

Individual- and area-level predictors of self-harm repetition

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Background No ecological studies have examined the relationship between area characteristics, individual characteristics and self-harm repetition.

Aims To investigate the association between area-level factors and incidence and repetition of self-harm, and to identify which area-level factors are independently associated with repetition after adjustment for individual factors.

Method Prospective cohort study using the Manchester Self-Harm database. Adults who were resident in Manchester and presented to an emergency department following self-harm between 1997 and 2002 were included ($n=4743$). The main outcome measure was repeat self-harm within 6 months of the index episode.

Results Four individual factors (previous self-harm, previous psychiatric treatment, employment status, marital status) and one area-based factor (proportion of individuals who were of White ethnicity) were independently associated with repetition.

Conclusions Repetition of self-harm may be more strongly related to individual factors than to area characteristics. We need to better understand the processes underlying ecological associations with suicidal behaviour before embarking on area-based interventions.

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Self-harm is a major public health problem (Schmidtke *et al*, 1996; Kapur *et al*, 1998; National Collaborating Centre for Mental Health, 2004; Kessler *et al*, 2005) and an important risk factor for suicide (Department of Health, 2002; Owens *et al*, 2002). Repetition of self-harm is common. Overall, 15% of individuals repeat within a year of presentation (Owens *et al*, 2002). Ecological studies have reported that socio-economic deprivation is strongly associated with self-harming behaviour (Congdon, 1996; Gunnell *et al*, 2000; Hawton *et al*, 2001). However, research to date has considered rates of self-harm rather than rates of repetition as the main outcome measure. A limited number of measures of area characteristics have been used, and these have tended to be census based. Studies have not explored whether area-level factors are associated with self-harm independently of individual characteristics. This study had three main objectives. First, to investigate the association between a wide range of area-level factors and incidence rates of self-harm. Second, to investigate the association between area-level factors and repetition of self-harm. Third, to identify which area-level factors are independently associated with repetition after adjustment for individual factors.

METHOD

Participants and setting

The Manchester Self-Harm (MASH) monitoring system identifies all presentations with self-harm to the three hospitals providing emergency care in the city of Manchester (Kelly *et al*, 2004). The system monitors self-harm through hospital computerised records, and collects a range of socio-demographic and clinical information for patients through standardised assessment forms which are completed by emergency department and psychiatric

staff. During the study period, data were collected for 77% of eligible emergency department presentations. Limited information is collected on those for whom forms are not completed but they are similar in terms of age (mean age 31.6 *v.* 32.4 years) to those for whom we have forms. Those without forms are slightly more likely to be male (45% *v.* 39%) and to have injured themselves (19% *v.* 13%) than those with forms. Data for individuals aged 16 years and over, resident in the Metropolitan Borough of Manchester, were extracted from the MASH database for the period 1 September 1997 to 29 February 2002 ($n=4743$). All participants were followed up for at least 6 months.

The electoral ward of residence was established by linking individuals' postcodes to ward codes for boundaries using a geography conversion table provided by the Updated UK Area Master-files project (Simpson & Yu, 1999). There were no ward boundary changes during the period under study (Office for National Statistics, 2002). Patients with no fixed abode ($n=128$, 0.03%) and those for whom ward of residence could not be established ($n=84$, 0.02%) were excluded from analysis.

Outcome measures

For each electoral ward in the Metropolitan Borough ($n=33$), the self-harm incidence rate (per 100 000 persons per year) was estimated using the resident population estimate from the 2001 census as a denominator.

Individuals who repeated self-harm within 6 months of their first episode during the study period (index episode) were identified by linking episodes to individuals on the MASH database. The cut-off point chosen was 6 months because the majority (over 75%) of those who repeat within a year do so within this time period (Gilbody *et al*, 1997).

For each electoral ward in Manchester, the 6-month repetition rate was estimated using the number of patients (per ward of residence) with an index self-harm episode as the denominator.

Individual and ward characteristics

Individual-level socio-demographic and clinical factors for analyses were obtained from the MASH database, which contains a large number of variables. The individual factors considered in this study were

specified *a priori* on the basis of their clinical importance and their association with repeat self-harm in previous studies (NHS Centre for Reviews and Dissemination, 1998; Sakinofsky, 2000).

Ward-level socio-demographic variables were selected from various sources to provide indicators for a wide range of area characteristics, including those found to be associated with area rates of self-harm in the general population. Measures for ward levels of unemployment, economic inactivity due to permanent sickness or disability, population turnover, single-person households, White ethnicity and concentrated advantage (the proportion of households where the head of the household is in a professional, managerial or technical job) were derived from Census 2001 tables provided by the Office for National Statistics on DVD in Supertable format. The Townsend Index is a widely used composite deprivation measure derived using four census variables: the proportion of non-owner-occupied households; the proportion of households without access to a car; the proportion of overcrowded households; and the proportion of individuals who are unemployed (Townsend *et al*, 1986). The measure for social fragmentation is another composite measure based on four census variables: population turnover; the proportion of single-person households; the proportion of unmarried adults; and the proportion of households living in private rented accommodation (Congdon, 1996).

Several indicators of deprivation were included to enable comparison with the Townsend Index, which has previously been found to be independently associated with ward rates of self-harm (Congdon, 1996; Hawton *et al*, 2001). These included the Index of Multiple Deprivation (IMD) 2000 (Office for National Statistics, 2003), the separate IMD 2000 domains and concentrated advantage. The IMD 2000 is based on both census and administrative data sources, and provides an overall measure and six separate domains (income, employment, health, education, housing and access to services) which reflect different aspects of deprivation. A seventh domain is also available (child poverty), but this does not contribute to the overall IMD score. The IMD was commissioned by the Department of Transport, Local Government and the Regions, and was obtained by download

from the neighbourhood statistics website (Office for National Statistics, 2003).

Data for the proportion of school leavers entering continuing education were collated by Career Partnership and were downloaded from the Community Health Information Profile (CHIP) for Manchester website (Manchester Geomatics Limited, 2003). The measure of population density was provided by Manchester City Council. All these measures were complete for the 33 wards under study.

Statistical analyses

Analyses were conducted using Stata software, release 8.0. The degree of association between area-level explanatory variables and ward-level self-harm incidence rates was first assessed using the non-parametric Spearman rank correlation coefficient (Bland, 2000). Logistic regression models were then fitted to identify the predictors of self-harm repetition within 6 months (the individual-level outcome). Initially, univariate models were fitted. A multivariate individual-level model was then created using backwards elimination procedures to enable mutual adjustment for individual characteristics. The degree of association between the area-level explanatory variables and self-harm repetition rates was then assessed using the non-parametric Spearman rank correlation coefficient. Finally, the area-level explanatory variables that were statistically significant in the Spearman rank correlation analyses were iteratively added to the multivariate individual-level model in a forwards-stepwise fashion. As the final model was multi-level in nature, with variables at both individual and area level, a survey variance estimator that corrected for potential area-level clustering effects was involved. The adjusted population

attributable fraction (PAF) was used to calculate the proportion of repetitions that were attributable to the risk factors in the multivariate model (assuming a causal relationship between risk factors and outcome). The PAF takes into account both the prevalence of a risk factor and its relative risk (Benichou, 2001).

RESULTS

Study population

Overall, 4743 individuals aged 16 years and over presented to participating emergency departments during the study period. Of these, 516 (10.9%) re-attended with an episode of self-harm within 6 months of their initial presentation.

Incidence of self-harm

There was considerable variation between the wards in the rates of self-harm (Table 1). The associations between the area-level explanatory variables and the ward-level self-harm incidence rates (per 100 000 persons per year) are presented in Table 2. The Spearman rank correlation analyses indicated strong associations for most of the explanatory variables, many of which were measures of material or social deprivation.

Individual-level predictors of self-harm repetition

A number of individual-level variables were significantly associated with repetition. These included both socio-demographic variables (for example, age, employment, marital status, living circumstances and White ethnicity) and clinical variables (for example, previous self-harm, psychiatric treatment, alcohol misuse and hopelessness at the index attempt).

Table 1 Summary statistics for counts and rates of self-harm and repetition of self-harm for 33 Manchester wards

Self-harm	Minimum	Maximum	Mean	s.d.
Total				
Ward counts	81	254	157.9	41.2
Ward rates ¹	129.4	674.1	354.7	124.7
Repetition within 6 months				
Ward counts	6	34	15.6	7.6
Ward rates ²	4.1	17.3	10.7	3.2

1. Rates are per 100 000 per year; population base is the ward population aged 16+ years.

2. Rates are per 100 per year; population base is the self-harm population aged 16+ years.

Table 2 Associations between area-level explanatory variables and ward-level deliberate self-harm incidence rate (per 100 000 persons per year)

Area-level explanatory variable	Spearman rank correlation coefficient	P
Index of Multiple Deprivation 2000	0.91	<0.001
Income domain	0.89	<0.001
Employment domain	0.89	<0.001
Health domain	0.77	<0.001
Education domain	0.61	<0.001
Housing domain	0.51	0.002
Access domain	-0.36	0.04
Child poverty domain	0.76	<0.001
Concentrated advantage	-0.68	<0.001
Townsend Index of Deprivation	0.73	<0.001
Unemployment	0.81	<0.001
Registered sick	0.75	<0.001
Social fragmentation	0.03	0.86
% population turnover	-0.06	0.75
% single-person households	0.40	0.02
Population density	-0.30	0.09
% continuing education	-0.46	0.007
% White ethnicity	-0.03	0.88

Table 3 Associations between area-level explanatory variables and ward-level deliberate self-harm repetition rate (% within 6 months)

Area-level explanatory variable	Spearman rank correlation coefficient	P
Index of Multiple Deprivation 2000	0.02	0.90
Income domain	0.05	0.77
Employment domain	0.12	0.50
Health domain	-0.02	0.91
Education domain	-0.23	0.19
Housing domain	0.27	0.13
Access domain	-0.14	0.43
Child poverty domain	-0.02	0.90
Concentrated advantage	0.25	0.17
Townsend Index of Deprivation	0.12	0.51
Unemployment	0.1	0.60
Registered sick	-0.07	0.69
Social fragmentation	0.25	0.15
% population turnover	0.24	0.17
% single-person households	0.07	0.70
Population density	0.03	0.88
% continuing education	0.26	0.14
% White ethnicity	-0.39	0.02

Area-level predictors of self-harm repetition

As with incidence rates, there was considerable variation between the wards in rates of

repetition of self-harm (Table 1). The associations between the area-level explanatory variables and ward-level self-harm repetition within 6 months are presented in Table 3. In contrast to the association between

area measures and self-harm incidence rates (Table 2), there was little evidence that area-level measures predicted repetition at ward level. The only variable significantly associated with poor outcome was the proportion of individuals in a ward who were from a White ethnic group. For this variable, the negative Spearman correlation coefficient (-0.39 , $P=0.02$) indicated that repetition rates were lower in wards with a predominantly White ethnic profile.

Individual and area-level multivariate model

The final multivariate model, combining variables at both individual and area levels is presented in Table 4. Variance inflation factors indicated that the model was not subject to collinearity problems. Four individual-level predictors (previous self-harm, previous psychiatric treatment, employment status and marital status) were found to be independently associated with repetition, together with one area-level variable (proportion of individuals with White ethnicity). This variable was re-categorised into tertiles in order to enhance interpretability. People living in wards with a lower proportion of White residents had a higher risk of repetition which was independent of the individual-level covariates. A *post-hoc* analysis showed that this relationship did not vary according to the ethnicity of the individual (P value for interaction = 0.98). The ecological association was in the opposite direction to that observed for the individual-level ethnicity variable; the univariate model indicated that White individuals were at higher risk of repetition (OR=1.70, 95% CI 1.19–2.42), although this variable was dropped from the multivariate model owing to non-significance.

The adjusted PAF estimates for the covariates in the final model are also presented in Table 4. These were large, ranging from 15.9% for White ethnicity (area-level) to 44.4% for previous self-harm (individual-level), which partly reflects the high prevalence of the risk factors in this high-risk sample. The combined adjusted PAF for all variables in the model indicated that 78.8% of all self-harm repetitions were attributable to these independent predictors. However, this estimate should be treated cautiously, as the explanatory variables in general are not modifiable and the associations are unlikely to be causal.

Table 4 Multivariate logistic regression model¹ for independent individual- and area-level predictors of repetition of self-harm within 6 months

Explanatory variables	Adjusted OR	(95% CI)	Prevalence of risk factor (%)	PAF (%) ³ (adjusted)	(95% CI)
Previous self-harm					
No	1.00	–	–	–	–
Yes	2.57	(2.00–3.29)	55	44.4	(34.3–52.9)
Previous psychiatric treatment					
No	1.00	–	–	–	–
Yes	1.73	(1.41–2.12)	51	26.4	(17.0–34.7)
Employment status					
Employed	1.00	–	–	–	–
Unemployed	1.41	(1.06–1.87)	45	13.2	–
Registered sick	1.67	(1.12–2.51)	11	6.0	–
Other inactive	1.10	(0.84–1.44)	19	1.2	–
Total for variable	–	–	–	(20.5)	(4.0–34.1)
Marital status					
Married/partnered	1.00	–	–	–	–
Single/separated/divorced/widowed	1.39	(1.09–1.76)	70	18.9	(5.3–30.6)
% White population (area-level)					
High – 1st tertile (93.5–95.6)	1.00 ²	–	–	–	–
Medium – 2nd tertile (82.4–93.5)	1.15 ²	(0.88–1.51)	31	3.5	–
Low – 3rd tertile (47.3–82.0)	1.45 ²	(1.14–1.84)	39	12.5	–
Total for variable	–	–	–	(15.9)	(3.6–26.7)

PAF, population attributable fraction.

1. Multivariate model created using 91% (4336/4743) of the whole sample. Variance estimation in this model was corrected for area-level clustering effects.

2. Evidence of linear trend in risk of repetition across tertiles ($Z=3.19$, $P=0.003$).

3. Estimate for combined effect of all covariates: PAF=78.8% (95% CI 71.1–84.4).

DISCUSSION

Main findings

We found a strong ecological association between the socio-economic characteristics of areas and their incidence rates of self-harm, with deprived areas generally having the highest rates. By contrast, few area-level characteristics appeared to influence the likelihood of repetition – the only factor that was significantly associated with outcome was the proportion of individuals in the ward who were of White ethnicity. In the final multivariate model, several individual-level characteristics were found to independently predict repetition. The area-level characteristic – the relative size of the White population – predicted repetition independently of the individual-level covariates. Collectively, the variables in the model accounted for almost 80% of the cases of repetition within 6 months, with 16% of cases being accounted for by the area-level characteristic.

Methodological issues

We used a wide variety of area-based measures from a number of sources, and

our multivariate analysis took account of ward-level clustering effects. Our study is the first, to our knowledge, to attempt to quantify the association between individual and area-level factors and repetition of self-harm. However, as with all studies of this type, we were restricted in the amount of data we could analyse – we did not measure all possible confounding and explanatory variables.

The findings of the current study need to be interpreted in the context of its specific methodological shortcomings. First, this study investigated individuals who presented to teaching hospitals serving a relatively deprived inner-city area, and the results may not be generalisable to other settings. Equally, our findings may not be applicable to those who do not present for treatment following self-harm or those who choose not to wait after presenting to hospital. Second, although the response rate for the MASH project is good and we have no evidence that the response rate varied systematically by ward, males and those who use cutting as a method of harm may be under-represented in our sample. Third, it is possible that, for wards on the

periphery of the study area, a proportion of patients attended hospitals which were not included in the MASH project. We do not have a direct estimate of the size of this effect for index episodes, but data from within the Manchester district suggest that repeat episodes are followed by presentation to the same hospitals as the index episodes in 80–90% of cases. Fourth, the number of repeat self-harm attempts in some wards was relatively small and we did not use statistical techniques such as Bayesian modelling (Richardson *et al*, 2004) to smooth the underlying risk estimates. However, the sensitivity of Bayesian disease-mapping models is low when (as in this study) the raised risks are moderate and the expected counts are less than 50 (Richardson *et al*, 2004). Fifth, we did not adjust for the fact that wards in close proximity to one another were likely to have similar exposure prevalence (spatial autocorrelation), but spatial autocorrelation may not be a major issue with ecological studies of suicidal behaviour (Wasserman & Stack, 1995). Sixth, we only considered two levels in this study: individual and small-area. There are suggestions that

exposures which occur at other levels (for example, at the level of household) may also be important determinants of mental health (Weich *et al*, 2005).

We could have elected to analyse the data using survival methods and we have used this approach in previous individual-level studies (Cooper *et al*, 2005). Using survival analysis would have allowed us to make full use of the data by including varying lengths of follow-up. However, the influence of area on repetition risk may vary according to the length of time since the index episode. Longer periods of follow-up would also have made it more likely that an individual would have moved between areas. We therefore decided *a priori* to investigate repetition within a fixed period of 6 months.

Interpretation of findings

It was striking that only one area-based variable was associated with repetition of self-harm. Why might this be? It is possible that the lower number of repeat episodes of self-harm (when compared with index episodes) limited the power of this study to detect significant associations. However, the coefficients reported in Table 4 are less than 0.3 in either direction (with the exception of the significant variable – White ethnicity), and type II error is therefore unlikely to be the explanation. It is also possible that our unit of analysis for area effects (electoral ward) was too large and heterogeneous to detect contextual influences on repetition. However, the self-harm event data would have become too sparse if we had used a smaller area-level unit than the ward. Of course, it may be that our findings are correct and that area-based influences were much more important for index cases of self-harm than for repeat episodes. Our failure to find area-based predictors of repetition in this comparatively large study could reflect the fact that such influences are not clinically important. Only very few studies to date have found an association between area-based factors and mental health after adjustment for individual factors (Skapinakis *et al*, 2005).

Individual-level risk factors appeared to be more important determinants of repeat self-harm than area characteristics. However, our final model did suggest that both individual- and area-based factors were independently associated with repetition. The finding, that the risk of self-harm increased as the proportion of individuals

who were from a White ethnic background decreased, appears counter-intuitive. Being of White ethnicity (on an individual level) was associated with increased risk of repetition. This is an example of how area-based and individual-level exposures may affect risk differently. There are several possible explanations for this finding. First, the association may be spurious. A ward's ethnic composition may simply be a proxy indicator of other exposures, for example relative deprivation or degree of social cohesion or other factors which we did not measure. A second explanation relates to the distribution of people who repeat self-harm within the borough. It is plausible that, given their characteristics, more of these individuals live in hostels, temporary accommodation and supported housing and that these types of accommodation may be concentrated in wards with more ethnically mixed populations. Third, the finding could reflect the underlying characteristics of the individuals who live in these ethnically diverse areas. Fourth, it could be a true effect, with the individual's risk being modified by the prevalence of the exposure (in this case ethnicity) at a ward level. Neeleman *et al* (2001) found that the risk of self-harm behaviour associated with individual ethnicity was mediated by the local size of the individual's ethnic group (as the size of the local ethnic population increased, the risk associated with Black and minority ethnicity on an individual level decreased). It could be that the degree to which an individual fits with the social environment influences the risk of adverse outcomes.

Clinical implications

If our findings are correct, then the repetition of self-harm may be more strongly related to individual factors than to the characteristics of the areas in which people live. This might suggest that the most productive strategy to reduce repetition would be to focus on individual-level interventions. However, area-based risk factors might also warrant consideration – in our study, such factors accounted for approximately 16% of repeat episodes in the population. It is possible that area-based interventions which, for example, seek to address issues related to social and material deprivation, might be more effective in preventing the incidence of self-harm rather than its repetition. We need to better understand the processes underlying ecological

associations with suicidal behaviour before embarking on area-based interventions.

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