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## RESEARCH REPORT

## Does young adult suicide cluster geographically in Scotland?

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**Background:** Suicide rose dramatically among young adults in Scotland between 1980–1982 and 1999–2001, especially among those living in deprived areas.**Objective:** To determine whether there are statistically significant geographical clusters of suicide and undetermined deaths among those aged 15 to 44 years in Scotland, and whether these persist through time.**Methods:** Deaths from suicide and undetermined causes by young adults in Scotland for three periods—1980 to 1982, 1990 to 1992, and 1999 to 2001—were aggregated into 10 058 small areas for Scotland. Tests for significant ( $p < 0.05$ ) geographical clustering of suicide were carried out for each period separately. Methods of suicide inside the identified clusters were compared with those in the rest of Scotland.**Results:** A significant geographical cluster of suicide among young adults was identified in east Glasgow in all three time periods (involving 92, 159, and 245 cases). Compared with the rest of Scotland, significantly more deaths in these clusters were caused by poisoning from liquids or solids over the entire period, but this was not the case in the most recent period (1999 to 2001). All three clusters could be explained by the concentration of socioeconomic deprivation in this part of Scotland.**Conclusions:** One interpretation of this large, persistent, and statistically significant cluster of suicides among young adults in east Glasgow is that suicide is geographically contagious, but the present results suggest that it is explained by the concentration of deprivation in this area. Suicide prevention strategies targeting at-risk populations living in east Glasgow are necessary to reduce the suicide burden in Scotland.

Suicide among young adults increased substantially in the United Kingdom and internationally during the second half of the 20th century. Although it is a relatively rare cause of death in Scotland, it remains a major health concern, partly because of the especially high rates among men in the more remote rural Highlands and Island areas.<sup>1–4</sup> Furthermore, the suicide rate among young adults in Scotland has been consistently higher than in the other constituent countries of the UK. Perhaps even more dramatic, however, are the rising rates among young adults in more deprived areas.<sup>5–7</sup> There is recent evidence that the suicide gap between the most and the least deprived areas widened considerably over the 20 years between the beginning of the 1980s and the beginning of the 21st century for those aged 15 to 44 years.<sup>8</sup> This raises the question of whether suicide among young adults is clustered geographically within Scotland and, if so, whether there is any evidence that suicide decisions may be “contagious”.

The spatial (and temporal) clustering of suicide has been examined empirically over the past 30 years, but the results are inconsistent. Joiner distinguishes between *point clusters*—defined as a collection of suicides that are proximal in time or space or both, often within an institutional setting such as a hospital, prison, or school where there is evidence of social contiguity—and *mass clusters*, which cluster in time rather than space and are often associated with media reports such as the deaths of celebrities.<sup>9</sup> Mass clusters have been studied extensively, although the results are inconclusive, while empirical studies in the USA suggest that point clusters account for approximately 1–5% of all suicides among adolescents and young adults.<sup>10</sup> Whether some form of contagious behaviour is involved is difficult to determine empirically; an alternative explanation is that vulnerable people cluster together well before the occurrence of any overt suicidal stimulus, and experience of severe negative events, such as the suicide of a peer, may increase the suicide risk for the whole group.<sup>9–11</sup>

Most research into suicide clusters and contagion has been undertaken in North America.<sup>9–12</sup> Only three papers appear to

have examined clusters in England and Wales,<sup>13–15</sup> and of these, two were limited to a mental illness/psychiatric setting.<sup>13–15</sup> In addition, while there has been anecdotal evidence of suicide clusters in some places, such as the Highlands of Scotland,<sup>16</sup> to our knowledge no study using robust statistical methods has examined whether suicides cluster geographically in Scotland.

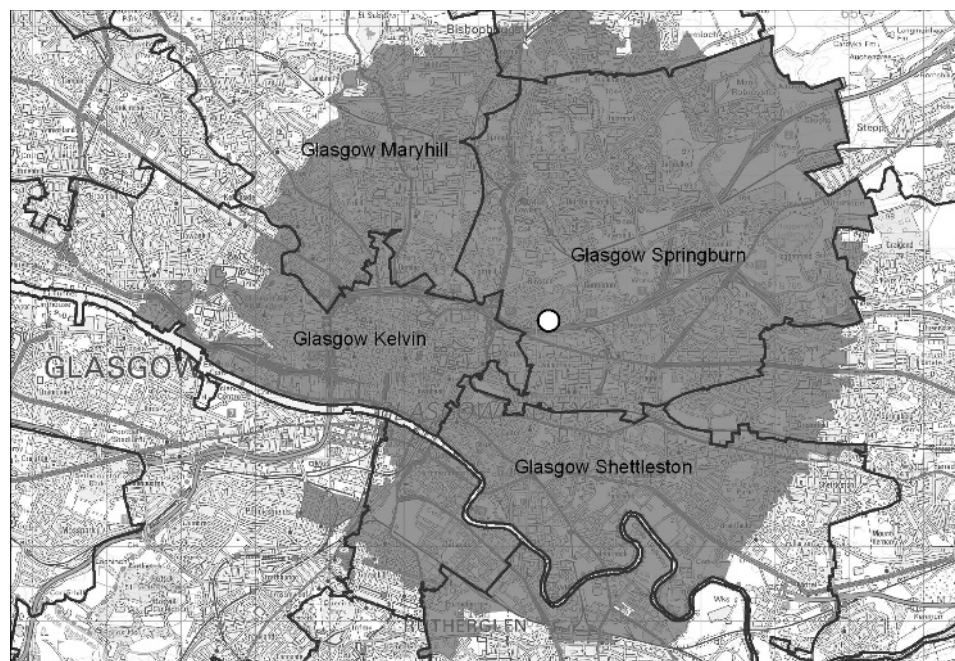
This study used a statistical cluster analysis of young adult suicides distributed across 10 058 small areas in Scotland for three separate time periods (1980 to 1982, 1990 to 1992, and 1999 to 2001).<sup>17</sup> Thus, we considered whether local level geographical variations in young adult suicides were clustered and, if so, whether they persisted through time. To shed further light on the possibility that contagious processes might be at work, we also examined whether the method of suicide was different between any identified clusters and the rest of Scotland. Finally, we also tested whether any clusters may be explained by the concentration of socioeconomic deprivation in certain parts of Scotland.

## METHODS

## Data

The General Register Office for Scotland (GROS) provided data on deaths from suicide and undetermined causes for young adults (15 to 44 years) for three periods; 1980 to 1982, 1990 to 1992, and 1999 to 2001 (*International Classification of Diseases*, ninth revision (ICD-9), codes E950–E959 E980–E989; 10th revision (ICD-10) X60–X84, Y10–Y34, Y87.0). These data included the post code of the deceased's usual residence. However, approximately 20% of suicides occur inside communal establishments (prisons, hospitals, and so on). In these instances, the GROS records the post code of the deceased's previous residential address if the deceased had been resident in the communal establishment for less than 13 months. In events where the deceased lived in a communal establishment

**Abbreviations:** CATTs, consistent areas through time; GROS, General Register Office for Scotland



**Figure 1** The significant cluster of suicides in Glasgow in the 1980 to 1982 period.

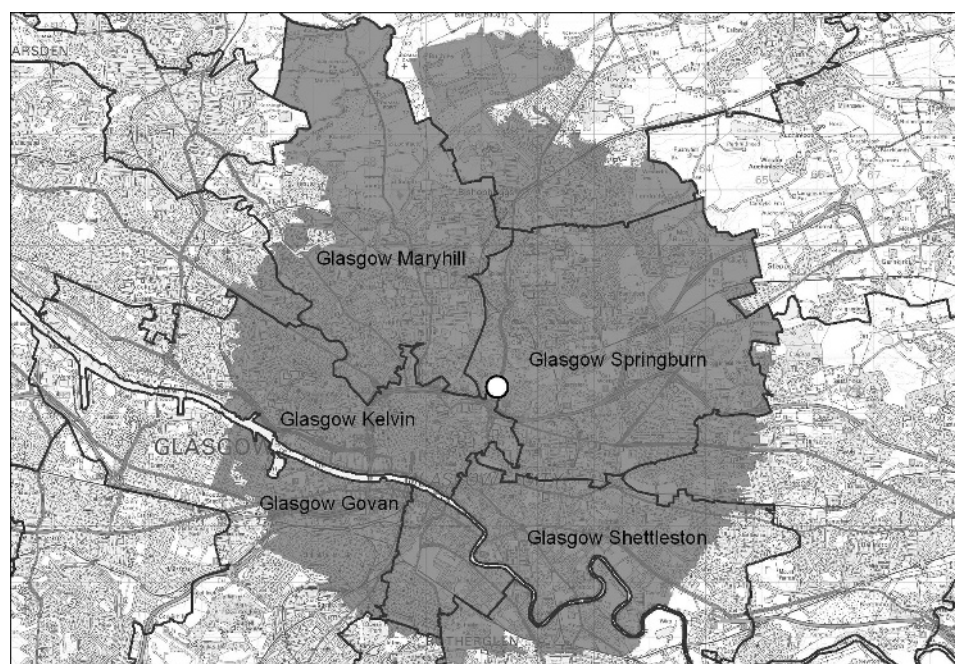
○ Centre of 1980 to 1982 cluster   □ 2001 Parliamentary constituencies   ■ 1980 to 1982 cluster

for 13 months or more, the post code of the communal establishment is provided as the deceased's usual residence. We excluded all deaths that occurred in communal establishments as we were interested in geographical clusters of suicide by residence. These deaths were aggregated into 10 058 consistent areas through time (CATTs), which encompass the whole of Scotland, the boundaries of which remain constant over the period of this study.<sup>17</sup> This provides a unique opportunity to compare how the geographical distribution of deaths changes in Scotland without being concerned that

apparent differences simply reflect reconfigurations of the boundaries of the areas for which the data are made available.<sup>18</sup>

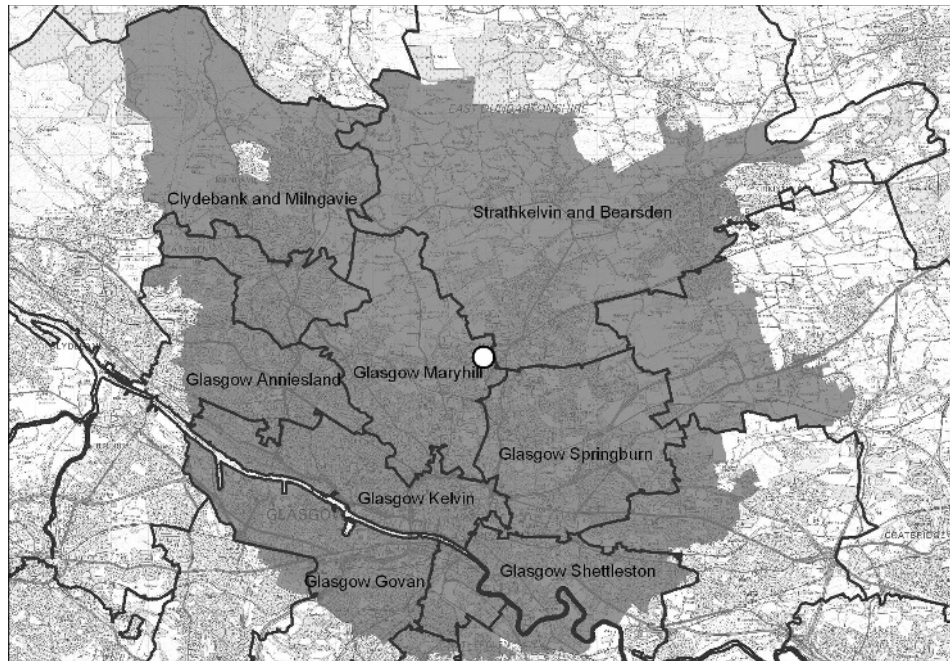
Population denominators for those aged 15 to 44 years were obtained for these geographical areas from the 1981, 1991, and 2001 censuses. The average population aged 15 to 44 in the CATTs during 1981–2001 was 210.

We calculated Carstairs deprivation scores for CATTs for each census period<sup>19</sup> and divided the CATTs into population weighted quintiles, each containing approximately one million people. There were 47 CATTs for which it was not possible to



**Figure 2** The significant cluster of suicides in Glasgow in the 1990 to 1992 period.

○ Centre of 1990 to 1992 cluster   □ 2001 Parliamentary constituencies   ■ 1990 to 1992 cluster



**Figure 3** The significant cluster of suicides in Glasgow in the 1999 to 2001 period.

○ Centre of 1999–2001 cluster    □ 2001 Parliamentary constituencies    ■ 1999–2001 cluster

calculate deprivation scores and these were excluded from the entire analysis, resulting in one suicide being excluded from the 1990–1992 analysis.

### Statistical methods

This study is designed to identify significant geographical clustering in a nationwide dataset using the spatial scan statistic<sup>20</sup> which has recently been applied to various different diseases.<sup>21–28</sup> The approach can detect clusters of any size located anywhere in the study region and is not restricted to clusters that conform to predefined administrative borders. The automated procedure involves placing numerous circular (moving) windows over a map of CATT centroids (grid references) to which the suicides and the denominator populations are attached. The circle radius varies continuously from zero to a previously user defined maximum, based on the denominator population, which was defined in this analysis as 50% of the population at risk, as recommended by Kulldorff.<sup>20</sup> For each circle, at every location, the log likelihood ratio is calculated. This determines whether the suicide rate within the circle differs significantly from the rate outside the circle. A Monte Carlo simulation was used to test the significance of the likely clusters. We defined significant clusters as those with a probability (*p*) value of <0.05. This technique can identify clusters at a range of scales from single zones to larger aggregations of zones.<sup>29</sup>

### RESULTS

In Scotland as a whole the number of suicides among young adults aged 15 to 44 increased over the study period: there were 932 in 1980–1982, 1241 in 1990–1992, and 1549 in 1999–2001. The suicide rate per 100 000 also increased significantly, from 15.38 (95% confidence interval, 14.38 to 16.38) in 1980–1982 to 19.76 (18.66 to 20.86) in 1990–1992, and to 24.32 (23.12 to 25.52) in 1999–2001.<sup>8</sup>

We undertook three separate cluster analyses for the whole of Scotland, one for each time period. A large and statistically significant cluster of suicides was identified in east Glasgow in each of the three time periods (table 1). This cluster included a considerable number of suicides in each period (92 in 1980–1982; 159 in 1990–1992; and 245 in 1999–2001) in areas which included young adult populations of 89 202 in 1980–1982, 140 396 in 1990–1992, and 220 204 in 1999–2002. In 1980–1982, the centre of the cluster fell in the Glasgow Springburn parliamentary constituency; many of the 383 CATTs belonging to this cluster were in the Glasgow Shettleston, Glasgow Maryhill, and Glasgow Kelvin parliamentary constituencies (fig 1). The centre of the 1990–1992 cluster (fig 2) was also located in the Glasgow Springburn parliamentary constituency, encompassing a similar although slightly larger area (600 CATTs). By 2001, the Glasgow cluster included 1053 CATTs, centred in Glasgow Maryhill, slightly to the northwest of the Glasgow based clusters in 1980–1982 and 1990–1992. The

**Table 1** Significant suicide clusters for adults aged 15 to 44 years (*p*<0.05)

Period	Cluster location	Population (15–44 years)	Number observed	Number expected	RR	<i>p</i> Value (controlling for age and sex)	<i>p</i> Value (controlling for age, sex and deprivation)
1980–1982	Glasgow	89 202	92	38.21	2.41	0.001	NS
1990–1992	Glasgow	140 396	159	78.54	2.02	0.001	NS
1990–1992	Midlothian	15 514	26	8.3	3.13	0.031	NS
1999–2001	Glasgow	220 204	245	160.7	1.53	0.001	NS

NS, not significant; RR, relative risk.

**Table 2** Suicide by method among young adults (15 to 44 years) 1980–1982, 1990–1992, 1999–2001, and all years for Glasgow clusters and the rest of Scotland (number and row percentage)

	Drowning and submersion	Poisoning by liquids or solids	Hanging, strangulation and suffocation	All other methods	Number of suicides	Pearson $\chi^2$ (3 df)
<b>1980–1982</b>						
Within cluster (%)	13 (14.1)	44 (47.8)	15 (16.3)	20 (21.7)	92 (100)	6.85 ( $p=0.077$ )
Rest of Scotland (%)	93 (11.1)	309 (36.8)	166 (19.8)	272 (32.4)	840 (100)	
<b>1990–1992</b>						
Within cluster (%)	17 (10.7)	86 (54.1)	28 (17.6)	28 (17.6)	159 (100)	32.65 ( $p=0.000$ )
Rest of Scotland (%)	98 (9.1)	355 (32.8)	252 (23.3)	377 (34.8)	1082 (100)	
<b>1999–2001</b>						
Within cluster (%)	21 (8.6)	79 (32.2)	100 (40.8)	45 (18.4)	245 (100)	5.44 (0.142)
Rest of Scotland (%)	74 (5.7)	400 (30.7)	523 (40.1)	307 (23.5)	1304 (100)	
<b>Total</b>						
Within cluster (%)	51 (10.3)	209 (42.1)	143 (28.8)	93 (18.8)	496 (100)	30.79 ( $p=0.000$ )
Rest of Scotland (%)	265 (8.2)	1064 (33.0)	941 (29.2)	956 (29.6)	3226 (100)	

df, degrees of freedom.

cluster overlapped with both the 1980–1982 and 1990–1992 clusters and sprawled into more of the Glasgow Govan, Strathkelvin and Bearsden, and Glasgow Rutherglen parliamentary constituencies; it now contained CATTs from the Glasgow Anniesland, Glasgow Pollok, Clydebank and Milngavie, and the Coatbridge and Chryston parliamentary constituencies (fig 3). Broadly, though, the geographical location of this single cluster, focused on east Glasgow, was remarkably consistent throughout the three periods.

A much smaller and less significant cluster was also identified in Midlothian during the 1990–1992 period (table 1). It comprised 26 cases and included much of the Edinburgh South and the Edinburgh East & Musselburgh parliamentary constituencies (figure not shown).

We tested whether the methods used to commit the suicides that fell within the Glasgow clusters were significantly different from the national distribution (table 2). Aggregated data for all three periods showed that the number of suicides within the

**Table 3** Distribution of suicide deaths and population (15 to 44 years) for Glasgow clusters and the rest of Scotland by deprivation quintile, 1980–1982, 1990–1992, and 1999–2001 (number and column percentage)

<b>(A) 1980–2 (Pearson <math>\chi^2</math> (4 df): 117.75, <math>p=0.000</math>)</b>				
Population weighted deprivation quintiles	1980–1982 (Glasgow cluster)		1980–1982 (rest of Scotland)	
	Suicides count (%)	Population count (%)	Suicides count (%)	Population count (%)
1	0 (0.00)	144 (0.16)	108 (12.86)	435 045 (21.37)
2	2 (2.17)	2476 (2.78)	161 (19.17)	417 944 (20.53)
3	0 (0.00)	2773 (3.11)	169 (20.12)	411 490 (20.21)
4	16 (17.39)	20 127 (22.56)	175 (20.83)	398 408 (19.57)
5	74 (80.43)	63 682 (71.39)	227 (27.02)	373 297 (18.33)
Total	92 (100.00)	89 202 (100.00)	840 (100.00)	2 036 184 (100.00)
<b>(B) 1990–1992 (Pearson <math>\chi^2</math> (4 df): 198.2, <math>p=0.000</math>)</b>				
Population weighted deprivation quintiles	1990–1992 (Glasgow cluster)		1990–1992 (rest of Scotland)	
	Suicides count (%)	Population count (%)	Suicides count (%)	Population count (%)
1	3 (1.89)	7 911 (5.36)	141 (13.03)	439 922 (20.66)
2	3 (1.89)	7555 (5.38)	195 (18.02)	448 499 (21.06)
3	9 (5.66)	11 163 (7.95)	201 (18.58)	439 418 (20.64)
4	10 (6.29)	19 181 (13.66)	247 (22.83)	437 790 (20.56)
5	134 (84.28)	94 178 (67.08)	297 (27.45)	362 165 (17.01)
Total	159 (100.00)	140 396 (100.00)	1 082 (100.00)	2 129 393 (100.00)
<b>(C) 1999–2001 (Pearson <math>\chi^2</math> (4 df): 125.70, <math>p=0.000</math>)</b>				
Population weighted deprivation quintiles	1999–2001 (Glasgow cluster)		1999–2001 (rest of Scotland)	
	Suicides count (%)	Population count (%)	Suicides count (%)	Population count (%)
1	10 (4.08)	33 589 (15.25)	126 (9.66)	358 943 (18.97)
2	8 (3.27)	17 243 (7.83)	186 (14.26)	409 248 (21.63)
3	20 (8.16)	25 827 (11.73)	263 (20.17)	398 794 (21.08)
4	41 (16.73)	37 211 (16.90)	326 (25.00)	396 112 (20.94)
5	166 (67.76)	106 332 (48.29)	403 (30.90)	328 620 (17.37)
Total	245 (100.00)	220 204 (100.00)	1 304 (100.00)	1 891 717 (100.00)

df, degrees of freedom.

combined cluster resulting from poisoning by liquids or solids was significantly greater than for Scotland as a whole. Some of these will have been directly or indirectly related to drug abuse. However, this result was not consistent through time; in the 1980–1982 and 1999–2001 periods the difference in the causes within the cluster compared to the rest of Scotland was not significant.

The CATTs identified within the Glasgow clusters were significantly more deprived than the average for Scotland (table 3) and, like the rest of Scotland, suicide was more common in the most deprived areas than would be expected from the population distribution. The cluster analysis was repeated for all three time periods controlling for deprivation, and in each time period the Glasgow cluster became statistically insignificant (table 1, final column).

## DISCUSSION

Suicide rose dramatically among young adults in Scotland during our study period, particularly in the most deprived areas.<sup>8</sup> This analysis extends our understanding of socio-economic variations in suicide by examining whether statistically significant geographical clusters exist. The results show that, controlling for the population distribution, there was a large and significant cluster of suicides among young adults (15 to 44 years) in east Glasgow, which persisted over two decades. While the geographical extent of this cluster increased a small amount over time, the consistency of this cluster over such a long period is remarkable. The number of suicides occurring inside this cluster was more than two and a half times greater in 1999–2001 than in 1980–1982.

One possible explanation for this spatial cluster is contagion, defined as “the exposure to suicide or suicidal behaviours within one’s family, one’s peer group, or through media reports of suicide [that] can result in an increase in suicide and suicidal behaviors”,<sup>30</sup> and it is acknowledged that this may be especially relevant among adolescents and young adults. Our data do not enable us to examine explicitly whether imitative suicides were involved in the clusters, nor is it possible to determine from our analyses whether the Glasgow clusters result from mass exposures, such as to media reports of suicides. Even so, our results do provide some insights into the possibility that contagious processes are at work.

We suggest that a contagion effect related to mass events is improbable. First, it would seem unlikely that mass events would result in a geographically focused cluster, although it may be possible that locally reported events only influence those in the Glasgow area. Second and more importantly, we would not expect a mass cluster to persist over this 20 year period.

We also suggest that this is unlikely to be a point cluster influenced by contagious processes. First, the Glasgow cluster would appear to be too large. It seems unlikely that the social networks would extend over such a wide area within the city, although it is of course possible that certain peer groups will extend over reasonably wide areas in Glasgow. Second, while the principal method of suicide in this cluster (poisoning by liquid and solid) was significantly higher than in the rest of Scotland for the entire period, this was not the case in each of the three year windows. Of course, while confirmation that suicide events within this cluster were more likely to result from a single cause would provide some support for the contagion hypothesis it would not of course confirm it incontrovertibly. We also need to be a little cautious about this interpretation, as during the 1990s the GROS changed the procedure for recording drug related deaths, resulting in a significant reduction in deaths reported as an “undetermined” drug related suicide (ICD9 code E980). This reduction was

accompanied by a significant increase in the number of “drug dependent” deaths (ICD code 304).<sup>31</sup> Therefore it is possible that our results underestimate the actual number of deaths by suicide inside this cluster in the latest period, although they will also have been underestimated in the rest of Scotland as well. Third, and most importantly, once the socioeconomic deprivation characteristics of the CATTs were accounted for, the clusters became insignificant. This suggests that the large cluster identified in east Glasgow reflects a persistent geographical concentration of significant deprivation.

Recent evidence shows that the link between young adult suicide and deprivation has strengthened in Scotland since the beginning of the 1980s.<sup>8</sup> The particular importance of east Glasgow in this relation is evident here, and the fact that the cluster has grown through time is cause for concern. Eight of the 15 parliamentary constituencies representing the “worst health million” in the analysis of the widening health, educational, social, and economic gaps in Britain were located in Glasgow.<sup>32</sup> Parts of those eight constituencies (Glasgow Shettleston, Glasgow Springburn, Glasgow Maryhill, Glasgow Pollok, Glasgow Anniesland, Glasgow Baillieston, Glasgow Kelvin, and Glasgow Govan) fell within the clusters reported here as well. Note also that drug related mortality has been substantially and consistently higher in the Greater Glasgow Health Board than in other Scottish health boards since 1996. In 2001, there were 96 drug related deaths in Glasgow, representing 29% of the Scottish total. Of these, 72 (75%) were associated with drug abuse.<sup>33</sup>

Existing cluster prevention guidelines in the USA<sup>34–35</sup> primarily target the media and appropriate reporting of suicides in particular, while interventions such as the identification of “at risk” individuals and key support networks (for example, teachers, community leaders, clergy, mental health support) are secondary factors. Given that the east Glasgow cluster has persisted and grown over time, our results highlight the need for specialised services and prevention mechanisms that target young adults in this area.

Our analysis allows us to identify the areas in Scotland that require particular attention in order to reduce the burden of

### What is already known

- Suicide among young adults in Scotland is strongly associated with deprivation, and this relation has strengthened with time.

### What this paper adds

- A statistically significant cluster of young adult suicide exists in east Glasgow, which has persisted and grown over the past two decades.
- This cluster can be explained by the concentration of deprivation in this part of east Glasgow.

### Policy implications

- Our results suggest that Scottish suicide prevention strategies should target young adults in east Glasgow.

suicide. The Scottish Executive has implemented a suicide prevention strategy ("Choose Life"), which aims to reduce suicide by 20% between 2003 and 2013.<sup>36</sup> The only geographically defined priority group in the Choose Life strategy relates to residents living in "remote rural or isolated areas", and there are several reports showing that suicide rates are indeed higher in these areas than elsewhere.<sup>1-4</sup> However, our recent results demonstrate the growing importance of deprivation in explaining the growth in young adult suicide<sup>8</sup> and the cluster analysis presented here focuses attention particularly on east Glasgow.

We believe that our present study strengthens the argument for targeting deprived communities in suicide prevention strategies, and that Glasgow City is a special case. Though people living in deprivation were not explicitly identified as a priority group in the original Choose Life strategy (although the homeless and those who misuse drugs were identified as priority groups), it has been recognised that Glasgow requires distinct intervention. As part of the implementation of Choose Life, Glasgow City Council has been awarded an additional £550 000 between 2003-2004 and 2005-2006 to develop a local suicide intervention strategy, which is substantially more than other council areas.<sup>37</sup> Whether this additional resource will be enough to tackle the significant suicide burden among young adults in east Glasgow identified in this analysis remains to be seen.

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