Social Psychiatry and Psychiatric Epidemiology (2019) 54:1209–1218
https://doi.org/10.1007/s00127-019-01716-8

ORIGINAL PAPER

Data-informed targets for suicide prevention: a small-area analysis of high-risk suicide regions in Australia

Michelle Torok[1] · F. Shand[1] · M. Phillips[1] · N. Meteoro[1] · D. Martin[1] · M. Larsen[1]

Received: 21 August 2018 / Accepted: 25 April 2019 / Published online: 30 April 2019

Abstract

Purpose To investigate small-area variation in risks associated with suicide deaths across four regional communities in New South Wales, Australia, and to determine whether these areas have unique demographic and socioeconomic risk profiles that could inform targeted means restriction suicide prevention efforts.

Methods Archival data on suicide mortality for all deaths in New South Wales, Australia, over the period 2006–2015 were geospatially attributed to four high-risk priority regions. Deaths in the four regions were compared to each other, and to NSW, on demographic factors, indicators of economic deprivation, and suicide means.

Results Priority means restriction targets were identified for all sites. In Murrumbidgee, suicide deaths were significantly more likely to involve firearms and older males ($p < 0.001$). The Central Coast had a greater proportion of overdose deaths ($p < 0.001$), which were associated with being female and unemployed. Suicide deaths in Newcastle were associated with being younger ($p = 0.001$) and involving 'jumping from a height' ($p < 0.001$), while economic deprivation was a major risk for suicide death in Illawarra Shoalhaven ($p < 0.001$).

Conclusions Local regions were significantly differentiated from each other, and from the State, in terms of priority populations and means of suicide, demonstrating the need for locally based, targeted interventions. There were, however, also some risk constancies across all sites (males, hanging, economic deprivation), suggesting that prevention initiatives should, optimally, be delivered within multilevel models that target risk commonalities and provide tailored initiatives that address risk specific to a region.

Keywords Suicide · Prevention · Epidemiology

Introduction

Suicide represents a significant disease burden in terms of premature mortality and preventable disability. More than 800,000 deaths worldwide occur per annum [1], and it is estimated that between 10 and 30 attempts are made per death [2]. Despite suicide prevention being a global health priority, the problem does not seem to be improving; no appreciable decline in suicide deaths has occurred in more than a decade [3]. Suicide has one of the most complex aetiologies of any disease burden, with no well-defined pathological mechanisms, and 50 years of research efforts to delineate individual level predictors of suicide have proved unsuccessful [3]. Given that suicide is usually an outcome of complex interactions of socio-environmental, behavioural, and psychiatric factors, individually focused prevention initiatives (e.g., on psychological risk) do not have sufficient specificity to guide effective preventive actions or to have potential for impact that would reduce suicide at a population level [4]. It appears both important and necessary to examine the broader social determinants of suicide, focusing on identifying risks associated with the communities in which people live, work, and age, to develop interventions that can appropriately address relevant social forces or aspects of the environment that may contribute to suicide. However, given that suicide is a rare mortality event, examining social determinants at an overly broad geographical aggregation (i.e., State, nationally, globally) can mask important small-area variation in patterns of contributing risks.

✉ Michelle Torok
m.torok@unsw.edu.au

[1] Black Dog Institute, University of New South Wales, Sydney, Australia

The need to understand suicide within small-area geographies is supported by a growing spatial epidemiological literature, which over the past decade has demonstrated significant geographical disparity in suicide trends at a national level [5] as compared to smaller spatial geographies within countries [6–8] using geographic information systems. The current study builds on such work by providing a more nuanced examination of potential contributing risks for suicide within small areas or communities that are known to have a high suicide rate using a 'suicide audit' methodology. A suicide audit is the systematic collection and analysis of local small-area suicide data [9] with the intent of evaluating health service performance (typically) and inform service planning. In the current study, small-area suicide audits were undertaken for four regions in New South Wales (NSW), Australia as part of a broader multi-level suicide prevention trial (i.e., LifeSpan). In the LifeSpan trial, nine evidence-based interventions are being delivered, simultaneously, into four communities with a focus on local ownership and community engagement. One of the nine strategies is 'means restriction', and the suicide audits were conducted with the specific intent of informing tailored means restriction activities in each region. It is well supported that means restriction is one of the most effective prevention strategies for suicide [10]; however, given that there is significant regional variation in suicide [11], a one-size-fits-all approach to means restriction is not optimal, nor possible. Accordingly, a small-area analysis 'suicide audit' has a critically important role in allowing key decision-makers to know what to do, and how to invest limited resources in means restriction, as well as other, strategies. New approaches to understanding specific needs of communities are increasingly necessary to optimise the impact of the limited resources for suicide prevention. Until now, suicide audits have been used exclusively outside of research settings (i.e., for government, health organisations, councils) to monitor progress of new policies or services [9]. As far as the authors are aware, this is the first study to present suicide audits findings in the context of a research trial.

The current study aims to: (1) compare suicide mortality risk profiles across the four LifeSpan trial regions on demographics, socioeconomic deprivation indicators, and methods of suicide to investigate the extent of heterogeneity in risks across communities, and (2) compare the suicide profiles of the LifeSpan regions to the rest of the State (i.e., NSW) to determine if small areas do uniquely differ in their risk profiles from broader aggregations. These small-area suicide audits might assist in identifying contributing risks for suicide that could serve as targets for prevention.

Methods

Design

This is a retrospective analysis of population-based archived (secondary) data on completed suicides in the four LifeSpan regions: Newcastle ('NC'), Illawarra Shoalhaven ('ILW'), Central Coast ('CC') and Murrumbidgee ('MM'), and the rest of NSW ('NSW'). For the purposes of the LifeSpan trial, regions were required to have a minimum population of 150,000 to have sufficient power to detect statistical change in fatal and non-fatal suicide rates.

Data

Unit-level mortality data (i.e., individual suicide cases) were acquired from the National Coronial Information System (NCIS) for all registered suicide deaths in NSW, where the underlying cause of death was determined as intentional self-harm (suicide) [12] [International Classification of Diseases Australian Modification codes: X60–X84 (intentional self-harm), Y87.0 (sequelae of intentional self-harm)]. Data were obtained for the period of 2006–2015, and each incident case was geocoded to a specific address. For each case, the address of where the incident occurred (defined by longitude and latitude coordinates) was geocoded to a suburb using Australian Bureau of Statistics (ABS) 2016 State Suburb Codes (SSC). This meant that each case could be assigned to one of the four respective regions [13]. All suicide mortality cases where location of death fell within the boundaries of one of the four sites identified for this study were included in the analyses.

For each of the unit-level incident cases, data were collected on:

- Age: years old at time of death; age bins (0–24 years: 'youth', 25–64 years: 'workers'; 65–84 years: 'retirees'; 85+: 'the elderly').
- Sex (biological): male or female.
- Marital status: not married, married/de facto, unknown.
- Employment status: unemployed, employed, unknown.
- Economic deprivation: this was measured through two indicators: (1) mean household weekly income, and (2) the index of relative socio-economic advantage and disadvantage (IRSAD) scores matched to decile rankings (1–10), from the socio-economic indexes for areas (SEIFA) [14]. The IRSAD summarises information about the economic and social conditions of people and households, and ranks areas on a continuum from most disadvantaged to least disadvantaged using national Census data. A low decile ranking on this

index indicates a high proportion of relatively disadvantaged people in an area. IRSAD values have been attributed to each individual case based on the individual's suburb of residence.

- Method of suicide: method of death was determined by underlying ICD-10 codes (X60–X84). ICD-10 codes were based on the first three category alpha and numeric digits for underlying cause of death. ICD-10 codes which contained more than three digits were coded according to the first three digits present in the ICD-10 code for underlying cause of death. When ICD-10 codes were not available, two separate researchers independently inspected the cases using data from mechanism of injury and medical cause of death. A third researcher resolved any disagreements.

Data on other proximal individual risks, such as substance use or mental health, were not available at the time of this study. The final data set included a total of 6663 across all of NSW. Of these, 1180 (17.8%) cases occurred within the four LifeSpan regions. The population size, regional characteristics, and suicide rates are described in Table 1.

Sites

The four LifeSpan sites (Fig. 1) were identified from an earlier geospatial research study, which was undertaken with the purpose of identifying communities with higher than national average rates of suicide (see [8]). Each site is comprised of one or more local government areas, which are meaningful geographies in Australia for policy and community interaction. The four sites were compared against all suicide deaths in NSW. For the purposes of analysis, suicide deaths which occurred within a LifeSpan site were excluded from the 'NSW' group.

Statistical analysis

Suicide deaths were grouped by site and compared on demographics, economics, and suicide method. Proportions were presented for categorical variables and means for continuous variables. Chi-square analyses were used to determine if there were differences between groups on categorical variables, reporting the χ^2 statistic and Cramer's v effect size (small effect: 0.10; medium: 0.30; large: 0.50). Where there were significant χ^2 values, pairwise examinations were performed to determine significant group differences, and odds ratios (ORs) and 95% confidence intervals (CIs) reported where possible. Where variables were continuous and distributions normative, one-way analysis of variance was used with means, standard deviations (SD) reported. Where the F value was significant, Tukey post hoc comparisons (which have the least chance of making type-1 errors) were performed to examine where means were significantly different from each other. Independent t tests were used to compare two groups on continuous outcomes, with ORs, 95% CIs, and Cohen's d

Table 1 Characteristics of the total resident populations of the four regional sites relative to the State

	LifeSpan regions				State
	Newcastle (NC)	Illawarra Shoalhaven (ILW)	Central Coast (CC)	Murrumbidgee (MM)	NSW
Local government areas within site boundaries	Newcastle	Shoalhaven Kiama Wollongong Shellharbour	Gosford Wyong	Hay, Snowy valleys, Wagga Wagga, Bland, Griffith, Hilltops, Leeton, Junee, Gundagai	All
Estimated resident population	155,411	393,204	327,736	164,364	7,987,264
Total geographic area (km^2)	262	5308	1767	33,942	809,444
Urban/coastal/rural	Coastal	Coastal	Coastal	Rural	–
Location in NSW	North–East coast	South–East Coast	North–East coast	South-Western inland	–
% Males	49.3	49.2	48.4	49.7	49.3
Median age (years)	37	43	42	42	38
Median household weekly income ($)	$1377	$1296	$1258	$1139	$1486
Number of suicides (aggregated)	178	449	372	181	6663
Suicide rate for males (per 100,000)[a]	18.1	17.6	17.4	19.4	17.5
Suicide rate for females (per 100,000)[a]	5.0	5.4	5.1	2.6	5.4
Ratio of male:female suicide deaths	3.6:1	3.2:1	2.9:1	7.4:1	3.2:1

[a]Rate is aggregated across the 10 years of data from 2006 to 2015

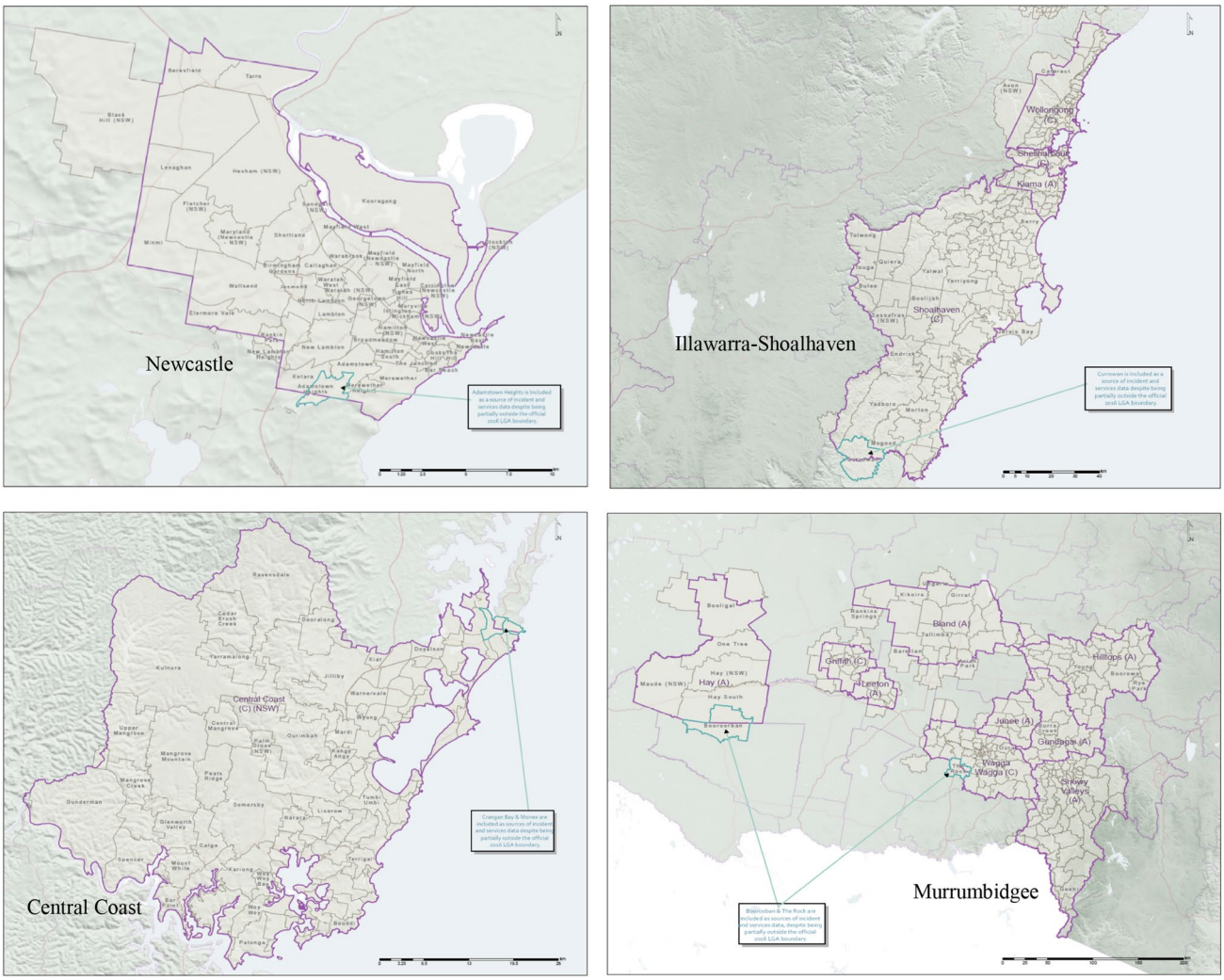

Fig. 1 Boundary maps of the four trial sites in the LifeSpan suicide prevention trial

reported (small effect: 0.20; moderate: 0.50; large: 0.80 [15]. Multinomial regression was used to estimate unique correlates of suicides × site, treating site classification as the dependent variable and 'NSW' as the referent class. All covariates were entered simultaneously in the model. Significant results were expressed as ORs and CIs. All analyses were conducted using SPSS version 24.0 [16].

Results

Sample characteristics

For the total sample ($n = 6663$), the mean age at point of death was 46.7 years (SD 18.0, *R* 12–104), and 24.4% were females. Just over half (51.2%) were unemployed, and not in a relationship at the time of death (57.1%). Among the LifeSpan sites, ILW had the most suicide deaths (38.1%), followed by CC (31.5%), MM (15.3%) and NC (15.1%). Specific characteristics for each site are presented in Table 2.

Comparison of demographic profiles across sites

Suicide deaths were compared based on site membership (Table 2). Significant differences between groups were reported for all demographic variables. There was a significantly higher proportion of deaths among males in the MM site compared to all other groups (MM vs. NC: $p = 0.01$; OR 0.89, 95% CI 0.81–0.98; MM vs. ILW: $p = 0.001$; OR 0.87, 95% CI 0.80–0.93; MM vs. CC: $p = 0.001$; OR 0.85, 95% CI 0.78–0.92; MM vs. NSW: $p < 0.001$; OR 0.44, 95% CI 0.28–0.69). The mean age at which point of death occurred was significantly younger in the NC group, as

Table 2 Comparisons of sites by demographics and methods of suicide

	NC ($n=178$)	ILW ($n=449$)	CC ($n=372$)	MM ($n=181$)	NSW[a] ($n=5483$)	Statistical significance	Significant differences between groups
Demographics							
Sex (male) *n* (%)	139 (78.1)	341 (75.9)	277 (74.5)	159 (87.8)	4122 (75.2)	$\chi^2=14.8$, $p=0.005$ Cramer's $v=0.09$	MM > NC, ILW, CC, NSW
Age (years) $M \pm SD$	42.5 ± 16.4	47.8 ± 17.8	48.1 ± 17.1	44.9 ± 19.5	46.72 ± 18.1	$F=3.68$; $p=0.005$	NC < ILW, CC, NSW
Age groups *n* (%)							
0–24 years	24 (14.0)	39 (8.7)	31 (8.3)	32 (17.7)	612 (11.2)	$\chi^2=15.1$, $p=0.005$ Cramer's $v=0.10$	NC, MM > ILW, CC; MM > NSW
25–64 years	136 (76.4)	327 (72.8)	279 (75.0)	118 (65.2)	3928 (71.6)	$\chi^2=7.9$, $p=0.09$ Cramer's $v=0.04$	NC, ILW, CC, NSW > MM
65–84 years	13 (7.3)	67 (14.9)	51 (13.7)	24 (13.3)	777 (14.2)	$\chi^2=7.2$, $p=0.13$ Cramer's $v=0.03$	ILW, CC, NSW > NC
85+ years	np	16 (3.6)	11 (3.0)	7 (3.9)	166 (3.0)	$\chi^2=1.2$, $p=0.88$ Cramer's $v=0.01$	–
Marital status (married/defacto) *n* (%)	62 (34.8)	166 (37.0)	130 (34.9)	68 (37.6)	1879 (34.3)	$\chi^2=31.9$, $p=0.001$ Cramer's $v=0.05$	ILW, MM > NC, NSW
Economic deprivation							
Employment status (unemployed) *n* (%)	86 (48.3)	261 (58.1)	197 (53.0)	76 (42.0)	2794 (51.0)	$\chi^2=27.9$, $p<0.001$ Cramer's $v=0.10$	ILW > MM, NSW
Household weekly income ($) $M \pm SD$	1358.0 ± 271.1	1241.4 ± 408.5	1306.6 ± 406.9	1220.2 ± 325.8	1590.1 ± 549.2	$F=18.7$ $p=0.000$	NSW > ALL; NC > ILW, MM
IRSAD decile ranking $M \pm SD$	5.0 ± 2.4	4.2 ± 3.0	4.3 ± 2.8	3.8 ± 2.4	5.9 ± 3.3	$F=63.2$ $p<0.001$	NSW > ALL; NC > MM
Methods of suicide							
Hanging *n* (%)	102 (57.3)	237 (52.8)	185 (49.7)	102 (56.4)	2712 (49.5)	$\chi^2=8.3$ $p=0.08$ Cramer's $v=0.05$	NC > NSW
Overdose (substance) *n* (%)	26 (14.6)	72 (16.0)	84 (22.6)	14 (7.7)	795 (14.5)	$\chi^2=25.8$ $p<0.001$ Cramer's $v=0.13$	CC > NC, ILW, MM, NSW; NC, ILW, NSW > MM
Poison by gas *n* (%)	15 (8.4)	47 (10.5)	33 (8.9)	18 (9.9)	479 (8.7)	$\chi^2=1.8$ $p=0.77$ Cramer's $v=0.03$	–
Jump from a height *n* (%)	16 (9.0)	27 (6.8)	14 (3.8)	np	466 (8.5)	$\chi^2=25.4$ $p=0.001$ Cramer's $v=0.10$	NC, NSW > CC
Firearm *n* (%)	6 (3.4)	15 (3.3)	14 (3.8)	27 (14.9)	359 (6.5)	$\chi^2=36.4$ $p<0.001$ Cramer's $v=0.20$	MM > NC, ILW, CC, NSW; NSW > ILW, CC
Jump in front of moving object	np	12 (2.7)	10 (2.7)	np	211 (3.8)	$\chi^2=5.9$ $p=0.21$ Cramer's $v=0.03$	–
Drowned *n* (%)	np	12 (2.7)	11 (3.0)	np	121 (2.2)	$\chi^2=2.3$ $p=0.68$ Cramer's $v=0.05$	–

np counts not provided where they are < 5 for confidentiality reasons, *IRSAD* index of relative socio-economic advantage and disadvantage, *SEIFA* socio-economic indexes for areas

[a]Excludes the cases from the NC, ILW, CC, MM regions (accounts for 82.2% of all NSW suicide deaths)

compared to ILW ($F = 11.4$, $p = 0.005$; Cohen's $d = 0.32$), CC ($F = 13.1$, $p = 0.00$; Cohen's $d = 0.30$) and NSW ($F = 4.0$, $p = 0.002$; Cohen's $d = 0.24$). More specifically, NC and MM had a higher proportion of 'youth' suicides than ILW (NC vs. ILW: $p = 0.04$; OR 1.72, CI 1.01–2.94; MM vs. ILW: $p = 0.001$; OR 2.26, CI 1.36–3.74) and CC (NC vs. CC: $p = 0.04$; OR 1.96, CI 1.03–3.13; MM vs. CC: $p = 0.001$; OR 2.36, CI 1.39–4.01). MM also had a higher proportion of youth suicides than NSW ($p = 0.007$; OR 1.71, CI 1.16–2.53). ILW, CC and NSW had a greater proportion of older suicides ('retirees') than NC (ILW vs. NC: $p = 0.01$; OR 2.23, CI 1.20–4.14; CC vs. NC: $p = 0.03$; OR 2.02, CI 1.07–3.18; NSW vs. NC: $p = 0.01$; OR 2.10, CI 1.19–3.70).

Comparison of economic deprivation profiles across sites

ILW had a higher proportion of suicide deaths involving unemployment than MM and NSW (MM vs. ILW: $\chi^2 = 16.6$, $p < 0.001$; ILW vs. NSW: $\chi^2 = 10.4$, $p = 0.006$). The average weekly household income was found to be significantly lower in all sites compared to NSW (NSW vs. NC: $F = 106.3$, $p < 0.001$; Cohen's $d = 0.53$; NSW vs. ILW: $F = 74.4$, $p < 0.001$; Cohen's $d = 0.72$; NSW vs. CC: $F = 81.0$, $p < 0.001$; Cohen's $d = 0.59$; NSW vs. MM: $F = 89.2$, $p < 0.001$; Cohen's $d = 0.81$), while NC had a higher average income compared to ILW ($F = 29.7$, $p < 0.001$, Cohen's $d = 0.34$) and MM ($F = 1.29$, $p < 0.001$, Cohen's $d = 0.46$). Consistent with this, NSW had a higher mean IRSAD decile ranking than all sites (NSW vs. NC: $F = 95.9$, $p < 0.001$; Cohen's $d = 0.33$; NSW vs. ILW: $F = 32.4$, $p < 0.001$; Cohen's $d = 0.53$; NSW vs. CC: $F = 81.2$, $p < 0.001$; Cohen's $d = 0.57$; NSW vs. MM: $F = 90.7$, $p < 0.001$; Cohen's $d = 0.74$), and NC had a higher IRSAD score than MM ($F = 0.14$, $p < 0.001$; Cohen's $d = 0.50$).

Comparison of suicide methods across sites

Differences in hanging, overdose, jumping from a height, and firearm deaths were reported across sites (Table 2).

Hanging

NC had a higher proportion of hanging deaths than NSW ($p = 0.039$; OR 1.37, CI 1.01–1.85). Significant sex × hanging interactions were found for ILW (40.7% female vs. 56.6% male; $p = 0.004$, OR 1.90, CI 1.22–2.94) and CC (35.8% female vs. 54.5% male; $p = 0.002$, OR 2.15, CI 1.33–3.48). Significant age group × hanging interactions were identified for ILW ('youth' [0–24 years]: 79.5% youth vs. 50.2% non-youth; $p < 0.001$, OR 3.84, CI 1.72–8.55), CC (67.7% youth vs. 48.1% non-youth; $p = 0.036$, OR 2.27, CI 1.04–4.95) and MM (81.3% youth vs. 50.3% non-youth; $p = 0.001$, OR 4.28, CI 1.66–10.90). Employment interactions were found for ILW (63.5% employed vs. 47.5% unemployed; $p < 0.001$, OR 1.92, CI 1.28–2.88) and CC (60.0% employed vs. 43.1% unemployed; $p = 0.002$, OR 1.98, CI 1.28–3.06). No significant interactions were found for marital status, household income or IRSAD decile ranking.

Overdose by substances

CC had a higher proportion of deaths involving *overdose by substance* than all other sites (CC vs. NC: $p = 0.029$; OR 1.54, CI 1.03–2.33; CC vs. ILW: $p = 0.017$; OR 1.41, CI 1.06–1.85; CC vs. MM: $p = <0.001$; OR 2.9, 1.7–4.9; CC vs. NSW: $p < 0.001$; OR 1.72, CI 1.33–2.22). Significant sex × overdose interactions were found for NC (33.3% female vs. 9.4% male; $p < 0.001$, OR 4.85, CI 2.02–11.63), CC (45.3% female vs. 14.8% male; $p < 0.001$, OR 4.76, CI 2.86–7.69) and MM (30.4% female vs. 4.4% male; $p < 0.001$, OR 9.09, CI 2.94–33.33). Employment × overdose interactions were found for ILW (9.4% employed vs. 19.5% unemployed; $p = 0.006$, OR 0.43, CI 0.23–0.79) and CC (15.2% employed vs. 29.4% unemployed; $p = 0.002$, OR 0.43, CI 0.25–0.74). No significant interactions were identified for age group, marital status, household income or IRSAD decile ranking.

Jump or fall from a height

NC and NSW had a higher proportion of suicide deaths involving a jump or fall from a height than CC (NC vs. CC: $p = 0.012$; OR 2.41, CI 1.22–4.86; NSW vs. CC: $p = 0.001$; OR 2.38, CI 1.04–3.10). We searched occupation status and found that 37.5% of jumping deaths in NC occurred among students; no clear patterns were identified for the remaining sites. Age group × jump or fall interactions were significant for NC ('youth': 32.0% youth vs. 5.2% non-youth; $p < 0.001$; OR 8.53, CI 2.84–25.65). No significant interactions were found for sex, employment, marital status, household income or IRSAD decile ranking.

Firearms

The MM group had the highest proportion of suicide deaths involving a firearm compared to all sites (MM vs. NC: $p = 0.012$; OR 4.76, CI 1.85–9.09; MM vs. ILW: $p < 0.001$; OR 4.55, CI 2.44–8.33: MM vs. CC: $p < 0.001$; OR 4.00, CI 2.13–7.14; MM vs. NSW: $p < 0.001$; OR 2.50, CI 1.64–3.82). Sex × firearm interactions were significant for MM (0% F vs. 17.1% M; $\chi^2 = 4.6$, p = 0.03) and CC (0% F

vs. 17.1% M; $\chi^2 = 5.0$, $p = 0.026$). Age groups × firearm interactions were significant for ILW ('retirees' [65–84 years]: 13.4% retirees vs. 1.6% non-retirees; $p < 0.001$; OR 9.72, CI 3.34–28.33) and MM ('retirees': 33.3% retirees vs. 12.1% non-retirees; $p = 0.007$; OR 3.63, CI 1.37–9.63). In MM 'farmers' accounted for 37% of firearm deaths. Farming occupations were not implicated in firearm deaths in any other LifeSpan site. No significant interactions were found for employment, marital status, income or IRSAD ranking.

Multinomial regression

NSW was treated as the reference or comparison group, given that the purpose of the regression was to determine how the four sites differed in their suicide profiles from that of the State. All variables contained in Table 2 were entered into the model, with the exception of age groupings. The model was significant ($\chi^2 = 463.68$, $df = 32$, $p < 0.001$), had a good fit as indicated by a p value greater than 0.05 (Pearson $\chi^2 = 0.91$) but, however, had poor accuracy, explaining between 7.9 and 12.1% of variance in site membership. ORs and CIs for significant variables are presented in Table 3.

Discussion

This study identified local determinants of suicide mortality across four communities in NSW, which may indicate unique economic, social, and cultural influences of a region on a population's mental health. The findings have translational value insomuch that they identify priority suicide prevention targets across distinct geographic regions which have previously been identified as having a suicide problem [8], and provide evidence that could inform targeted, local prevention efforts within each region.

Site-specific implications: reducing suicidality through targeted initiatives

Firearm deaths emerged as an important means restriction target for Murrumbidgee, particularly among older males. This association is likely to be explained by Murrumbidgee's geography—it is a rural region of Australia, and where agricultural occupations (i.e., farming) are common. Farmers are an occupational group at increased risk of suicide due to a host of factors, including social isolation, potential for financial losses related due to reasons beyond their control (e.g., weather patterns), barriers or unwillingness to seek mental health services [17], and who also have easy access to firearms [11, 18]. Notably, more than one-third of all firearm deaths in the Murrumbidgee region involved farmers, while the other LifeSpan sites had no suicide deaths involving farmers, despite having farming communities. As suicide attempts may be facilitated by having readily accessible methods at the point of crisis [19], restricting firearm availability among farmers should be targeted.

Differences in help-seeking patterns of farmers may offer a practical solution for restricting firearm access. Research has shown that the although farmers have the same rate of contact with general practitioners (GPs) as the general population, a greater proportion of farmers present to primary health for physical health symptoms only [18], despite high rates of depression being reported in the farming industry [20]. Help-seeking preferences for physical problems may be linked to a focus on traditional masculine norms and accordingly increased stigma around mental health issues in this industry [21]. Indeed, all firearm deaths among farmers in Murrumbidgee were exclusively males. GPs could consider introducing brief screening for depression and suicidal intention as part of a standard consultation, and where either condition is diagnosed, consideration should be given to the temporary removal of firearms within the context of safety planning [22]. Safety planning has emerging evidence for reducing suicide attempts and suicidal ideation among high-risk populations [23].

Table 3 ORs and CIs for significant independent correlates of suicide by region (NSW treated as referent)

	NC			ILW			CC			MM		
	OR	(95% CI)		OR	(95% CI)		OR	(95% CI)		OR	(95% CI)	
Age (years)	0.97*	0.93	0.99									
Household weekly income	1.13***	1.01	1.25	1.10***	1.01	1.19	1.04***	1.01	1.10	1.09***	1.01	1.19
IRSAD decile rank	1.15**	1.05	1.28	1.13**	1.06	1.21						
Firearm deaths				0.34***	0.19	0.61	0.51*	0.28	0.90	1.76**	1.11	2.79
Overdose by substance							1.81***	1.37	2.40			
Unemployed										0.57**	0.41	0.79

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

For the Central Coast, overdose deaths by substance use should be a unique target for means restriction. Given that potentially fatal moments of suicidal crises are often brief, and can be strongly ambivalent [4], restricting the availability and dosage of potentially lethal medications among high-risk persons may be important in managing overdose risk in this region. Restricting availability may be possible through greater collaborative 'pharmacovigilance' between locally based GPs, psychiatrists, and pharmacists, particularly when patients are females and/or unemployed. Pharmacovigilance has, historically, been associated with significant reductions in suicide deaths, such as when reduced packet sizes of paracetamol were introduced [24]. More universally, providing tailored gatekeeper training to pharmacists and pharmacy staff may be useful in helping them to detect suicide risk at point of medication dispensing [25]. Preventing overdose deaths in the Central Coast should confer a significant reduction in the total suicide deaths, given it was the second most common method, and that method substitution is uncommon [26].

Indicators of economic deprivation were particularly pronounced in Illawarra Shoalhaven, with the highest rates of unemployment, low household income, and high rates of relative disadvantage. A link between coastal areas and unemployment among suicide deaths has been reported in prior research [11], where employment opportunities may be limited. As labour market participation constitutes a certain role in society, material losses and decline in social reputation related to joblessness may provoke anxiety and psychological stress, placing out-of-work people at high risk for suicide [27]. Prevention considerations may include introducing mandatory screening for proximal risks for suicide (e.g., depression) and/or for active suicidal ideation in local welfare departments as part of social support eligibility assessments, in conjunction with skills-based gatekeeper training for welfare department employees. Fiscal policies that include initiatives which aim to increase social welfare and create local employment opportunities may be particularly important for suicide prevention in this region [28]. The Illawarra also had the highest proportion of suicide among retired aged individuals, who may be on pensions, contributing the overall lower economic profile of this region. Strategies such as encouraging relatives and GPs to participate in community gatekeeper training could assist in the early identification of vulnerable older individuals, while establishing telephone-counselling outreach programmes may overcome some of the barriers older people associate with face-to-face care [29].

Newcastle had a higher proportion of 'youth' suicide deaths (ages 0–24 years) than most areas, and a lower proportion of deaths among retirees (ages 65–84 years) than other coastal sites (CC, ILW). It is well evidenced that young people are reluctant help-seekers [30] which may increase vulnerability to suicide, such that in Newcastle it would be worthwhile to focus on strategies which increase the capacity for others in the community to recognise risk (e.g., 'gatekeeper' programmes in schools/universities for teachers, parents, peers) in young people. There is evidence that gatekeeper training in youth settings (e.g., schools) can lead to short-term improvements in suicide risk assessment [31], and in some cases can facilitate young people accessing mental health care [32]. Additionally, one-third of jumping deaths in this region involved students, such that using school or university counselling services to offer self-guided evidence-based online (eHealth) programmes, which are known to be effective in reducing suicidal thinking and depression, [33] may be an effective way of connecting vulnerable young people to care.

Similarities between regions: what are the data telling us?

Though differences between regions were reported, there were some risk consistencies at local and State levels that could be targeted through scalable public health approaches: male deaths, suicides by hanging, and economic deprivation. At both the regional and State levels, universal prevention initiatives that seek to increase help-seeking among males should be considered. For example, this could be public awareness campaigns run via social media platforms, using targeted parameters (e.g., location, sex, age) to reach males, and as a medium for promoting eHealth programmes to at-risk men. For hanging, universal prevention strategies such as working with the media to reduce the popularity or sociocultural acceptability of this method may be effective [34], while more targeted approaches may include involving parents or guardians in gatekeeper training and safety planning for young people who have a history of suicidal ideation or behaviour. Finally, all LifeSpan sites had higher levels of social and economic disadvantage than NSW, such that policies which reduce socioeconomic deprivation may be an important strategy in the prevention of suicidal behaviour. There is evidence to suggest that this may be especially important for reducing suicide attempts among young men who are particularly vulnerable to economic stressors [35]. Interventions which address 'common' priorities which straddle geographies should, ideally, be delivered within multilevel prevention models to allow for targeting of risk constancies, while providing flexibility to tailor additional approaches to regional needs.

Study limitations

We only used suicide mortality data for this study which can be subject to errors, including underestimating the extent to which these deaths occur, misclassification (e.g., as 'accidental'), or cases being left as an open verdict in the absence of clear evidence, potentially obscuring trends or biasing findings. The accurate identification of cases of suicide is an area of constant concern in suicide research. Moreover, as a rare event, suicide mortality may not properly reflect current prevention needs. Incident data for non-fatal intentional self-harm from agencies or stakeholders who are likely to have a high incidence of contact with suicidal persons (e.g., local hospitals, schools, justice agencies) are also needed to develop a comprehensive local profile of a region. Additionally, only a restricted set of variables were captured in our dataset, and other data should be acquired (e.g., cultural and linguistic diversity status, criminality, mental health, substance use, built environment) which could provide richer insight into the social and ecological aspects of areas that may give rise to suicide. Given that our multinomial analysis only explained up to 12% in variation in suicide death across regions, considering other data and variables is important for developing comprehensive regional profiles.

Conclusion

The findings of this study highlight that small regions, even those within reasonably close geographic proximity to each other (e.g., NC, CC), can be quite varied in their suicide profiles. This local area differentiation highlights how valuable data can be as a planning tool for the development of regionally specific suicide prevention initiatives. It should be a priority that suicide audits are more routinely incorporated into early planning and development phases of prevention initiatives in research and policy sectors, to not only ensure that efforts are being prioritised in areas which have greatest need, but also minimise resource wastage by ensuring that the strategies being implemented align most strongly with an area's unique risk profile.

Acknowledgements This study is funded by a grant from the Paul Ramsay Foundation. We would also like to thank the National Coronial Information System for the provision of data, and the data team at Black Dog Institute who were instrumental in cleaning and managing the data (Alex Burnett, Emily Li).

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical standards This study was approved by the Hunter New England Local Health District Human Research Ethics Committee (HREC/16/HNE/399; SSA/16/HNE/400) and the National Coronial Information System Justice Human Research Ethics Committee (M0381).

References

1. World Health Organization (2014) Preventing suicide: a global imperative. WHO, Geneva
2. De Leo D, Cerin E, Spathonis K, Burgis S (2005) Lifetime risk of suicide ideation and attempts in an Australian community: prevalence, suicidal process, and help-seeking behaviour. J Affect Disord 86:215–224
3. Franklin JC, Ribeiro JD, Fox KR, Bentley KH, Kleiman EM, Huang X, Nock MK (2017) Risk factors for suicidal thoughts and behaviors: a meta-analysis of 50 years of research. Psychol Bull 143:187–232. https://doi.org/10.1037/bul0000084
4. Yip PSF, Caine E, Yousuf S, Chang S-S, Wu KC-C, Chen Y-Y (2012) Means restriction for suicide prevention. Lancet 379:2393–2399
5. Haagsma JA, Graetz N, Bolliger I et al (2016) The global burden of injury: incidence, mortality, disability-adjusted life years and time trends from the global burden of disease study 2013. Injury Prev 22:3–18
6. Bando DH, Brunoni AR, Benseñor IM, Lotufo PA (2012) Suicide rates and income in São Paulo and Brazil: a temporal and spatial epidemiologic analysis from 1996 to 2008. BMC Psychiatry 12:127
7. Qi X, Hu W, Page A, Tong S (2012) Spatial clusters of suicide in Australia. BMC Psychiatry 12:86–96
8. Torok M, Konings P, Batterham PJ, Christensen H (2017) Spatial clustering of fatal, and non-fatal, suicide in new South Wales, Australia: implications for evidence-based prevention. BMC Psychiatry 17:339
9. Owens C, Roberts S, Taylor J (2014) Utility of local suicide data for informing local and national suicide prevention strategies. Public Health 128:424–429
10. Zalsman G, Hawton K, Wasserman D, van Heeringen K, Arensman E, Sarchiapone M et al (2016) Suicide prevention strategies revisited: 10-year systematic review. Lancet Psychiatry 3:646–659
11. Middleton N, Sterne JA, Gunnell D (2006) The geography of despair among 15–44-year-old men in England and Wales: putting suicide on the map. J Epidemiol Commun Health 60:1040–1047
12. World Health Organization (1992) The ICD-10 classification of mental and behavioural disorders: clinical descriptions and diagnostic guidelines. WHO, Geneva
13. Australian Bureau of Statistics (2016) 1270.0.55.003—Australian statistical geography standard (ASGS), vol 3. Non ABS structures. Australian Bureau of Statistics, Canberra
14. Australian Bureau of Statistics (2018) Socio-economic indexes for areas (SEIFA). Technical paper 2033.0.55.001. Australian Bureau of Statistics, Canberra
15. Cohen J (1988) Statistical power analysis for the behavioral sciences, 2nd edn. Lawrence Earlbaum Associates, Hillsdale
16. SPSS Inc. (2016) IBM SPSS statistics 240. SPSS Inc, Chicago
17. Milner A, Spittal M, Pirkis J, LaMontagne A (2013) Suicide by occupation: systematic review and meta-analysis. Br J Psychiatry 203:409–416
18. Booth N, Briscoe M, Powell R (2000) Suicide in the farming community: methods used and contact with health services. Occup Environ Med 57:642–644

19. Milner A, Witt K, Maheen H, LaMontagne A (2017) Access to means of suicide, occupation and the risk of suicide: a national study over 12 years of coronial data. BMC Psychiatry 17:125
20. Andersen K, Hawgood J, Klieve H, Kõlves K, De Leo D (2010) Suicide in selected occupations in Queensland: evidence from the State suicide register. ANZJP 44:243–249
21. Roche AM, Pidd K, Fischer JA, Lee N, Scarfe A, Kostadinov V (2016) Men, work, and mental health: a systematic review of depression in male-dominated industries and occupations. Saf Health Work 7:268–283
22. Stanley B, Brown GK, Brenner LA et al (2018) Comparison of the safety planning intervention with follow-up vs usual care of suicidal patients treated in the emergency department. JAMA Psychiatry 1:1. https://doi.org/10.1001/jamapsychiatry.2018.1776
23. Bryan CJ, Mintz J, Clemans TA, Leeson B, Burch TS, Williams SR, Rudd MD (2017) Effect of crisis response planning vs. contracts for safety on suicide risk in U.S. army soldiers: a randomized clinical trial. J Affect Disord 212:64–72
24. Hawton K, Bergen H, Simkin S, Dodd S, Pocock P, Bernal W et al (2013) Long term effect of reduced pack sizes of paracetamol on poisoning deaths and liver transplant activity in England and Wales: interrupted time series analyses. BMJ 346:f403
25. Painter NA, Kuo GM, Collins SP, Palomino YL, Lee KC (2018) Pharmacist training in suicide prevention. J Am Pharm Assoc 58:199–204
26. De Leo D, Dwyer J, Firman D, Neulinger K (2003) Trends in hanging and firearm suicide rates in Australia: substitution of method? SLTB 33:151–164
27. Helbich M, Plener PL, Hartung S, Bluml V (2017) Spatiotemporal suicide risk in germany: a longitudinal study 2007–11. Sci Rep 7:7673
28. Zimmerman SL (2002) States' spending for public welfare and their suicide rates, 1960 to 1995: what is the problem? J Nerv Ment Dis 190(6):349–360
29. Lapierre S, Erlangsen A, Waern M, De Leo D, Oyama H, Scocco P, Gallo J et al (2011) A systematic review of elderly suicide prevention programs. Crisis 32(2):88–98
30. Salaheddin K, Mason B (2016) Identifying barriers to mental health help-seeking among young adults in the UK: a cross-sectional survey. Br J Gen Pract 66:e686–e692
31. Mo PKH, Ko TT, Xin MQ (2018) School-based gatekeeper training programmes in enhancing gatekeepers' cognitions and behaviours for adolescent suicide prevention: a systematic review. Child Adolesc Psychiatry Ment Health 12:29
32. Kataoka S, Stein BD, Nadeem E, Wong M (2007) Who gets care? Mental health service use following a schoolbased suicide prevention program. J Am Acad Child Adolesc Psychiatry 46:1341–1348
33. Witt K, Spittal MJ, Carter G et al (2017) Effectiveness of online and mobile telephone applications ('apps') for the self-management of suicidal ideation and self-harm: a systematic review and meta-analysis. BMC Psychiatry 17(1):297. https://doi.org/10.1186/s12888-017-1458-0
34. Gunnell D, Bennewith O, Hawton K, Simkin S, Kapur N (2005) The epidemiology and prevention of suicide by hanging: a systematic review. Int J Epidemiol 34:433–442
35. Hawton K, Harriss L, Hodder K, Simkin S, Gunnell D (2001) The influence of the economic and social environment on deliberate self-harm and suicide: an ecological and person-based study. Psychol Med 31(5):827–836