven temporal clusters with 277 unemployed suicides (4.4% of all unemployed suicides) in Australia. All of them were found within the month of January 2010. They were located in all states and territories separately except Tasmania. The highest proportion of unemployed suicides clustered in time was found in Victoria (7.1%), followed by Australian Capital Territory (6.4%) (Table 4).

Our sensitivity analyses using FlexScan can be seen in Supplementary Table 1 and Supplementary Fig. 1. Results suggest that 54 of 62 (87%) cluster areas identified using FlexScan were same as the cluster areas identified using SaTScan. The difference between these two methods was that FlexScan identified one cluster in Northern Territory and only two in Victoria.

Table 1 Descriptive characteristics of Australian suicides by unemployed persons

Characteristics	Number	Annual rate per 100,000 unemployed persons
<i>Sex</i>		
Male	4894	26.8
Female	1357	4.7
<i>Age group</i>		
<=19	366	4.1
20–34	2532	22.1
35–49	2365	21.5
50–64	988	6.3
<i>Marital status</i>		
Never married	2420	11.8
Married/de facto	1576	8.0
Separated	701	40.7
Divorced	447	11.1
Widowed	49	4.4
Unknown	1058	–
<i>State/territory</i>		
NSW	1536	9.5
VIC	1126	9.5
QLD	1609	18.4
WA	1005	23.8
SA	428	11.6
NT	224	49.7
TAS	214	16.8
ACT	109	17.8
<i>Year of death</i>		
2001	530	14.6
2002	541	14.9
2003	467	12.9
2004	439	12.1
2005	446	12.3
2006	374	10.3
2007	406	11.2
2008	470	13.0
2009	473	13.1
2010	495	13.7
2011	498	13.8
2012	563	15.6
2013	549	15.2

Suicide rates per 100,000 in the Australian population during the period of the study was: 2001 = 12.7; 2002 = 11.8; 2003 = 11.1; 2004 = 10.4; 2005 = 10.3; 2006 = 10.4; 2007 = 10.7; 2008 = 11.0; 2009 = 10.8; 2010 = 11.3; 2011 = 10.7; 2012 = 11.4; 2013 = 11.1 (ABS 2006, 2016a, b)

NSW New South Wales, VIC Victoria, QLD Queensland, WA Western Australia, SA South Australia, NT Northern Territory, TAS Tasmania, ACT Australian Capital Territory

Table 2 Details of the spatial-temporal clusters of suicides by unemployed persons

Cluster no.	States	Number of clusters (% of state/territory unemployed suicides)	Time period	Number of months	Remoteness	Number of cases	Log likelihood ratio	P value
1	NSW	1 (1%)	Oct 2006–Aug 2007	11	Major cities	16	19.14	<0.001
2	VIC	5 (4.2%)	Jan 2010	1	Major cities	12	29.43	<0.001
3	VIC		Jan 2010	1	Regional	10	22.95	<0.001
4	VIC		Mar 2011–Nov 2011	9	Major cities	9	16.96	0.005
5	VIC		Jan 2010	1	Major cities/regional	8	16.47	0.008
6	VIC		Sep 2001–Feb 2002	6	Regional	8	15.16	0.024
7	QLD	1 (0.6%)	Jan 2010	1	Regional/remote	9	19.04	<0.001
8	WA	2 (2.9%)	Apr 2012–Mar 2013	12	Remote	22	29.43	<0.001
9	WA		Jan 2010	1		7	16.58	0.003
10	SA	1 (1.2%)	May 2003–Mar 2004	11	Remote	5	35.58	<0.001
	Total	10				106		

NSW New South Wales, VIC Victoria, QLD Queensland, WA Western Australia, SA South Australia, NT Northern Territory, TAS Tasmania, ACT Australian Capital Territory



Fig. 1 Geographical location of the spatial-temporal clusters of suicides by unemployed persons. *Notes* Age standardised rates for 2013: New South Wales = 9.4 per 100,000; Victoria = 8.7 per 100,000; Queensland = 14.4 per 100,000; South Australia = 11.6 per 100,000; Western Australia = 13.2 per 100,000; Tasmania = 13.8 per 100,000; Northern Territory = 14.3 per 100,000; Australian Capital Territory = 9.6 per 100,000; Australia = 10.9 per 100,000 (ABS 2016a, b)

Table 3 Details of the spatial clusters of suicides by unemployed persons

Cluster no.	States	Number of clusters (% of state/territory unemployed suicides)	Remoteness	Number of cases	Log likelihood ratio	<i>P</i> value
1	NSW	3 (22.4%)	Major cities	122	30.69	<0.001
2	NSW		Regional	118	16.77	<0.001
3	NSW		Major cities	104	15.90	<0.001
4	VIC	3 (11.6%)	Major cities	55	19.65	<0.001
5	VIC		Major cities	60	10.87	<0.001
6	VIC		Major cities	16	8.55	0.049
7	QLD	2 (11.7%)	Remote	92	61.12	<0.001
8	QLD		Regional	96	16.07	<0.001
9	WA	3 (16.6%)	Remote	96	84.07	<0.001
10	WA		Major cities	29	11.92	<0.001
11	WA		Regional/remote	42	10.72	0.003
12	SA	1 (2.3%)	Remote	10	51.68	<0.001
	Total	12		840		

NSW New South Wales, VIC Victoria, QLD Queensland, WA Western Australia, SA South Australia, NT Northern Territory, TAS Tasmania, ACT Australian Capital Territory



Fig. 2 Geographical location of the spatial clusters of suicides by unemployed persons. *Notes* Age standardised rates for 2013: New South Wales = 9.4 per 100,000; Victoria = 8.7 per 100,000; Queensland = 14.4 per 100,000; South Australia = 11.6 per 100,000; Western Australia = 13.2 per 100,000; Tasmania = 13.8 per 100,000; Northern Territory = 14.3 per 100,000; Australian Capital Territory = 9.6 per 100,000; Australia = 10.9 per 100,000 (ABS 2016a, b)

4 Discussion

The results of this paper suggest that suicide among unemployed persons were more likely to cluster in space (13.4% of all unemployed suicides) than time (4.4% of all unemployed suicides). Unemployed suicides that cluster in both time and space comprised relatively few suicides (1.7%). In terms of spatial patterns, it appears that clusters of unemployed suicides were most likely to occur in the metropolitan areas of Australia's two most populated states (Victoria and New South Wales), but in regional or remote areas in the other states and territories of the country. In terms of temporal pattern, clusters of unemployed suicides tended to occur in only one particular month. All temporal clusters occurred in January 2010. Unlike the general population (where rates of suicide have been stable over the period of the study), suicide among the unemployed population increased over time.

The contagion model argues that an underlying susceptibility to both suicide and contagion are necessary conditions to being in a cluster, as well as proximity to others in the suicide cluster, and being part of an at-risk population (Haw et al. 2013). A past review indicated that persons in suicide clusters often have employment problems and financial problems prior to death (Haw 1994, Haw et al. 2013). As pointed out in the introduction of this paper, unemployed persons share many of the risk factors that predispose a person to being a suicide cluster (Milner et al. 2014; Paul and Moser 2009; Crawford and Prince

Table 4 Details of the temporal clusters of suicides by unemployed persons

Cluster no.	States	Number of clusters (% of state/territory unemployed suicides)	Time period	Number of months	Number of cases	Log likelihood ratio	<i>P</i> value
1	NSW	1 (3.3%)	Jan 2010	1	51	42.53	0.001
2	VIC	1 (7.1%)	Jan 2010	1	80	120.73	0.001
3	QLD	1 (4.1%)	Jan 2010	1	66	66.77	0.001
4	WA	1 (4.4%)	Jan 2010	1	44	47.00	0.001
5	SA	1 (4.9%)	Jan 2010	1	21	24.54	0.001
6	NT	1 (3.6%)	Jan 2010	1	8	7.15	0.036
7	ACT	1 (6.4%)	Jan 2010	1	7	9.90	0.001
	Total	7			277		

NSW New South Wales, VIC Victoria, QLD Queensland, WA Western Australia, SA South Australia, NT Northern Territory, TAS Tasmania, ACT Australian Capital Territory

1999; Ahs and Westerling 2006; Milner et al. 2013). Recent research also indicates that people who are unemployed perceive lower social support than those who are employed (Milner et al. 2016). Social support is recognised as an important protective factor against suicide (Milner et al. 2015a) and those who are in suicide clusters have been found to be more socially isolated (Haw et al. 2013). This suggests that unemployed persons also lack the protective factors that are potentially prohibitive against being in a suicide cluster. Further, in Australia and many other countries, the majority of those who die by suicide are male (ABS 2016a), which has also been recognised as being a risk factor for being in a suicide cluster (Haw et al. 2013). Thus, unemployed persons are an at-risk population vulnerable to being in a suicide cluster, although we are unsure precisely what mechanism may underlie this.

While we have no data on whether the persons identified in our paper had direct knowledge of one another, our results suggest that a substantial proportion of these people lived in close geographical proximity to one other. This was particularly the case in New South Wales and Western Australia, where those in clusters represented over 20 and 16% of all suicides occurring among unemployed persons. It is also possible that these geographical clusters reflect socio-economic disadvantage for at-risk individuals within these specific areas. This would make sense considering that the experience of unemployment and suicide appears to be socio-economically patterned, in that lower skilled and precariously employed workers are more prone to experience unemployment than higher skilled and permanently employed workers (Oesch 2010; Abrassart 2015). Those working in lower skilled jobs are also more at risk of suicide (Milner et al. 2015b; Roberts et al. 2013). There is already evidence to suggest that lower socio-economic areas have higher rates of suicide (Rehkopf and Buka 2006) and are more likely to be in a suicide cluster (Qi et al. 2012a).

The temporal cluster identified in 2010 appeared to occur in all areas of Australia except Tasmania. This was not a time of particularly high unemployment in Australia (ABS 2016b). The available evidence suggests that unemployment is more of a risk factor for suicide during times of economic prosperity than during times of economic recession (Crawford and Prince 1999; Ahs and Westerling 2006; Milner et al. 2013). This is because

there is a normative effect of job loss, which when rare in society (i.e., during low unemployment), is associated with greater hopelessness and social stigma. In contrast, when unemployment rates are higher in society, job loss may be more normative and therefore associated with less stigma (Crawford and Prince 1999; Ahs and Westerling 2006; Milner et al. 2013). For these reasons, we would speculate that unemployed persons in suicide cluster may be at greater risk for suicide when unemployment rates in the country are lower, such as in 2010. We should note, however, that we are not able to test this hypothesis with our data because there is no information on when the sample became unemployed.

The main contribution of this paper is that it provides the first evidence that suicide clusters may occur among specific population groups such as the unemployed. The strengths of the study are that it systematically explored clusters close in time, space and both time and space. We included residential location rather than suicide location, which allows for the development of community based suicide prevention initiatives. We used a specific spatial parameter size based on the maximum incidence rate rather than using the default value (50%) usually used in the previous studies (Qi et al. 2012b; Cheung et al. 2013). This seems to provide a more precise detection of clusters (cross-checked by visualising local railway suicide rates). We also employed a smaller percentage of population at risk to allow identification of a smaller size and larger number of clusters. Like previous studies (Chang et al. 2013; Milner et al. 2014), this paper also found an increase among suicide among the unemployed. As in past research, we suggest that this may be connected to the 2007 economic crisis and ongoing feelings of job insecurity experienced following these events (Milner et al. 2014).

However, this study has some limitations. First, the number of suicides may be underestimated, as active coronial investigations could not be included. It is also likely that the total number of suicides included in this study were under reported due to delays in the coronial reporting process. Second, we applied a circular shape as the spatial base for the cluster detection, although our sensitivity analyses allowed for clusters of irregular shapes. Future research should expand that set of analytic approaches to understanding cluster suicides, thus allowing the identification of nonlinear shapes (Ishioka et al. 2010). Third, we did not have data on direct exposure to suicide (whether the deceased knows someone else died by suicide). Fourth, our methodology only allows for detecting clusters in close spatial and temporal proximity but does not allow examining other types of clusters; for example, clusters occurring in close social and familial proximities. Fifth, we used area centroids instead of population weighted centroids (determined by population distribution over the space of a postcode area) because we were not able to compute population weighted centroids for all postcodes from the smallest geographical unit (collection districts) as they do not correspond well to postcodes. This is likely to have influenced the results mainly in regional and remote areas where postcodes are typically large but the population mainly lives in a small area. Lastly, we did not have the ability to investigate the risk factors associated with clusters of unemployed suicides. We would suggest this as an area of future research.

In conclusion, our study suggests that unemployed persons vulnerable to suicide maybe at risk of being in a suicide cluster, both space and (to some extent) time. This is likely because unemployed persons who die by suicide possess many of the same characteristics as those persons identified as being at risk of being in a suicide cluster. Future research is needed to identify specific individual and area-level risk factors for unemployed suicide clusters, and to develop effective suicide prevention strategies. Prevention efforts should

target areas where large numbers of unemployed persons who have died by suicide resided before death.

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