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**The association between self-harm and area-level characteristics in Northern Ireland: An
ecological study**

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ABSTRACT

Background: Factors contributing to suicidal behaviour are complex and multi-faceted. This study took an ecological approach to examine the association between area-level factors and rates of self-harm in Northern Ireland.

Methods: Data on self-harm presentations to emergency departments (EDs) were obtained from the Northern Ireland Self-harm Registry. The study included residents of Northern Ireland aged 16-64 years. Deprivation was measured using the Northern Ireland Multiple Deprivation Measure 2017. Population density and social fragmentation were calculated using measures from the 2011 census. Associations between area-level factors and self-harm rates were explored using negative binomial regression.

Results: Between 2013 and 2015, 14,477 individuals aged 16-64 years presented to EDs in Northern Ireland following self-harm. The rate of self-harm was 472 per 100,000 and was higher for male residents (478 vs. 467). Self-harm rates were highest in urban areas – 680 per 100,000 in Belfast City and 751 per 100,000 in Derry City. Rates of self-harm in Northern Ireland were more than four times higher in the most deprived areas. A positive association with rates of self-harm held for the deprivation domains of employment, crime, education, health and income. There was a moderate association with population density. Some gender differences emerged, with associations with male rates of self-harm more pronounced.

Conclusion: These findings indicate that self-harm rates are highest for those residing in highly deprived areas, where unemployment, crime and low level of education are challenges. Community interventions tailored to meet the needs of specific areas may be effective in reducing suicidal behaviour.

Keywords: Self-harm, deprivation.

Introduction

The incidence of suicidal behaviour has been shown to vary both between and within regions.[1] The contributory factors for suicidal behaviour are complex and multi-faceted – comprising of individual, community and societal factors.[2] An ecological approach to investigate the area-level factors contributing to rates of self-harm may provide context-specific information. In Northern Ireland, rates of self-harm are higher than those reported in neighbouring jurisdictions.[3, 4] In particular, elevated rates of self-harm among men and in urban areas have been recorded. However, despite these differences, the profile of presentations to hospital following self-harm is similar to those recorded in other countries.[5, 6]

There have been relatively few studies exploring the relationship between hospital-treated self-harm and area-level factors, with most demonstrating an association between self-harm incidence and socioeconomic deprivation.[7] Two Irish studies based on national data found that the highest rates of hospital treated self-harm are in deprived, urban areas [8] and are influenced by proximity to hospital services, population density, social fragmentation and deprivation.[9] However, research examining a combination of these factors with self-harm using nationally representative population data are limited.

We sought to explore the association between self-harm and area-level factors in Northern Ireland, at a small area level. The use of small geographical units ensures that these areas are relatively homogenous in terms of population size. It also ensures that any variation of area-level measures within areas is minimal. In addition, we used a multiple deprivation measure, along with measures of population density and social fragmentation, to identify area-level characteristics which may be associated with rates of self-harm.

Methods

Setting

The population of Northern Ireland according to the 2011 census is 1,810,863. The geographical area units used in this study are Super Output Areas (SOAs), of which there are 890, with an average population size of 2,000.[10] There are two cities in Northern Ireland: Belfast and Londonderry (Derry), accounting for 15% and 6% of the overall population, respectively. According to the Northern Ireland Statistical Research Agency,[11] 62% of SOAs were classified as urban settlements, 30% as rural settlements and 8% as mixed urban-rural settlements.

Data source

Data on self-harm presentations to hospital emergency departments (EDs) were obtained from the Northern Ireland Self-harm Registry. The Registry is a system which operates across all twelve hospital EDs. The Registry uses the following as its definition of self-harm: ‘an act with non-fatal outcome in which an individual deliberately initiates a non-habitual behaviour, that without intervention from others will cause self-harm, or deliberately ingests a substance in excess of the prescribed or generally recognised therapeutic dosage, and which is aimed at realising changes that the person desires via the actual or expected physical consequences’.[12] This is an internationally-recognised definition of self-harm, which is consistent with definitions used by similar systems in Ireland [13] and England.[14] Data are recorded by independently-trained data registration officers. Presentations involving self-harm are identified via clinical files in the emergency department. The Registry records a range of data items including both demographic and clinical information relating to the self-harm act. Methods of self-harm are recorded according to the World Health Organization’s ICD-10 classification system.[15] Since 2013, the Registry has geocoded addresses for each self-harm patient to SOA level. For this study, data for the three-year period January 2013 to December 2015 was utilised.

During the period 2013 to 2015 there were a total of 26,220 presentations to hospital EDs as a result of self-harm. The analysis was limited to permanent residents of Northern Ireland aged 16-64 years

(n=24,539), due to the relatively small number of presentations made by children and older adults. The analysis excluded visitors (n=47; 0.2%), those with no fixed abode (n=1,107; 4.2%), prisoners (n=351; 1.3%) and hospital inpatients (n=58; 0.2%). SOA codes were missing for a minority (n=669; 2.7%) of residents. The final analysis was performed using a sample of 22,307 presentations.

Deprivation measure

Deprivation was measured using the Northern Ireland Multiple Deprivation Measure 2017.[10] The measure consists of seven domains of deprivation as well as an overall deprivation measure. The seven domains are: income deprivation; employment deprivation; health deprivation and disability; education, skills and training deprivation; access to services; living environment; crime and disorder. SOAs were divided into quintiles based on the ranked scores for the overall measure and for each domain (quintile 1 = least deprived areas, quintile 5 = most deprived areas).

Population density

Population density was used as a proxy for urban-rural classification of SOAs. For this, the number of persons residing in each SOA (per hectare) was obtained. SOAs were divided into quintiles based on population density (quintile 1 = least densely populated areas, quintile 5 = most densely populated areas).

Social fragmentation

A measure of social fragmentation for each SOA was constructed based on previous work [9, 16], based on Congdon's anomie score [17]. The following measures from the 2011 census were used: the percentage of persons in private rented accommodation; the percentage of the adult population unmarried; the percentage of persons who were living alone; the percentage population turnover in year preceding the census. The social fragmentation measure was created by summing z scores from each variable, giving a mean of 0.00 (SD=3.10). SOAs were divided into quintiles based on this social fragmentation score (quintile 1 = least fragmented areas, quintile 5 = most fragmented areas).

Statistical analyses

Pooled rates of self-harm per 100,000 for 2013-2015 were calculated based on the number of persons who presented to hospital following self-harm in each calendar year. Annual population estimates were obtained from the Northern Ireland Statistics and Research Agency. We calculated 95% Confidence Intervals (CI) for these rates, using the normal approximation for the Poisson distribution.

Univariate associations between area-level variables and hospital-treated rates of self-harm were examined using negative binomial regression models. All significant associations ($p < 0.05$) were considered for the multivariate model. Due to intercorrelations between area-level measures, a stepwise approach was adopted. The first variable added to the model was the one that gave the greatest increase in the log likelihood. Further variables were added based on their effect on the log likelihood, as long as the effect was statistically significant. The analysis reported incidence rate ratios (IRRs) and their 95% confidence intervals (CIs).

We assessed whether associations were modified by sex and by broad age groups (i.e. interaction) using likelihood ratio tests. As an example, for gender this involved fitting a model with each area-level variable and gender as the only independent variables and then fitting the model that also includes the interaction between gender and the explanatory variable. A likelihood ratio test assesses the presence of interaction by comparing the log likelihood of the two models.

Maps were generated using QGIS, version 2.18.16 (<https://www.qgis.org/>). All analyses were conducted using Stata Version 12.

Ethical approval

Ethical approval has been granted by the Office for Research Ethics in Northern Ireland (ORECNI) for the Northern Ireland Self-harm Registry in April 2007.

Results

Between January 2013 and December 2015, there were a total of 22,307 self-harm presentations by 16-64 year-olds made to emergency departments in Northern Ireland. There was an even gender split in the sample – 11,141 (50%) of presentations were by females. The mean age was 34 years (sd=12.82). The most common method of self-harm recorded was intentional drug overdose (n=16,455; 74%), followed by self-cutting (n=5,329; 24%). In total, 14,477 individuals presented to hospital. This implies that almost one-quarter (n=3,260; 22.5%) of individuals made more than one presentation to hospital in the three-year period. A small proportion (n=489; 3%) of individuals presented more than five times during the study period, accounting for 19.3% (n=4,316) of all presentations recorded.

The pooled, person-based rate of self-harm for 2013-2015 for those aged 16-64 years was 472 per 100,000 (Table 1). The rate of self-harm among city residents was higher than the national rate – 44% for residents of Belfast City and 59% for Derry City residents. For residents in the rest of Northern Ireland, the rate of self-harm was 45% lower than the national rate. Nationally, the male rate of self-harm was 2% higher than the female rate (478 vs. 467 per 100,000, respectively). The gender difference was most pronounced among residents of Belfast City, where the male rate was 15% higher. In other regions the male and female rates were comparable.

Insert Table 1

The incidence of self-harm according to super output area (SOA) in Northern Ireland is detailed in Figure 1a, with the higher rates of self-harm in urban areas clearly illustrated. Figures 1b-d map the area-level variables used in this study, according to SOA. Variation in deprivation (1b), population density (1c) and social fragmentation (1d) can be observed across Northern Ireland. Overall, deprivation, population density and social fragmentation scores are higher in urban areas, in particular in Belfast City and Derry City.

Insert Figure 1

Association between rates of hospital-treated self-harm and area-level variables

Table 2 outlines the unadjusted incidence rate ratios (IRRs) between each area-level variable and rates of self-harm, considering all persons aged 16-64 years. A positive association was found between increasing rates of self-harm and measures of deprivation, social fragmentation and population density. Rates of self-harm were more than four times higher in the most deprived areas (quintile 5) (IRR=4.20; 95% CI=3.78-4.67). Rates of self-harm were also more than four times higher in areas with the highest social fragmentation scores (4.35, 3.93-4.83) and more than three times higher in the most densely-populated areas (3.47, 3.08-3.92).

Almost all domains of the multiple deprivation index were positively associated with rates of self-harm. The only exception was the lack of access to services domain, which measures online and physical access to key services. Rates of self-harm were 69% lower (65%-73%) in the most deprived areas.

There was evidence of effect modification by gender in relation to all of the area-level variables ($p < 0.05$). There was no effect modification for age.

Insert Table 2

Multivariate model

Table 3 presents the multivariate stepwise regression model, according to gender. The following measures were not selected in the stepwise model: living environment deprivation domain and social fragmentation. At a multivariate level, a positive association with rates of self-harm among all persons held for the deprivation domains of employment, crime, education and health, with self-harm rates 60%, 53%, 49% and 39% higher in the most deprived areas, respectively. The association with income deprivation was less pronounced. The negative association between rates of self-harm and the access to services deprivation domain was attenuated in the multivariate model. There was also an association between both population density and self-harm incidence, with rates 47% higher in the most densely-populated areas.

Associations between area-level variables and self-harm incidence varied according to gender.

Associations with employment, education, crime and health were associated with both male and female rates of self-harm, with associations for employment, education and health more pronounced for males. The association between population density and rates of self-harm held for males only, with rates of male self-harm 67% higher in the most densely populated areas. While the overall association between rates of self-harm and access to services did not reach significance, rates of female self-harm were 29% (19%-37%) lower in the areas with poorest access to services. The overall association with income deprivation did not hold according to gender.

Insert Table 3

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Discussion

Main findings

This study examined the incidence of hospital-treated self-harm among working-age adults in Northern Ireland, the variation in rates regionally and the impact of area-level characteristics on rates of self-harm at a small area. We found that within this cohort, the rate of self-harm was higher among males and city residents. The reported rate of 472 per 100,000 is higher than reported in an Irish study of 15-64 year-olds [9] and an England study of those aged 15+ years.[18] Considering all ages, we have previously found that the Northern Ireland rate is high when compared with other countries.[3, 5] Among those aged 16-64 years, the male rate of self-harm was higher than the female rate, influenced by relatively high male rates in Belfast City. This is in contrast to studies which have consistently found that rates of hospital-treated self-harm are higher among females.[13, 18, 19] In Northern Ireland, the effects of a 30-year civil conflict (the 'Troubles') may contribute to these patterns. It is estimated that among adults in Northern Ireland, more than one-third have experienced a conflict-related traumatic event in their lifetime, with the prevalence of post-traumatic stress disorder estimated to be higher than most European countries.[20, 21]

In line with previous research deprivation was the area-level variable most strongly associated with self-harm. This association has previously been reported in studies from Ireland and England.[8, 22, 23] However, it should be noted that associations from these studies used different measures and units of analysis. Furthermore, Northern Ireland is more deprived than neighbouring regions, with 37% of the Northern Ireland population in the most deprived fifth of the United Kingdom.[24] Therefore, the findings of these studies are not directly comparable. Employment deprivation had the strongest independent association with incidence of self-harm, with male and female rates of self-harm 93% and 68% higher in areas with the highest rates of unemployment, compared to areas with the lowest rates of unemployment. A weaker association with income deprivation was observed. Measures of economic disadvantage have previously been shown to be associated with increased risk of suicidal behaviour at both an ecological [7, 25, 26] and individual level,[27] with these effects often more pronounced among men.[28] Compared to neighbouring jurisdictions, recovery following the 2008

global economic recession has been slower in Northern Ireland.[29] Both male and female self-harm rates were associated with education deprivation, with rates higher in areas with greater school absenteeism, lower academic performances and poor uptake of higher education.

Crime and disorder deprivation was associated with increased rates of self-harm. Health deprivation was moderately associated with rates of self-harm. This domain contains an indicator of mental health, which may contribute to this association. At an individual-level, the association between psychiatric illness and suicidal behaviour is well established [30], and more recent research has demonstrated a link between risk of suicide and physical illness.[31, 32]

Other domains of deprivation had weaker associations with rates of self-harm. For females, the rates of self-harm in the most deprived areas in relation to access to services were 29% lower than the least deprived areas (i.e. those with better services). This domain relates to both online and physical access to a wide range of key services, including hospital emergency departments. This finding may be in part be explained by proximity to hospital emergency departments. A previous Irish study found that residents in close access to hospitals were more likely to attend following self-harm.[9] This requires further exploration in the Northern Ireland context.

The association between rates of self-harm and population density reported in other studies [33, 34] was not fully observed in our study, limited to male residents only. The association with social fragmentation did not hold in the multivariate model.

Strengths and limitations

This is one of the few studies to examine variation in rates of self-harm at a small area level, using data from a national registry. In addition, this variation was examined using a range of area-level variables, including a multi-domain measure of deprivation. The use of small geographical units increases precision and ensures that area-level measures will be relatively homogenous in these units. We used a large (>14,000 individuals) national dataset of hospital-treated self-harm, coded to area of residence, ensuring that both rural and urban areas have been represented. We also used a multi-

domain measure of deprivation, which allowed us to examine the effects of specific domains of deprivation on self-harm.

Largescale routine registries lack more detailed socioeconomic data. As a consequence we were unable to adjust for individual- and household level variables which may be important consider, as demonstrated in a study of suicides in Northern Ireland.[16] In the absence of individual-level data, it is important to note that the observed associations are at an area-level and are prone to the ecological fallacy.

The data on self-harm was limited to presentations made to acute hospital settings and did not include those treated in other healthcare settings (e.g. primary care) or self-harm acts which were untreated. To this end, the results we have presented here may not be generalisable to those who engage in self-harm without seeking help.

We used the most recent data available to construct the area-level variables included in this study. The NIMDM 2017 is primarily based on indicators pertaining to 2015 and 2016, which overlaps with the study period.[10] However some of the indicators are derived from census data from 2011. In addition, the constructed social fragmentation score and measure of population density were also based on 2011 census data.

Implications and conclusion

The high rate of male self-harm in Northern Ireland is of concern, given that self-harm is a strong predictor of suicide.[35] The male rate of suicide in Northern Ireland in 2015 was 27 per 100,000, higher than that of Ireland and the United Kingdom.[36] These figures highlight the challenge of engaging with males at risk for suicidal behaviour, in particular as shame and stigma are often barriers to help-seeking.[37]

Our findings indicate that self-harm is influenced by social inequalities and those vulnerable reside in highly deprived areas, where unemployment, crime, lack of education and health are challenges. The findings from this study would suggest that suicidal behaviour is associated with the characteristics of a locality, and that these associations are different for males and females. The observed associations

with economic, social and health deprivation suggest that reducing suicidal behaviour requires a cross-sectoral approach, where prevention is not just the responsibility of health services. Across Northern Ireland, rates of self-harm varied regionally. Therefore strategies to reduce suicidal behaviour may need to be area-specific, and neighbourhood characteristics should be considered. These area-level findings would suggest that population-based and community interventions may be effective in targeting and reducing suicidal behaviour, in line with multi-level approaches to reduce suicide which have been advocated.[38,39] Future research in this field should examine the effects of community-based strategies and interventions on self-harm and suicide. In particular, measures targeting levels of unemployment may help reduce rates of suicidal behaviour, and further research into such prevention initiatives, particularly for males, should be considered. While some of our findings are consistent with other studies, others were unique and so area-level results may be context-specific.[7] The legacy of the conflict has impacted on deprivation in Northern Ireland, and has increased social inequalities.[40] Therefore it is important that such analyses are replicated in other jurisdictions, emphasising the need for high-quality national data relating to health outcomes.

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Competing interests

None to declare

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Keypoints

- This was a national study examining the association between area-level factors and rates of self-harm in Northern Ireland, using a multi-domain measure of deprivation.
- Employment, crime, education and health deprivation were all strongly associated with higher rates of self-harm.
- These findings highlight the challenges faced by health services in responding to self-harm, engaging vulnerable populations and tackling health inequalities.

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Table 1. Incidence of self-harm in Northern Ireland and area type, 2013-2015.

	Persons			Male			Female		
	Rate ^a	95% CI	% Difference ^b	Rate ^a	95% CI	% Difference ^b	Rate ^a	95% CI	% Difference ^b
Northern Ireland	472	465-480	-	478	434-454		467	457-477	-
Belfast City	680	658-702	+44.1%	728	695-760	+52.3%	634	604-664	+35.8%
Derry City	751	714-789	+59.2%	753	698-807	+57.4%	750	698-803	+60.7%
Rest of Northern Ireland	261	256-266	-44.8 %	261	254-268	-44.5%	261	254-268	-44.2%

^aPerson-based rate per 100,000 for residents aged 16-64 years.

^bDifference is percentage difference from the national rate..

Table 2. Unadjusted associations between area-level variables and self-harm rates (by quintile)

	Quintile 2 IRR (95% CI)	Quintile 3 IRR (95% CI)	Quintile 4 IRR (95% CI)	Quintile 5 IRR (95% CI)
Multiple Deprivation Index	1.31 (1.17-1.46)	1.55 (1.39-1.73)	2.26 (2.03-2.51)	4.20 (3.78-4.67)
Income	1.40 (1.23-1.60)	1.78 (1.56-2.03)	2.00 (1.76-2.28)	3.13 (2.75-3.56)
Employment	1.32 (1.19-1.46)	1.70 (1.54-1.88)	2.69 (2.44-2.96)	4.72 (4.28-5.19)
Health	1.40 (1.27-1.55)	1.78 (1.62-1.97)	2.86 (2.60-3.15)	5.02 (4.58-5.52)
Education	1.29 (1.16-1.43)	1.71 (1.55-1.90)	2.63 (2.38-2.91)	4.65 (4.22-5.13)
Access to services (including hospital EDs)	0.81 (0.72-0.92)	0.74 (0.65-0.83)	0.48 (0.42-0.54)	0.31 (0.27-0.35)
Living environment	0.92 (0.80-1.06)	1.03 (0.90-1.19)	1.13 (0.98-1.30)	1.62 (1.41-1.87)
Crime	1.34 (1.21-1.50)	1.94 (1.75-2.16)	2.88 (2.60-3.19)	4.58 (4.14-5.07)
Social fragmentation	1.31 (1.18-1.47)	1.89 (1.70-2.10)	3.14 (2.83-3.49)	4.35 (3.93-4.83)
Population density	1.49 (1.31-1.68)	2.00 (1.77-2.26)	2.52 (2.23-2.85)	3.47 (3.08-3.92)

Note: Reference category is quintile 1. IRR=Incidence Rate Ratio. CI=Confidence Interval.

Table 3. Adjusted associations between area-level variables and quintiles of self-harm rates, according to gender

	All IRR (95% CI)	Male IRR (95% CI)	Female IRR (95% CI)
Income			
Quintile 2	1.12 (1.02-1.23)		
Quintile 3	1.14 (1.03-1.25)		
Quintile 4	1.13 (1.02-1.26)		
Quintile 5	1.23 (1.10-1.38)		
Employment			
Quintile 2	1.20 (1.08-1.34)	1.36 (1.17-1.58)	1.15 (1.01-1.32)
Quintile 3	1.25 (1.09-1.44)	1.49 (1.23-1.81)	1.19 (1.01-1.40)
Quintile 4	1.36 (1.14-1.61)	1.54 (1.23-1.94)	1.40 (1.15-1.71)
Quintile 5	1.60 (1.32-1.95)	1.93 (1.49-2.50)	1.68 (1.34-2.10)
Health			
Quintile 2	1.17 (1.05-1.31)	1.12 (0.96-1.32)	1.19 (1.04-1.37)
Quintile 3	1.17 (1.01-1.35)	1.08 (0.88-1.33)	1.20 (1.00-1.43)
Quintile 4	1.24 (1.04-1.47)	1.29 (1.01-1.65)	1.15 (0.93-1.42)
Quintile 5	1.39 (1.14-1.71)	1.42 (1.07-1.89)	1.30 (1.02-1.66)
Education			
Quintile 2	1.07 (0.96-1.19)	1.09 (0.94-1.26)	1.08 (0.95-1.23)
Quintile 3	1.12 (1.00-1.26)	1.15 (0.98-1.35)	1.15 (1.00-1.33)
Quintile 4	1.22 (1.07-1.39)	1.28 (1.07-1.53)	1.26 (1.08-1.48)
Quintile 5	1.49 (1.29-1.73)	1.68 (1.37-2.05)	1.47 (1.23-1.75)
Access to services (including hospital EDs)			
Quintile 2	0.97 (0.89-1.05)		0.92 (0.84-1.00)
Quintile 3	1.07 (0.97-1.18)		1.00 (0.92-1.10)
Quintile 4	1.02 (0.90-1.16)		0.85 (0.77-0.95)
Quintile 5	0.89 (0.75-1.06)		0.71 (0.63-0.81)
Crime			
Quintile 2	1.12 (1.02-1.22)	1.15 (1.02-1.31)	1.10 (0.98-1.23)
Quintile 3	1.23 (1.11-1.36)	1.15 (1.01-1.32)	1.31 (1.16-1.48)
Quintile 4	1.31 (1.17-1.47)	1.31 (1.13-1.53)	1.33 (1.16-1.53)
Quintile 5	1.53 (1.36-1.73)	1.55 (1.32-1.82)	1.57 (1.35-1.82)
Population density			
Quintile 2	1.20 (1.07-1.35)	1.40 (1.24-1.58)	
Quintile 3	1.36 (1.18-1.57)	1.57 (1.38-1.78)	
Quintile 4	1.35 (1.16-1.58)	1.50 (1.31-1.71)	
Quintile 5	1.47 (1.24-1.74)	1.67 (1.46-1.95)	

Note: Reference category is quintile 1. Social fragmentation and living environment deprivation domain did not contribute to the multivariate model. For the model based on male data, income deprivation lack of access to services deprivation domains did not contribute to the multivariate model. For the model based on female data, income deprivation domain and population density did not contribute to the multivariate model.

Figure 1. Incidence of self-harm (pooled rates for 2013-2015) according to super output area in Northern Ireland for residents aged 16-64 years (a); extent of deprivation (b); population density (number of persons per hectare) (c); social fragmentation score (d).

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