An ecological analysis of prison overcrowding and suicide rates in England and Wales, 2000-2014

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Abstract

Prisoners are at a greatly increased risk of suicides compared to the general population. Differences in suicide risk can be partly explained by individual risk factors, but the contribution of prison characteristics remains unclear. Overcrowded prisons have higher suicide rates, but this may be related to prison function, security level, population size and turn-over. The aim of the current study was to investigate the contribution of each of these prison characteristics to suicide rates, using data from the Ministry of Justice for adult prisons in England and Wales from 2000 to 2014. Negative binomial regression analysis showed that larger population size, higher turn-over, higher security and public management were associated with higher suicide rates. When controlling for these factors, overcrowding was not found to be related to suicide rates. Questions remain about the causal mechanisms underlying variation in prison suicides and the impact of the lived experience of overcrowding. Further research is needed to examine the relative contribution of prison and prisoner characteristics to suicides.

Keywords: prison, suicide, mortality, overcrowding, security, turn-over

1. Background

Suicide rates in prison are consistently higher than in the general population (Fazel, Benning, & Danesh, 2005; Fazel, Grann, Kling, & Hawton, 2011; Joukamaa, 1997). This is true for men and women, although the risk is further enhanced for female prisoners compared to their community counterparts (Fazel & Benning, 2009). Suicide rates inside and out of prison fluctuate substantially over time, and also vary greatly between different (prison) populations (Opitz-Welke, Bennefeld-Kersten, Konrad, & Welke, 2013; Shaw, Appleby, Humber, Moloney, & Baker, 2011). In 2014, 84 of 243 deaths in prison in England and Wales were classified as self-inflicted (Ministry of Justice, 2015b).[1] The number of self-inflicted deaths has been increasing since 2011 (when there were 58), but was even higher in 2004 (when there were 96). In the 1990s there were fewer suicides per year, but the suicide rate per 1,000 prisoners was higher (Ministry of Justice, 2015b). With relatively rare events like suicides it is difficult to know if fluctuations are coincidental or reflect changes in the constellation of risk factors associated with prison suicide. This means it is important to identify and further study the risk factors for prison suicide, because such acts signify the immense psychological distress of the individual. It is especially concerning if imprisonment, or specific conditions of imprisonment, elevate the risk of suicide, particularly when one considers that the state owes a duty of care to those it holds in custody.

In 2015 the Harris Review panel published its report of an independent review into self-inflicted deaths of 18-24 year olds in prison (Harris, 2015). Prior to this Review, a number of reports had raised concerns about the management of children and young people in prisons and their specific vulnerabilities. The purpose of the Review was to reduce future occurrences of suicides in prison. The Review argued that there were not

[1] For more information on the classification of self-inflicted deaths, please refer to the section 'Suicide rates' in the methodology section.

enough purposeful activities in prisons for young people and that they too often spent their time locked up in cells. This, in combination with bullying and unsafe cell conditions, contributed to suicides (Harris, 2015). One of the most prominent recommendations was that the statement of purpose for prisons needed to be updated. Lord Harris recommended that *rehabilitation* should be the primary purpose of prisons and the current Incentives and Earned Privileges scheme should be reviewed, as it compounded the vulnerability of prisoners who might be unable to reach a higher level of privileges and incentives. Finally, the Review underlined the importance of good staff-prisoner relationships in preventing suicides, but expressed concern about lack of appropriate training and staff shortages across the prison estate.

One area of particular concern is the extent of overcrowding in English and Welsh prisons. This is because overcrowding places substantial strains on the system and exacerbates existing problems in terms of prisoner association, meaningful activity and prisoner-staff ratios. The prison population in September 2015 stood at 85,741, which is nearly double the prison population in 1993, and 70 of 117 English and Welsh prisons are typically operating above their designed capacity (Prison Reform Trust, 2015). In practice this means double occupation of cells designed for single use and triple occupation of double cells. The lack of meaningful activities and high population density may contribute to prisoner misconduct and mental health problems. In a report on self-inflicted deaths in prison in 2013/14, the Prisons and Probation Ombudsman for England and Wales (2015) noted that 81% of prisons where suicides took place were overcrowded, whereas 48% of prisons without suicides were overcrowded. Correspondingly, overcrowding has been identified as a risk factor for prison suicides in analyses of European country-level data and US prison data (Huey & McNulty, 2005; Rabe, 2012). Overcrowding is a pressing concern internationally: 115 out of 204 countries included in the World Prison Brief have an occupation rate that exceeds the official capacity (Institute for Criminal Policy Research,

2015). It is important to recognise the limitations of occupation rate as a measure of overcrowding, because prison systems may have increased formal capacity without commensurate increases in staff, activities, and medical and mental health resources (Haney, 2006).

Prison characteristics associated with overcrowding are whether a prison holds remand prisoners (those awaiting trial) and a large prison population (Fazel, Cartwright, Norman-Nott, & Hawton, 2008; Leese, Thomas, & Snow, 2006; Opitz-Welke et al., 2013). Local prisons in England and Wales, which receive remand prisoners from nearby courts, hold an average of 978 prisoners compared to an average of 618 prisoners in other prisons.[2] Remand prisoners are especially vulnerable to suicides: in 2014, 20% of suicides were by remand prisoners, while they account for only 14% of the prison population (Prison Reform Trust, 2015). Indeed, most suicides occur within the first month of imprisonment and nearly a quarter in the first week (Liebling, 2007; Ministry of Justice, 2015c), meaning that the early stages of imprisonment are a crucially important time for preventing prison suicide. Liebling (1999) suggested that remand imprisonment may be especially difficult due to the sudden separation from friends and family, lack of activities, uncertainty of the pre-trial period, overcrowding, and the highly unstable and changing prisoner population. First-time prisoners may feel particularly anxious about facing an unknown situation, a new environment and being deprived of their freedom. It is possible, then, that the disproportionate concentration of suicides in overcrowded prisons can be (partly) explained by the stresses associated with remand imprisonment and entry into prison.

There are various reasons why overcrowding can contribute to a more negative prison experience, not least because of reduced privacy and comfort resulting from sharing a small cell. Overcrowding may also increase prisoners' vulnerability because it limits their

[2] Based on data from the Ministry of Justice's prison population monthly bulletin for June 2014.

access to purposeful activities. The institutional capacity for organising activities does not match demand in overcrowded prisons and as a result, prisoners spend more time locked up. A lack of purposeful activity has been found to predict suicides (Leese et al., 2006). The same study did not find a significant independent effect of overcrowding, assault rates and cost per prisoner when the type of prison was controlled for. However, including a simple measure of prison type in a cross-sectional study may inadvertently 'soak up' much that is unique about each prison and thus make it more difficult to assess the effects of other factors associated with a given prison. Further, due to its cross-sectional approach this study was not able to explore trends over time within prisons, which would give a more accurate picture of the independent contributions of each of these factors. Finally, as is well rehearsed, cross-sectional studies do not allow an assessment of temporal ordering.

A further negative effect of overcrowding is the added burden on staff, who are forced to divide their time over a greater number of prisoners, at the cost of supportive staff-prisoner relationships and their ability to effectively monitor prisoner behaviour. It is important to note that increased workload of staff is likely to be a problem across the English and Welsh prison estate: between 2010 and 2014 there was a 29% decrease in staff in public prisons (Prison Reform Trust, 2015). Additionally, sickness of staff is reason for concern, with an average of 11 days a year per prison-officer (for 2013/2014) lost to sickness absence, in comparison to 9.8 days in 2011/2012 and 4.4 per worker in the general labour market (Prison Reform Trust, 2015). Haney (2006) notes that:

> [P]rison systems responding to the press of numbers often forgo the careful screening, monitoring, and managing of vulnerable or problematic prisoners—in part because there are too many of them to conscientiously assess, and in part because the system lacks the capacity to address their special needs anyway. (p. 273)

A counter-intuitive point is that overcrowding could inadvertently *reduce* suicide risk in some instances, as cell sharing introduces more direct supervision from a cell mate, who

may also provide emotional support. In European countries, national prison suicide rates tend to follow an opposite trend from overcrowding levels and prison population size (Duthé, Hazard, Kensey, & Shon, 2009; Fruehwald, Frottier, Ritter, Eher, & Gutierrez, 2002). This is in contrast with the cross-sectional findings discussed above, which found a positive correlation between overcrowding and prison suicides. It is possible that overcrowding has multiple, opposing effects on suicides. At an individual level, single cell occupation has been identified as a predictor of suicide (Fazel et al., 2008). Yet, on average, prisoners who share a cell rate their prison experience more negatively than prisoners in a single cell (Molleman & Van Ginneken, 2015). Overcrowding and cell sharing may thus act as a form of unreliable situational prevention, but not remedy and potentially even exacerbate the underlying causes of suicides.

The contribution this paper makes is threefold. First, to date, no study has separated the contributions of overcrowding, prison size, prison function and population turn-over on suicide rates in prisons. Second, studies of prison suicides have typically focused on prisoner-level risk factors, which are better understood (Fazel et al., 2008; Liebling, 1999), whereas this study uses publically available prison-level data to focus on the impact of environmental stressors on prison suicides. Third, quantitative studies of prison suicide are normally cross-sectional in nature or otherwise describe trends (see Duthé, Hazard, & Kensey, 2014 and Leese et al., 2006 for exceptions), whereas we take 'the long view' on suicide, by conducting a unique longitudinal, ecological assessment of adult prison suicides in England and Wales in the period 2000-2014.

2. Data and Method

2.1 Suicide rates

The outcome measure for this paper is the rate of suicides per 1,000 prisoners, per prison, per year (prison-year). We calculated this by using publically available data on prison

suicides (Ministry of Justice, 2015a) and the average annual prison population for a given institution (see section 2.3 below). Prison suicide statistics are based on the official classification of deaths in custody, which includes 'any death of a person who has apparently taken his or her own life irrespective of intent' (Ministry of Justice, 2015a, p. 9). Some suicides may not be captured in the data, while other deaths are inaccurately labelled suicides; however, this is likely to be a very small number and we have no reason to believe that there is systematic bias in particular years or prisons (every death in prison is subject to investigation by a coroner, the police, and the Prison and Probations Ombudsman).

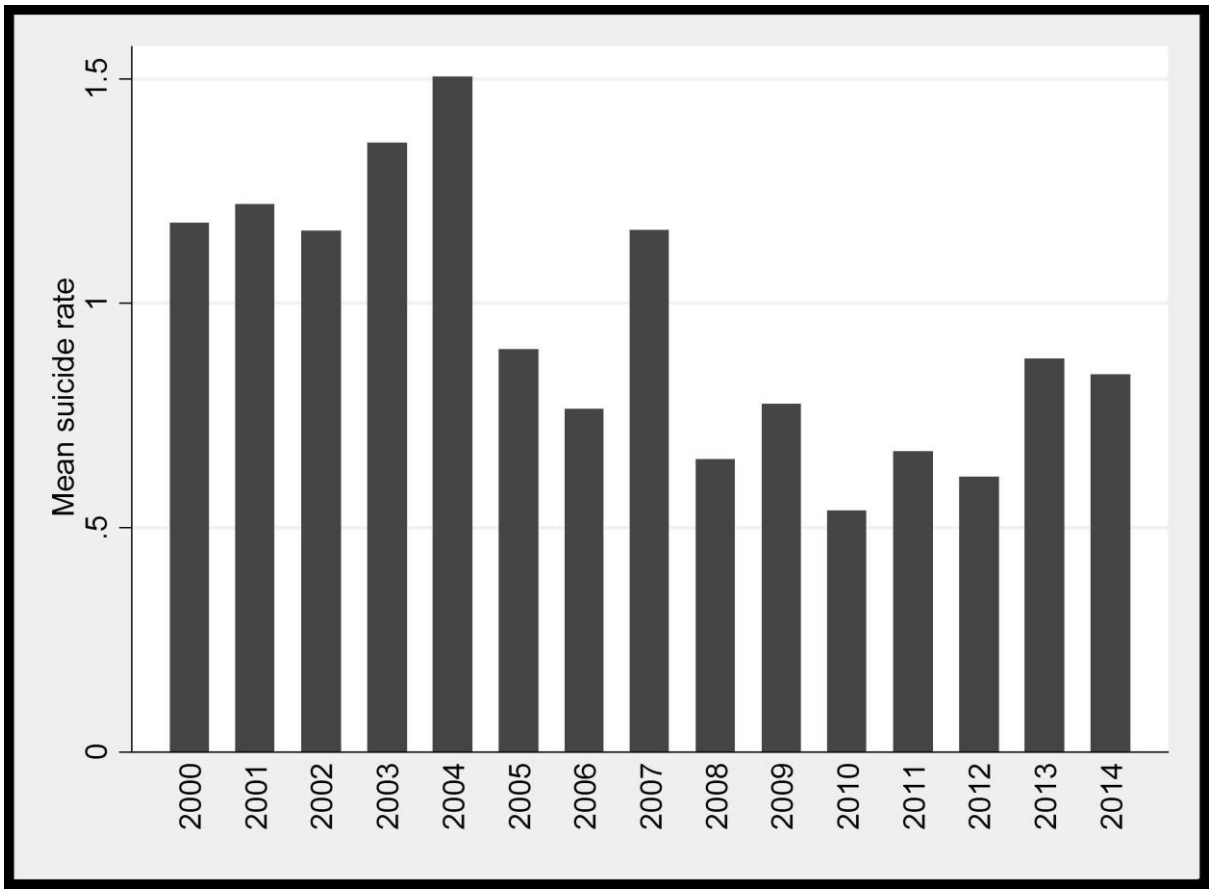
Table 1 shows that in 65% of the prison-years no suicides occurred in the past decade. In approximately a quarter of the prison-years one or two prisoners committed suicide. Three or more suicides in a prison-year are less common.

Table 1: Distribution of total number of suicides per prison, per year (2000-2014)

Number of suicides	Prison-years	Percent
0	1,146	65.4%
1	355	20.3%
2	136	7.8%
3	78	4.5%
4	26	1.5%
5	8	0.5%
6	3	0.2%
7	1	0.1%

Figure 1 displays the trend in prison suicide rates from 2000 to 2014 in England and Wales, which represents the average suicide rate (suicides per 1,000 of the prison population) for each year, across the prisons in our sample. It shows a generally decreasing trend from 2004 to 2010, after which suicides started to increase again. A total of 1,030 suicides were recorded in the study period, with a minimum of 0 and a maximum of 7 per prison, per year. The mean number of suicides per prison-year is 0.59 (SD = 1.00). In total, the dataset contains 1,752 observations (prison-years) for 132 prisons. Not every prison has 15 observations, because some prisons closed and/or (re)opened during the study period.

Figure 1: Annual suicide rates per 1,000 prisoners for England and Wales 2000-2014



2.2 Overcrowding (occupation rate)

Population and overcrowding statistics for each prison were available from the Ministry of Justice (2007-2014) and Home Office monthly population bulletins/briefs (2000-2006). Prisons are technically considered overcrowded when they have more prisoners than their certified normal capacity; i.e. more prisoners sharing a cell than it was designed for. As was noted in section 1 above, the occupation rate has limitations as a measure of overcrowding, because formal capacity does not always reflect actual capacity, nor does it include information about the lived experience of (over)crowding. The occupation rate is expressed as the percentage of certified normal accommodation (CNA) in use, with any number greater than 100 considered overcrowding. The mean occupation

rate across the sample is 112 (SD = 23, min = 48, max = 197). Meaning that, on average over the 15 years observed, UK prisons were 12% overcrowded. To ease interpretation, the overcrowding variable was centred on 100, so that the intercept in each model reflects the expected outcome when prisons are, on average, operating at capacity. Prison-years where prisons were going through changes such as opening, closing or re-rolling (i.e. a change in function, population or security classification) were excluded from the analysis as these prisons did not have a constant population or function throughout the year.

Descriptive statistics of the sample and variables used for analysis are reported in Table 2. There is substantial variation across the sample. From year to year, however, mean overcrowding levels were between 103 (in 2000) and 115 (in 2008 and 2014). Correspondingly, the total number of prisons that were overcrowded ranges from 49 (in 2001) to 79 (in 2008). This demonstrates that overcrowding is not exclusively a recent problem, but has increased in recent years.

2.3 Prison population

In line with Brooker et al. (2010), we chose June as the measurement point for population and overcrowding data as the representative value for the entire year. Population size changes gradually and one would therefore not expect dramatic differences in population or overcrowding on either side of June, but we acknowledge that it would be more accurate to measure prison population on a monthly basis. That said, population and overcrowding levels within prisons tend to remain fairly stable over time, which can also be seen through inspection of the variation in both from year to year for each prison. The average prison population size over the years was 609 (SD = 325), with a minimum of 39 and maximum of 1675 prisoners.

2.4 Prison population turnover ('churn')

We also included a measure of turn-over of prisoners ('churn'), which refers to the movement of prisoners in and out of prison, and between prisons. We should expect churn to increase suicide rates by affecting the stability of the prisoner population, through the influx of new prisoners and the resulting impact on informal social control and cohesion. A churn-rate was available for prisons for each year in the period 2001-2009 (Ministry of Justice, 2010). A churn rate of 1 indicates that the prison – on average – turns over its population once per year. A higher 'churn rate' indicates higher turnover of the population. We created an *average* churn rate for each prison by adding the churn rates available for each prison in the years 2001-2009, divided by the number of years data were available for (typically nine years but less in some cases). We then included average churn rate as a control variable at the prison level. (A replication of the final model restricted to 2001-2009 with time-varying values for churn did not yield substantially different results.) The mean churn rate of 3.13 (SD = 2.00) indicates that, on average, prisons in the sample had 'refreshed' populations three times a year. Churn rates are higher for local (M = 5.37, SD = 1.69) than training prisons (M = 2.17, SD = 1.75), which would be expected given the high proportion of remand and short-sentence prisoners in local prisons.

2.5 Additional control variables: prison type (category & function), public or private, male or female

There is greater variation in population and overcrowding statistics between different types of prisons (as opposed to within prisons over time). Characteristics of prison type (*security category* and *function*) were therefore included in the analysis. We categorise *function* as a dichotomous, time-varying[3] variable consisting of local or training prisons, with training prisons as the reference category. *Local prisons* receive prisoners from local courts; primarily remand and short-sentence prisoners, and tend to be the more

[3] We have allowed security category, prison function, prison management (public/private) and population (male/female) to vary over time, because some prisons have changed function over time. This approach accounts for the assumption that there is unexplained variance at the prison level that is not captured by these variables (e.g. the building and staff).

overcrowded, have the largest populations and the highest turn-over. *Training prisons* (including *dispersal prisons*, which hold prisoners that are considered most dangerous*)* have a more stable prison population.

In England and Wales, prisons are assigned one of four *security classifications* (Categories A, B, D and D), which determines the type of prisoners they are designed to hold. Category A is the highest security prison and Category D prisons are open prisons, which have minimal security and prepare prisoners for release into the community. Category B is used as reference group, as it is the most common security category.

The type of management of a prison (*public or private*) is also included as time-varying control variable. In 2014, 13 out of 108 prisons (12%) were managed privately, compared to 6 out of 115 prisons (5%) in 2000 (see Grimwood, 2014, for background information on the role of the private sector in the management of prisons). Finally, a variable for male and female prisons was included. Prison-years (n = 15) with mixed sex populations were excluded from the analysis as there was no separate population and overcrowding data for the different male and female populations (this did not change the results). Immigration Removal Centres (IRCs) and Young Offender Institutions (YOIs) were excluded on the basis that they hold populations that are different from the mainstream prison population in terms of risk factors for suicide. Furthermore, IRCs and YOIs do not have the same type of security classification or function as mainstream prisons and therefore could not be analysed on the basis of these characteristics.

Table 2: Descriptive statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Prison-year level					
Suicide rate (per 1,000 prisoners)	1729	0.95	1.80	0	16.89
Prison population size	1729	609.35	324.90	39	1675
Overcrowding (0 = 100% occupation rate)	1729	11.59	22.64	-52	97

Prison function	Prison years	Proportion
Training/Dispersal	1223	70%

	Local	530	30%			
Prison security						
	Cat A	131	8%			
	Cat B	804	46%			
	Cat C	595	34%			
	Cat D	223	13%			
Population						
	Male	1554	89%			
	Female	199	11%			
Management						
	Public	1616	92%			
	Private	137	8%			
Prison level		Observations	Mean			
Average churn rate 2001-09		1752	3.13	2.00	.3	8.2

2.6 Method

We employ multilevel negative binomial models. Negative binomial analysis is appropriate because the distribution of the annual counts of suicides is over-dispersed. The multilevel element was necessary because we have repeated measures of suicides, meaning that observations are clustered within prisons. The use of multilevel models also enables one to assess (and explain) within and between-prison variation in outcomes by including covariates.

Negative binomial analysis often includes an exposure variable in order to account for variation in the sample in terms of opportunity for the event to occur. For an annual count of prison suicides, the ideal exposure variable would be the number of people who have been in an establishment during the year and the number of days they have spent in prison (i.e. prison days *x* prisoners). This means that neither receptions nor population at one point in time is an accurate measure of population at risk, because they do not take into account the duration of stay and turn-over. Since this data is not available, we used population size and population turn-over as control variables. Population size is added as a predictor rather than exposure variable, because it is possible that the size of the

population affects suicides beyond opportunity.[4] We have also adjusted for risk by calculating the suicide *rate* per 1,000 prisoners.

The models described below are based on negative binomial regression models with random intercepts, using Stata's *xtnbreg* command. Observations were grouped (clustered) by prison, and year of measurement was the 'time' variable. As described above, this means that prison-years are the unit of analysis. Incidence rate ratios (IRRs) are reported, which – in this paper – reflect the suicide rate per 1,000 prisoners, per year, relative to a baseline or comparison group.

3. Results

Table 3 presents results from our negative binomial regression models. Model 1 shows the relationship between prison-year level variables and suicide rate; Model 2 also includes prison function (training/local) and Model 3 further includes the prison-level variable 'churn'. In Model 1, the relationship between overcrowding and suicide rate is significant (IRR = 1.005), which means that a prison operating 10% above capacity has a suicide rate of 0.05 (*.005 * 10*) per 1,000 prisoners higher than a prison with a 100% occupation rate, all other things being equal. This confirms the *prima facie* correlation between overcrowding and suicides in prison. A larger population is also significantly associated with a higher suicide rate (IRR = 1.001), while private prisons, on average, had an expected suicide rate that was 57.1% (*1 - .429*) lower than public prisons (see Hilbe, 2011). Category C and D prisons have significantly lower suicide rates than the reference group of Category B prisons (the difference between Category B and A prisons is non-significant).

[4] As a predictor, the coefficient of population size will be determined by the data; as an exposure variable the coefficient would be set to 1.

With the addition of prison function in Model 2, overcrowding becomes non-significant. An inspection of suicide rates by function shows that function is a very good proxy for suicide and overcrowding (local prisons are more overcrowded and more likely to be the site of suicides), so this variable absorbs a substantial amount of variation. This hints at our earlier suggestion that prison function is not as useful analytically and that the focus should be on the characteristics that 'function' proxies.

Model 3 adds churn, and we found that churn was significantly related to the suicide rate in prisons (IRR = 1.146), with a higher turn-over predicting a higher suicide rate. A prison with a churn rate of 3 has a suicide rate that is 0.3 (*2 * .146*) higher than a prison with a churn rate of 1. In our sample, 64 out of 132 prisons had a mean churn rate of 3 or higher, of which 28 a rate of 5 or higher. Public prisons remain associated with more than double the suicide rates in private prisons, while Category C and D prisons have significantly lower suicide rates than Category B prisons. Category A and B prisons do not have significantly different suicide rates, although this may be due to limited statistical power; the IRR suggests that Category A prisons may have higher suicide rates than Category B prisons. Larger prisons have significantly higher suicide rates, with each population increment of 100 prisoners associated with a 0.1 increase in the suicide rate. Note in Table 2 that the mean prison population size is 609 prisoners, with a standard deviation of 325. Model 3 also shows a significantly lower suicide rate for female prisons compared to male prisons. With the addition of churn to the model, prison function becomes insignificant, which is likely because local prisons tend to have much higher turn-over rates. It thus appears that population turn-over ('churn') has an impact on suicide rates, rather than prison function in itself.[5]

[5] Interaction terms between function and overcrowding and security category and overcrowding were not significant in the final model.

Table 3 Multilevel negative binomial regression of suicide rates per 1,000 prisoners for 2000-2014 (n = 1729)

	Model 1		Model 2		Model 3	
Prison characteristics (prison-year level)	IRR	SE	IRR	SE	IRR	SE
Overcrowding	1.005*	.003	1.002	.003	1.000	.003
Population size	1.001***	.000	1.001**	.000	1.001**	.000
Private management	.429***	.084	.448***	.084	.483***	.086
Cat A	.951	.183	1.161	.219	1.210	.210
Cat C	.253***	.038	.366***	.062	.378***	.061
Cat D	.008***	.008	.010***	.011	.010***	.010
Female population	.710	.160	.795	.171	.650*	.139
Local prison			1.845***	.276	1.292	.210
Prison-level						
Churn					1.146***	.040
Intercept	1.147		.468*		.470*	
Wald X^2	207.00***		229.69***		260.61***	

Note. Overcrowding is centred around 100; "public", "Category B" and "training" are reference variables. *p<.05. **p<.01. ***p<.001.

4. Discussion

An analysis of suicide rates in prison for 2000-2014 shows that overcrowding was not associated with higher suicide rates, independent from the function of the prison and prisoner turn-over. While local and overcrowded prisons have higher suicide rates, it appears that this can be explained largely by their higher prisoner turn-over. Although overcrowding is not associated with a higher suicide rate as was found by Huey and McNulty (2005), it is also not protective against suicides, as was found in other previous studies (Duthé et al., 2009; Fruehwald et al., 2002). Prison characteristics that are associated with increased suicide rates are: a larger population size, public management of a prison, higher security category, a male population, and high turn-over.

It is clear from the analysis that prison characteristics have an influence on suicides, in particular the size of the population, population turn-over and the prison's security. A larger population is associated with higher suicide rates. This cannot be explained as a function of exposure, because the number of suicides per prison was adjusted for the size of the population. Possibly, a larger prison population increases the sense of anonymity of

prisoners and diminishes the quality of staff-prisoner relations (Johnsen & Granheim, 2012); more social control in smaller prisons, as well as improved signalling of distress, may contribute to lower incidence of suicides. This finding is cause for concern considering that the building of larger prisons is regarded as better value for money in purely economic terms. A new super prison in Wrexham (North Wales), to open in 2017, will accommodate over 2,000 prisoners (see also Grimwood, 2016).

The significant effect of population turn-over can be explained in various ways. First, high turn-over means that a prison receives a relatively large proportion of new (sentenced and remand) prisoners. Those who newly enter prison are at an increased risk of suicide (Liebling, 2007; Ministry of Justice, 2015c). Secondly, high turn-over contributes to instability of the prison population in terms of social interactions. This may negatively affect prisoners' ability to form networks of social support and also makes it more difficult for staff to get to know the prisoners and establish supportive staff-prisoner relationships. Social contact with other prisoners and staff could potentially reduce emotional distress and help identify prisoners at risk. In a recent study of staff experiences in managing self-inflicted death in prison (Ludlow et al., 2015), staff-prisoner relationships were identified as the key to managing suicide risk. Discontinuity of care, on the other hand, was found to be detrimental; this was related to low staffing, insufficient time to talk to prisoners, and the moving around of staff. While the Harris Review concentrated on self-inflicted deaths among 18-24 year olds, our results offer tentative support that continuity of care and good staff-prisoner relationships matter for the general adult population, too.

Another interesting finding from this paper is that higher security is associated with higher suicide rates, independent from prison function and occupancy rates. This may reflect a difference in population composition with regards to individual risk factors, but it is also possible that the higher suicide rate is related to greater deprivation and isolation in Category A and B prisons (see Huey & McNulty, 2005). Liebling (2015) has argued, on the

basis of extensive fieldwork in a Category A prison, that maximum security prisons have increasingly become hostile and even cruel places of punishment. Rather than trying to cultivate relationships on the basis of mutual trust, staff are preoccupied with risk in their interactions with prisoners. In the 'bleak environment [of maximum security imprisonment] hope, identity, and meaning were scarce' (Liebling, 2015, p. 106). In contrast, prison environments that are characterised by greater trust and prisoner responsibility may be associated with a higher quality of life. This may also be achieved in prisons with high security classifications. For example, therapeutic communities such as HMP Grendon (Category B) have been described as environments that promote trust, responsibility, self-worth and hope (Stevens, 2013).

It is also noteworthy that private prisons have lower suicide rates than public prisons. The cuts in staffing levels in public prisons may have had a negative impact on officers' ability to monitor prisoners, although private prisons are generally said to suffer from higher staff turn-over, low staffing levels and inexperienced staff (Prison Reform Trust, 2005). The relationship between quality of life and public/private management of prisons is not straightforward; some private prisons have indeed been found to outperform their public counterparts on the quality of prison life, but others perform considerably worse (Crewe, Liebling, & Hulley, 2014). A recent study did not find a significant relationship between perceived legitimacy and the public or private management of prisons in England and Wales (Brunton-Smith & McCarthy, 2015). Crewe et al. (2014) described private prisons as generally 'lighter', that is, characterised by more humane treatment of prisoners by prison staff, better material prison conditions, and greater freedom for prisoners (e.g. more time out of cell). However, the 'absence' of power in some private prisons resulted in unsafe and unsupportive environments. Further research should explore how these attributes of prisons are related to prisoners' mental health and suicide risk, in

order to explain the relationship between private/public management of prisons and suicide rates.

The finding that female prisons have a lower suicide rate than male prisons (but still a greatly elevated risk compared to the general population) is consistent with previous research (Fazel et al., 2008). In general, women are less likely to commit suicide than men (Office for National Statistics, 2015). But, it is likely that the picture would have been very different had we been looking at self-harm, which is known to be much higher among female prisoners (Fazel & Seewald, 2012; Hawton, Linsell, Adeniji, Sariaslan, & Fazel, 2014).

Relying on publicly available data has its limitations. First, there may be inaccuracies in the data that we were not aware of. Second, the ecological variables we used are rather crude measures of very complex and dynamic environments (as noted above). Moreover, we only had data on churn for a limited number of years, which forced us to calculate an average over time. It is likely that this variable absorbs variation from other factors that do and do not change over time. Future studies should therefore try to unpick this variable to understand which specific factors contribute to the elevated suicide rate associated with it (e.g. the average length of prisoners' stay in a prison).

Our understanding of prison suicides could be further improved by including prison and prisoner characteristics into a multilevel analysis, which could be partly informed by the fatal incident reports published by the Prisons and Probation Ombudsman. In addition to the prison factors considered in our analysis, it could be informative to include, for instance, information on prison health care, performance ratings, and staffing levels. Examples of relevant individual characteristics that may influence vulnerability to suicides are mental health problems, offence history, and sentence details. Even more detailed analyses might include information on a person's circumstances and concerns beyond imprisonment (e.g. related to family and finances). Yet another factor

to consider is the clustering of suicides in prisons; there is evidence that the occurrence of a suicide increases the likelihood of future suicides in the same prison (Cox & Skegg, 1993; McKenzie & Keane, 2007). To investigate this, it would be helpful to have more detailed space-time information than year and prison alone, as used in this study.

Whilst overcrowding was not associated with the suicide rate, this should not be taken as conclusive evidence that overcrowding is not harmful as this does not claim to be a causal analysis. It is possible that the protective effect of cell sharing on suicides associated with overcrowding and the harmful effect of limited meaningful activity result in an apparent null effect. The measurement of overcrowding in this study, the percentage of certified normal accommodation in use, does not give any detailed information about the lived experience of overcrowding in the prison in a given year. Accurate information about time spent out of cell, participation in meaningful activities, cell sharing, access to support, waiting times to see a doctor and staff-prisoner ratios may provide a better picture of the impact of overcrowding. In short, the pathways through which over-crowding might affect prisoner mental health are poorly understood. Overcrowding may be a 'distal' cause of prison suicide, manifested through several channels simultaneously (a cause of causes). The temporal and structural relationships between the factors listed in this paragraph (and our paper) need to be explored in more detail before drawing firm conclusions about overcrowding.

Furthermore, the dynamics of overcrowding and other relevant ecological factors may be substantially different in other countries, so we would urge caution in generalising these findings to other jurisdictions. Nonetheless, our results demonstrate the complexity of the relationship between overcrowding and suicide, as well as the importance of considering other prison characteristics. High prisoner turn-over is a challenge that most countries have to reckon with; its potential negative impact on prisoner well-being and safety has not been sufficiently recognised.

To conclude, while further research may give a more detailed insight into the risk factors of suicides in prison, various suggestions for improvement can already be identified. This study confirms that specific prison environments and characteristics may elevate suicide rates in prison; these ecological risks may further compound individual risk. Our results chime with what common sense and a humane view of prisons would suggest: a small-scale and stable prison environment is associated with a lower risk for suicide. More research is needed to identify the elements of low security and private prisons that can help decrease suicide rates. Additionally, it would be helpful to combine individual and environmental measures over time in order to understand the dynamic interaction between individual and environmental risk.

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