

Green space in prison improves wellbeing irrespective of prison/er characteristics, with particularly beneficial effects for younger and unsentenced prisoners, and in overcrowded prisons.

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Green space in prison improves wellbeing irrespective of prison/er characteristics, with particularly beneficial effects for younger and unsentenced prisoners, and in overcrowded prisons.

Dominique Moran, Jacob A Jordaan & Phil I Jones

Abstract

In this paper we present evidence of estimated significant associations between greenspace and prisoners' self-reported wellbeing, self-harm and violence in prisons in England and Wales.

Refining and extending previous research that estimated the relationship between greenspace and self-harm and violence whilst controlling for the effects of prison characteristics (e.g. prison size, over-crowding & security level), the findings in the present study show that greenspace remains significantly related to self-harm and violence when we additionally control for prison population characteristics (such as prisoner age, ethnicity, sentence length) and when we use additional self-reported indicators of well-being. Furthermore, our findings also show that the beneficial effects of greenspace appear to be particularly prominent in prison establishments that suffer from overcrowding or hold relatively large shares of younger and un-sentenced prisoners. Finally, our results reveal that greenspace has important impacts on the inter-relationships between self-reported wellbeing, self-harm and prison violence.

Keywords: green space, prison, wellbeing

1. Introduction

Over the last decades an extensive body of research has identified an array of prison and prisoner characteristics that can be linked to prisoner wellbeing and misconduct (Wooldredge, 2020; Quick et al., 2023). However, it is commonly agreed that there is ample scope to continue to search for additional or new factors that influence the behaviour and welfare of prisoners (Quick et al., 2023; Steiner et al., 2016). Within this context, a growing number of studies have traced the benefits of nature contact in prisons (Moore 1981; Nadkarni et al. 2017; Moran and Turner 2019; Moran 2019, Reddon & Durante 2019, Moran et al 2021a&b, Moran et al 2022). Most of the evidence on the effects of nature contact is obtained from qualitative research or from the evaluation of specific programs run in individual prisons (DelSesto, 2022); relatively little macro research has been done on the potential effects of greenspace or nature contact in a nation's prison system.

Recent research by Moran et al. (2021a&b, 2022) forms an important exception to this. Using Geographical Information Systems (GIS) mapping and statistical methods, they calculate the amount of greenspace within a set of English and Welsh prisons. Applying multivariate statistical analysis controlling for a set of prison characteristics (e.g. age, security level, crowding), they find that greenspace is positively related to prisoner and staff wellbeing, as prisons with a higher percentage of greenspace have significantly lower levels of self-harm, violence and staff absence.

The purpose of the present paper is to extend and improve upon these initial findings on the relationship between greenspace and prisoner wellbeing in the English and Welsh prison system. To understand and explain prisoner misconduct and wellbeing, researchers commonly refer to three types of explanation: importation theory (characteristics of prisoners when entering the prison system), deprivation theory (experiences of prisoner whilst imprisoned) and prison management styles (Steiner, 2016; Wooldredge, 2020). By estimating the relation between greenspace and prisoner wellbeing whilst controlling for several prison

characteristics, Moran et al. (2021a&b, 2022a&b) focused mainly on factors related to the deprivation theory and prison management style. For the present study we collected additional data on prisoner characteristics, allowing us to control for a wider set of factors related to the deprivation theory and several factors related to the importation theory. Our first aim of this paper therefore is to examine whether the association between greenspace and prisoner wellbeing persists when controlling for a wider set of prison and prison population characteristics. Additionally, we also assess whether and how the relationship between prison population characteristics and wellbeing is affected by greenspace.

Our second aim is to further refine the estimated relationship between greenspace and prisoner wellbeing. As acknowledged by Moran et al. (2021a), the use of data on self-harm and violence as proxies for wellbeing constitutes a rather blunt approximation of a much more nuanced issue. In addition to data on various prisoner characteristics, we also collected new data that captures a range of self-reported measures of wellbeing (e.g. experiencing mental health/emotional problems, feeling unsafe and un-respected, and medication and substance abuse). By using such self-reported indicators of prisoner wellbeing as alternative dependent variables, we further examine whether greenspace is related to prisoner wellbeing and how the relationship of prisoner characteristics with these alternative indicators of wellbeing is affected by greenspace. This allows us to assess under which conditions an increase in greenspace is more likely to generate particularly beneficial effects.

Third, by considering a wider array of prisoner wellbeing indicators, we examine inter-relationships between self-reported prisoner wellbeing and incidences of self-harm and violence, and the role that greenspace plays within these. If, as we might assume, self-reported wellbeing is predictive of self-harm and/or violence, does the presence of greenspace affect this relationship? In other words, does the presence of greenspace mitigate the 'translation' of poor self-reported wellbeing into incidences of self-harm and/or violence?

It is important to note that the dataset that we assembled does not allow use to make any claims about causal impacts of greenspace and prison(er) characteristics on wellbeing. We use a cross-sectional prison-level dataset for prisons in England and Wales and estimate associations between greenspace and prisoner wellbeing, conditioned on a range of prison and prisoner characteristics. To obtain evidence that would identify any causal impacts of greenspace, the use of some form of experimental research approach would be required (see. e.g. Van der Linden, 2015; DelSesto, 2022). However, given the paucity of statistical research on the effects of greenspace, especially at the macro level, we believe that our study does provide important new evidence about the potentially important contributions that greenspace may generate for prisoners wellbeing.

The paper is constructed as follows. In section two we discuss in more detail research on the effect of nature contact or greenspace on prisoner wellbeing. Section three discusses the data and the specification of our regression model. Section four presents our main empirical findings, containing new evidence on the relationship between greenspace and prisoner wellbeing, how greenspace is associated with the relation between prisoner characteristics and wellbeing and how greenspace is important for the relationship between prisoner-reported indicators of wellbeing and self-harm and prison violence. Section five summarises and concludes.

2. Greenspace and wellbeing in prisons

The link between greenspace and wellbeing has been the subject of academic inquiry for many decades. Ulrich's (1984) study, for example, found faster recovery rates from surgery in hospital rooms with a view of green space compared to those facing onto a blank wall. A great deal of work since has investigated the role of nature in the built environment to foster wellbeing (for example, James et al. 2009, Bertram & Rehdanz 2015, Gilchrist et al. 2015). The psychological and physiological mechanisms driving this effect remain somewhat ambiguous, although individuals with a greater sense of connectedness to nature seem to derive greater wellbeing benefits from exposure (Pritchard et al. 2020). A recent systematic review (Houldon

et al. 2018) found evidence for hedonic wellbeing (life satisfaction) being related to *presence* of local greenspace, though there was less evidence to support an impact on wellbeing derived from *visits* to different types of greenspace and wider greenspace accessibility.

Within a carceral context, prisoners have less freedom to visit green spaces, meaning that the effects of greenspace presence and views may be more pronounced. There has been work examining effects of prisoners' direct exposure to natural environments (such as through horticultural programmes, see DelSesto, 2022), but in practice only limited numbers of prisoners can be involved in such schemes (for example, Farrier et al. 2019). In contrast, research on nature presence and views applies to the effects on wider prison populations. Moore (1981), for example, noted that prisoners with a view of nature made fewer sickness calls. Self-reported responses to nature contact in UK and Norwegian prisons revealed increased feelings of calm and ability to reflect (Moran & Turner, 2019; Moran 2019). Similarly, a recent study of 326 male prisoners across three prisons in China identified a positive relationship between views of nature from their cells and self-reported well-being (Li et al., 2021)

Recently, a set of studies has examined the relationship between greenspace and wellbeing in the prison system of England and Wales (Moran et al., 2021a&b, 2022a&b). Using publicly available data for a cross-section of prisons, these studies relate prison-level incidents of self-harm, violence amongst prisoners and violence towards staff to the percentage of greenspace of prison terrains and various prison characteristics (e.g. security level, crowding, size). As discussed in detail in Moran et al. (2021a), GIS analysis of Ordnance Survey Mastermap data and geo-rectified aerial photographs of the prisons was used to calculate the percentage greenspace (vegetated landcover) of the terrains encapsulated by prison walls. The results of these studies indicate significant negative associations between greenspace and self-harm and prison violence, suggesting that greenspace exercises a positive effect on prisoner wellbeing (Moran et al., 2021a). A similar negative association was identified between greenspace and the rate of

staff-absence of the prisons, indicating that greenspace may also contribute to the well-being of prison staff (Moran et al., 2021b). In extension, another study reports further corroborating evidence in the form of negative associations between the extent of greenspace of a 500-meter buffer surrounding prison perimeters and self-harm and prison violence (Moran et al., 2022a).

3. Method and Data

In order to accurately estimate associations between greenspace and prisoner wellbeing, our regression model needs to sufficiently account for other factors that previous research has shown to be related to self-harm and violence. At least three different types of explanation for the variation of misconduct across prisoners and/or prisons are frequently examined: the importation theory, the theory of deprivation and the theory on prison management (Schenk & Fremouw, 2012; Steiner, 2016; Steiner et al., 2014). In general terms, the importation theory posits that prisoners' pre-prison characteristics provide an explanation for their behaviour in custody. Factors that are linked to this type of explanation include e.g. their age, race, education and previous criminal history. In contrast, the deprivation theory argues that prisoner misconduct can be explained by conditions and experiences whilst in prison. Examples of factors that this theory posits to be important include sentence length, level of prison crowding and frequency of contact with visitors. Prison management forms the third type of explanation and include aspects such as a prison's management style in relation to its security level, communication between staff and prisoners and the regimentation of the prisoners' daily activities.

Figure 1. Drivers of prisoner wellbeing

[Figure 1 here]

Figure 1 shows how we envisage the various groups of factors to be associated with prisoner wellbeing. Moran et al. (2021a, 2022a&b) focused on estimating the relation between

greenspace and inverse indicators of prisoner wellbeing in the form of self-harm and prison violence, whilst controlling for various prison characteristics. As such, these studies are based on estimating models that primarily relate the variation of wellbeing to how prisons differ according to factors related to prison management and deprivation. In the present study we provide an important extension on this, by adding several variables that capture characteristics of prisoners and their prison experience.

Thus, we capture the effects of a wider set of factors related to deprivation theory and management style and we also include elements of importation theory. In so doing, our aim is not to examine whether management, deprivation or importation theory provides a better explanation for self-harm and prison violence. Instead, by controlling for a wider range of factors that are related to these theories we aim to obtain a better picture of what is important for prisoner wellbeing.¹ This is also facilitated by the use of alternative dependent variables. As indicated in the right hand side of the figure, we follow Moran et al. (2021a, 2022a&b) by using self-harm and prison violence as proxy indicators of wellbeing. In addition, we introduce several alternative dependent variables that are more directly linked to prisoners' self-reported indicators of wellbeing. This links the present study more closely to wider studies on greenspace and well-being that usually rely on using such self-reported indicators (see e.g. Krols et al., 2022; Sang et al., 2016).

Furthermore, the inclusion of prisoner characteristics allows us to extend our analysis of the importance of greenspace. One advantage is that by controlling for a wider set of variables that may be related to prisoner wellbeing, we lower the risk that the estimated effect of greenspace is affected by omitted variable bias. The second advantage is that it allows us to examine whether particular prisons are more likely to benefit from greenspace. This is indicated in Figure 1 by the dashed lines between the lines indicating the relationships between prison(er)

¹ This is in line with developments in the literature towards integrating the various separate theories as they all provide only partial explanations for prisoner misconduct (e.g. Huebner, 2003; Toman et al., 2015; Wolff, 2016).

characteristics and wellbeing. In contrast to most variables of deprivation theory that are seen to increase prisoner misconduct, greenspace is expected to *reduce* prisoner misconduct. We believe it to be likely that greenspace also impacts on the relationship between variables of both the importation and deprivation theory and wellbeing. For instance, it may be that young prisoners who are commonly found to experience more problems adjusting to prison life may find this easier to do so when a prison offers sufficient greenspace. Similarly, the anxiety experienced by prisoners awaiting trial and/or sentencing may be lower in the presence of sufficient greenspace. If this is the case, our findings will have important implications for policy making in prisons with a high presence of young or un-sentenced prisoners.

To estimate the relations depicted in Figure 1, we estimate a number of specifications of the following regression model:

$$(1) Y_i = \beta_0 + \beta_1 \text{Greenspace}_i + \beta_2 \text{Prisonerchars}_i + \beta_3 \text{Prisonchars}_i + \varepsilon_i$$

where Y is the prisoner-averaged number of occurrences of self-harm, prisoner-on-prisoner assaults or prisoner-on-staff assaults for prison i , averaged for the period 2014-2018. Following the approach described by Moran et al. (2021), we assembled publicly available data for all operational prison sites for over 18s in England and Wales relating to reported incidents of self-harm, violence towards staff and prisoner-on-prisoner violence. We interpret self-harm, assaults among prisoners and assaults towards staff members all as types of violent prisoner misconduct; the distinguishing feature of self-harm is that the perpetrator and the victim are the same person (Pickard, 2015; Slade, 2017). The main variable of interest 'Greenspace' is measured as the percentage of prison territory (the space contained by the perimeter wall or fence) that consists of vegetated landcover (see Moran et al., 2021).

The vector 'Prisonerchars' contains a set of characteristics of the prison populations. We collated data on prison population characteristics from inspection reports produced by Her Majesty's Inspectorate of Prisons (HMIP). HMIP is an independent inspectorate providing independent scrutiny of the conditions for and treatment of prisoners in England and Wales. Prisons are

inspected at least once every five years, with most establishments inspected every two to three years. Inspection of a prison normally spans a period of two weeks, the first week of which involves a full survey of a random sample of the prison population conducted by a team of HMIP researchers. Prison-aggregated results are made publicly available on the HMIP website. In order to align with the period covered by the dependent variables, we collated data from appendices of HMIP reports conducted in or around 2014 (the year of publication of the reports that we used ranges from 2012 to 2016)².

One variable related to prisoner characteristics is the extent to which a prison houses un-sentenced prisoners. We expect a positive relationship between this variable and the dependent variables, given findings from previous research that show that prisoners awaiting trial and/or sentencing are more likely to feel distressed or to engage in self-harm (Hawton et al., 2014; Schenk & Fremouw, 2012; Arbach-Lucioni et al., 2014). To capture the effect of un-sentenced prisoners we construct a dummy variable that takes the value of 1 for prisons with an above sample mean % of un-sentenced prisoners.

Another variable capturing prisoner characteristics is the % of young prisoners. As many studies have found, youth is one of the strongest predictors of self-harm and prison violence (Fazel et al., 2016; Quick et al., 2023). To capture this effect, we use two different variables. The variable “age_18-21” is measured as the % of the prison population falling into the 18-21 age bracket; “age22_29” is the % of the prison population in the 22-29 age bracket.

Next, we control for the ethnic composition of the prison population. As Steiner and Wooldredge (2009) note, ethnicity is frequently included in modelling prisoner behavior, often without a clear justification or hypothesis. It is beyond the scope of this paper to outline the extreme complexity and time- and context-specificity of any hypothesised relationship between ethnicity and indicators of wellbeing. However, for the purposes of our present analysis, we suggest that, as

² Combining the datasets resulted in a dataset containing around 100 prisons; due to missing observations our empirical estimations are carried out on samples varying between 85-95 prisons.

Steiner and Wooldredge (2009) venture, the frequent equal status contact occurring between individuals of different ethnic backgrounds in diverse prison populations *may* be a protective factor reducing tension within the overall prison population. We use two variables here. The first is the % of the prison population that is of British nationality. We expect a positive association with the dependent variables, since a high % of one nationality may lead to tensions with prisoners of minority nationalities. Since there is considerable ethnic variation within the population of British nationals, our other variable is “ethnic_fractionalisation”, defined as $1 - \sum_i s_i^2$, where s_i = share of an ethnic group (white, mixed, Asian/Asian British, Black/Black British, Other ethnic groups) in a prison population. This variable can be interpreted as indicating the probability that two randomly-selected prisoners in a prison population belong to different ethnic groups.

We also control for the average sentence length of the prison population. Prisoners serving long sentences are less likely to engage in prisoner misconduct (Reidy & Sorensen, 2018; Toman et al., 2015; Quick et al., 2023), arguably because they have come to terms with their sentence and have adjusted to prison conditions. Using information on groups of prisoners with different sentence lengths, we calculate an indicator of average prison sentence length, using the % shares of the groups of prisoners as weights.

Finally, we include two variables that relate to the extent that a prisoner is isolated from the environment and the outside world. Overall, studies that examine the effect of prison visitation find that visits from friends and family have beneficial effects on prisoner wellbeing and lower prisoner misconduct and recidivism (De Claire & Dixon, 2017; Meyers et al., 2017). To capture this effect, we include a variable labelled “difficulty_visits”, measured as the % of prisoners that indicate that it is (very) difficult for their family and friends to visit them. The other variable that we include is “low_outside”, measured as the % of prisoners that do not (want to) go outside + the % of prisoners that go outside only once or twice a week. We interpret this variable as an indicator whether inmates isolate themselves from social life inside the prison.

Next to the controls for prisoner characteristics we also include several variables capturing prison characteristics. We add prison dummy variables related to prison type and security levels. Based on findings presented in Moran et al. (2021), we add a dummy variable for female prisons when estimating the model with self-harm as dependent variable. We add dummy variables for young offenders' institutes and high security prisons when using violence among prisoners as dependent variable and for Category C prisons when using violence towards staff as dependent variable. Furthermore, we collected data from the prisons on three prison-level variables that Moran et al. (2021a) found to be associated with prisoner well-being: size (number of prisoners in 2014), prison structure (dummy variable identifying prisons that started operations in the 19th century) and an inverse indicator of the level of crowding (official operational capacity of a prison divided by the actual number of prisoners in 2014).³

4. Empirical findings

4.1. Greenspace, prison population characteristics, self-harm and violence

Table 1 presents the main findings from estimating various specifications of regression model (1) for the three dependent variables. Columns (1-4) report the results with self-harm as dependent variable. In column (1) we report the estimated coefficients of greenspace, female prisons and the prison population characteristics. In line with Moran et al. (2021a), the estimated coefficient of Greenspace is significant and negative, indicating that the negative association of greenspace with self-harm persists when we control for various prisoner characteristics unaccounted for in previous research. The estimated effects of these characteristics are in line with expectations. For example, the estimated significant positive coefficient of the two young age category variables confirms that self-harm is more common

³ For evidence on the effects of prison size and crowding, see e.g. Caravaca-Sanchez et al. (2019), Goncalves et al. (2014) and Franklin et al. (2006).

amongst younger prisoners. Also, the estimation reveals that impediments to visitation are positively associated with self-harm.

[Table 1 here]

The estimated association of “% British nationality” is also significant and positive, indicating that prisons with a relative high % of British nationals are characterised by a significantly higher level of self-harm. As shown in column (2), ethnic fractionalisation carries an estimated significant negative coefficient, indicating that prison populations with a higher degree of ethnic diversity have lower rates of self-harm. As discussed earlier, we interpret these findings as an indication that more ethnically diverse prison populations are less likely to foster tension between different ethnicities or nationalities.

Column (3) reports the findings from including the three prison characteristics as used by Moran et al. (2021). This inclusion does not affect the estimated significance of the prisoner characteristics, indicating that they are relevant for understanding levels of self-harm. Importantly, their inclusion also does not change the significance of the estimated negative association of Greenspace with self-harm.

Column (4) presents the standardised beta coefficients of the control variables that carry significant coefficients. By capturing by how many standard deviations the dependent variable changes following a one standard deviation change in the independent variables, standardised beta coefficients enable us to *compare* the effects of the control variables. We find that the dummy variable identifying female prisons and the variable Greenspace appear to exercise the largest effect on self-harm, followed by the variables age 22-29, Centuryold and ethnic fractionalisation.

Columns (5-8) report the results with violence between prisoners as dependent variable. The estimated association of Greenspace is significant and negative, confirming that prisons with more greenspace have significantly lower levels of violence between prisoners. The variable identifying prisons with a high % of unsentenced prisoners carries a positive coefficient, in line

with the notion that the high presence of such prisoners leads to unrest and misconduct. The other factor important for prison violence is prisoners' age, as the variables age 18-21, age 22-29 and the Young Offenders Institute dummy variable carry positive coefficients. The Standardised beta coefficients (column 8) also indicate that the effects of the young prisoner variables are the most important, followed by Greenspace.

Columns (9-12) repeat the estimations with violence towards prison staff as dependent variable. The importance of Greenspace is confirmed, as is the share of young prisoners in the prison population (age 18-21 & age 22-29). In addition, we also find that the average sentence length is negatively associated with prison violence, in line with findings from other studies. Considering the relative importance of the effects (column 12), a high level of young prisoners again appears to exercise the strongest effect on violence, followed by Greenspace.

Summarising, the results in Table 1 identify several prisoner characteristics that are significantly associated with self-harm and violence. This is a clear extension of previous research on the UK that has focused primarily on the effects of prison characteristics. Furthermore, the results show that when we control for variables capturing prison categories, prison characteristics *and* prison population characteristics, there is no change in the significance of the negative association of greenspace with the dependent variables, as initially found by Moran et al. (2021a, 2022a&b). In our augmented analysis greenspace persists to exercise a significant and dampening effect on both self-harm and violence, further supporting the notion that greenspace is important for wellbeing in the prison system of England and Wales.

4.2. Greenspace and self-reported prisoner wellbeing

In the next step of our analysis we replace self-harm and prison violence with self-reported indicators of wellbeing. The use of the self-harm/violence indicators is based on the plausible assumption that they approximate a *lack of wellbeing* (Moran et al., 2021a). Although we are not

challenging this assumption, by further examining whether greenspace is associated with other indicators of prisoner wellbeing, we can obtain further evidence of the role of greenspace. We use four different dependent variables that relate to prisoner wellbeing. One is the % of prisoners indicating that they experience mental health and/or emotional problems. Second, we construct a variable by performing a principal component analysis on the variables % of prisoners reporting mental or emotional problems, % of prisoners reporting having developed a drug habit in prison and % of prisoners reporting having started to misuse medications. We take the first principal component as an indicator of the occurrence of problems with mental health and drugs/medication dependency, labelled 'PC_1 mental health'. A third dependent variable is measured as the % of prisoners that indicate not feeling respected and the % of prisoners feeling unsafe. The fourth variable is a multidimensional indicator of factors related to negative wellbeing: % of prisoners not feeling respected; % feeling unsafe; % reporting mental and/or emotional problems; % reporting having developed a drug/medications habit in prison; % reporting having experienced abuse from other prisoners; % reporting having experienced abuse from staff; and % having officially reported abuse from staff to the prison authorities. We perform a principal component analysis on this set of variables and use the first principal component which we label 'PC_1 Multidimensional' as indicator of this broad indicator of negative aspects of prisoner wellbeing.

[Table 2 here]

Table 2 presents the results from estimating the model with the various indicators of self-reported wellbeing. Columns (1-5) use mental health and emotional problems as dependent variable. We first estimate the associations of greenspace and prison type: Greenspace (female prison, local prison) is negatively (positively) associated with mental health problems, Next, we include characteristics of prison populations and prisons. In all the estimations, the estimated coefficient of greenspace is significant and negative. Surprisingly, the effect of the age category age 21 is negative, which goes against the common notion that young people are more

susceptible to mental health problems (e.g. Patel et al., 2007). A possible explanation for the negative association is that young prisoners are less likely to *report* experiencing these problems. The estimated positive coefficient of the variable British and the negative coefficient of ethnic fractionalisation indicate that ethnic diversity exercises a positive effect on mental health. Of the prison characteristics, the estimated effect of the variable 'Centuryold' is negative, in line with the findings of Moran et al. (2021a). The coefficient of the inverse indicator of overcrowding also carries a negative sign, indicating that overcrowding is associated with a higher occurrence of mental health problems. Finally, looking at the standardised beta coefficients in column (5), greenspace is third in importance, after female prison type and the effect of ethnic fractionalisation.

The remainder of Table 2 shows the results from using the dependent variables PC_1 Mental health, feeling unsafe and not respected and the multidimensional indicator PC_1 Multidimensional. In all estimations greenspace carries a significantly and negatively signed coefficient, strongly indicating that greenspace is associated with these various types of prisoner wellbeing. Other key findings reported in Table 2 are that younger prisoners are more likely to experience problems with drug/medication abuse (age 22-29) and to feel disrespected and unsafe (age 18-21). The ethnic composition of the prison population appears to be important both for mental health and substance abuse and for the multidimensional indicator of prisoner wellbeing. Depending on the indicator of wellbeing, prison category variables capturing female prisons and local prisons exercise significant effects. As for prison characteristics, the estimated effect overcrowding is significant in all the estimations, indicating that, like greenspace, overcrowding appears to be important for all these types of prisoner wellbeing. Looking at the standardised beta coefficients in column (14), greenspace appears to exercise the largest effect on multidimensional wellbeing, followed by overcrowding.

4. 3. Interactions between greenspace and prisoner characteristics – when is greenspace most beneficial?

Next, we consider *under what circumstances* an increase in greenspace might be most beneficial. In other words, can we determine whether increases in greenspace are likely to have particularly strong effects on wellbeing (irrespective of how we measure it) in prisons whose populations have particular characteristics? Considering first self-harm and violence, the results in Table 1 show that sentenced/unsentenced status and age are both important prisoner characteristics. To further examine their importance in relation to greenspace, we re-estimated the models underlying columns (3), (7) and (11), adding interaction terms between the prisoner characteristics and greenspace.⁴ Using the results of these estimations, we estimated predictive margins of the interaction terms which we present graphically in Figures 2 and 3.

[Figures 2-3 here]

Figure 2 presents the results of the interaction between greenspace and the dummy variable identifying prisons with a high % of unsentenced prisoners. The general importance of greenspace is confirmed; irrespective of whether the % of unsentenced prisoners is low or high, an increase in greenspace appears to reduce self-harm and violence. The exception to this is the case of violence between prisoners in prisons with a low % of unsentenced prisoners - where violence remains low at all levels of greenspace. Furthermore, irrespective of which dependent variable we consider, the decrease in self-harm and violence under an increase in greenspace is faster in prisons with a high % of unsentenced prisoners. This suggests that increasing greenspace can have a particularly pronounced effect on wellbeing in establishments holding many prisoners awaiting trial or sentencing.

⁴ Given the limited number of observations we include an interaction term between greenspace and one of the prisoner characteristics at a time.

Figure 3 shows the findings on the interaction between greenspace and % of prisoners aged 18-21. Since both variables are continuous, plotting the predictive margins would result in a three-dimensional surface. To simplify visualisation, we estimated predictive margins of the interaction for a set of pre-specified values of the two variables (indicated on the horizontal and vertical axes). We plot these values against the estimated predictive margins in contour plots, whereby differently-coloured areas capture different ranges of the predictive margins. Taking the first contour plot of Figure 3 as example, the red area – showing the highest level of self-harm – is characterised by low greenspace and a high % of prisoners aged 18-21. In contrast, a high level of greenspace and a low share of young prisoners is accompanied by a relatively low level of self-harm, indicated by the dark blue area in the bottom right of the contour plot. Importantly, the decrease in self-harm when greenspace is increased is stronger when the % of young prisoners is high. Starting at the top left of the contour plot, an increase in greenspace is accompanied by a more rapid movement between the ranges of the predictive margins compared to a similar-sized increase in greenspace when the % of young prisoners is low. The other two plots indicate that a similar difference exists for violence amongst prisoners and violence towards staff members. This suggests that an increase in greenspace can be particularly effective in terms of improving well-being when such a change in greenspace is targeted at prisons with many young prisoners.⁵

Next, we examine the interactions between greenspace, high % of un-sentenced prisoners and % of young prisoners for the models that use the alternative dependent variables. In addition, we also examine the interaction between greenspace and overcrowding, given the findings in Table 2. Figure 4 presents the plots for the interaction between greenspace and high % of un-sentenced prisoners. There is no difference in the response to an increase in greenspace when considering feelings of lack of safety or respect. The outcome variables `pc1_mental health`

⁵ For space considerations we omit the plots for the interaction between age 22-29 and greenspace. These plots look similar to Figure 2, further indicating the important role that greenspace can play in improving well-being in prisons with high shares of young prisoners. The plots with age 22-29 are available upon request.

and pc1_multidimensional decrease slightly faster when greenspace is increased in prisons with a high % of unsentenced prisoners. The rate of decrease in prisons with a high % of unsentenced prisoners is the fastest when considering mental health and emotional problems as outcome variable.

Figure 5 presents the plots for the interaction between greenspace and the % share of 18-21 year old prisoners. The findings with mental health and emotional problems or pc1_mental health as dependent variable suggest that prisons with a low % of young prisoners are the most affected by these problems. Although this is in line with the finding in Table 2 that prisons with a high % of young prisoners have significantly lower levels of mental health problems, this may reflect that young prisoners are less willing or able to indicate that they are experiencing such problems.⁶ The plot with unsafe & not respected as dependent variable is in line with the findings from Figure 3: prisons with a high % of young prisoners experience a faster improvement in wellbeing when greenspace is increased compared to prisons with a low % of young prisoners.

The last two plots of Figure 5 show the results for the interaction between greenspace and the multi-dimensional indicator of well-being. Given the similarity with the plots for mental health and pc1_mental health, it is likely that the plot at the bottom left is also affected by the negative relationship between % young prisoners and reporting mental health problems. Therefore, we also re-estimated the model with an interaction between greenspace and the first principal component of all the self-reported indicators of wellbeing except mental health. As the plot in the bottom right shows, doing so gives results that suggest that prisons with a high % of young prisoners and low greenspace are characterised by the lowest level of wellbeing. Again, an increase in greenspace in prisons with a high presence of young prisoners appears to create a larger positive impact on wellbeing than a similar increase in greenspace in prisons with a low presence of young prisoners.

⁶ The contour plots on the interaction between greenspace and age 22-29 are available upon request.

[Figures 4-6 here]

Finally, Figure 6 depicts the findings on the interaction between prison overcrowding and greenspace. Given that overcrowding is measured as the ratio of a prison's operational capacity over its actual number of prisoners, a low value indicates that a prison is relatively overcrowded. The negative effect of overcrowding on wellbeing is confirmed in all four contour plots, with the red area located in the bottom left of the plots. Also, an increase in greenspace has the largest effect when the level of the overcrowding variable is high, especially when using *pc1_mental health* and feelings of lack of safety and respect as outcome variables. This indicates that greenspace is likely to impact particularly strongly on prisoner wellbeing in prisons with high levels of overcrowding.

4.4. Greenspace, self-reported wellbeing and self-harm and violence

So far, our analysis shows that greenspace is significantly associated with self-harm and prison violence, even when we control for the effects of both the characteristics of prisons *and* their populations. Furthermore, our results also show that greenspace is associated with alternative dependent variables that more directly capture prisoners' *self-reported* wellbeing. What these results do not consider, however, is that there may be inter-relationships between self-reported wellbeing, self-harm and violence and that greenspace may potentially impact upon these interrelationships.

[Table 3 here]

Table 3 shows the results from estimating bivariate regression models with self-harm or violence as dependent variables, and self-reported indicators of prisoner wellbeing as explanatory variables. As the results show, there are clear and significant associations between the various indicators of self-reported prisoner wellbeing, and self-harm or violence. This suggests that we can think of self-harm and violence as *outcome* variables that are influenced by

the various indicators of self-reported wellbeing. We therefore may need to account for this relationship in our estimations of the relation between greenspace and wellbeing, as greenspace is associated *both* with the outcome variables *and* with self-reported wellbeing.

One approach to estimate the effect of prisoner wellbeing and greenspace in a multivariate setting is to apply ordinary least square (OLS) techniques to the following regression model:

$$(2) Y_i = \beta_0 + \beta_1 \text{Greenspace}_i + \beta_2 Z_i + \beta_x X_i + \varepsilon_i;$$

where Y = self-harm; violence between prisoners; violence towards staff; Greenspace = percentage prison greenspace; Z = mental health, measured by mental health problems; PC_1 mental health; or PC_1 Multidimensional; X = prison and prisoner characteristics.

Interpreting the estimated effects of Greenspace and mental health (Z) from model (2) is problematic, however. Greenspace impacts on Z (see Table 2), which in turn impacts on Y (see Table 3), whilst Greenspace also impacts directly on Y (see Table 1). To assess whether and to what extent this biases the OLS estimation of model (2), we therefore also estimate the following system of equations using three stages least squares (3SLS) techniques:

$$(3a) \text{Greenspace} = \vartheta_0 + \vartheta_1 \text{Prison Categories} + \gamma$$

$$(3b) Z = \rho_0 + \rho_1 \text{Greenspace} + \theta$$

$$(3c) Y = \beta_0 + \beta_1 \text{Greenspace} + \beta_2 Z + \beta_x X + \varepsilon$$

In the first stage, we regress Greenspace on those prison category dummy variables that are not significantly associated with prisoner mental health, self-harm and prison violence. In the second stage, we regress prisoner wellbeing on the instrumented variable Greenspace. The advantage of this approach is that the 3rd stage estimation provides unbiased estimates of the effects of both Greenspace and self-reported wellbeing on self-harm and prison violence and that it indicates whether there is also an *indirect* effect of Greenspace on self-harm and violence running via the relationship of Greenspace with self-reported wellbeing.

[Table 4 here]

Table 4 shows the results from estimating models (2) and (3a-c) using mental health as indicator of prisoner wellbeing and self-harm or violence as dependent variable. The OLS results in column (1) indicate that both Greenspace and mental health are positively associated with self-harm. However, the findings from the 3SLS estimation (column 2) are substantially different. The estimated effect of Greenspace is much larger, indicating that – after taking out any effect on mental health – the negative association of Greenspace with self-harm is much larger. As for the effect of mental health, the estimated negative effect indicates that a higher occurrence of mental health problems leads to a decrease in the occurrence of self-harm. This seems to be a surprising result, but may reflect a self-awareness effect. Self-harming may be used as a coping tool by prisoners who are insufficiently aware that they are suffering from mental health and emotional problems to seek assistance. If so, this would show up as a negative association between self-reported mental and emotional health problems and self-harm.⁷

The results in columns (3-6) are from estimating the regression model with prison violence as dependent variable. The OLS estimations produce significant positive associations of both Greenspace and mental health. The 3SLS estimations confirm the effect of Greenspace but also show that the effect of mental health turns insignificant. This indicates that although mental health may impact on violence, this effect is caused by the impact of Greenspace on mental health. After taking out this relationship, there is no additional effect of mental health on prison violence.

[Table 5 here]

⁷ This may also explain why the estimated effect of the two young age variables turns insignificant in column (2), especially given the findings in Table 3 that indicate that prisons with a relative high % of young prisoners have less self-reported levels of mental health and emotional problems.

Table 5 summarizes the main results from estimating models (2) and (3a-c) with PC_1 Mental health or PC_1 Multidimensional as indicators of self-reported prisoner wellbeing. Except for column (4), Greenspace is always significantly negatively associated with self-harm and violence. As for prisoner wellbeing, there is a significant positive association of mental health and substance abuse with violence (columns 6), even after accounting for the association of Greenspace with prisoner wellbeing (column 10). This is also the case for the multidimensional indicator of prisoner wellbeing in the model with self-harm as dependent variable (column 4). In the other estimations, the association of prisoner wellbeing with the dependent variables turns insignificant in the 3SLS estimation. This change further underlines the importance of Greenspace: not only does Greenspace appear to exercise direct effects on self-harm and violence, it *also* appears to generate indirect effects via its relationship with self-reported prisoner wellbeing. Next to acting as an important transmitting channel of this indirect effect of Greenspace, prisoner wellbeing also appears to exercise direct impacts on self-harm or violence in several of the estimations.

Conclusions

This paper presents an extension of previous statistical studies of the relationship between greenspace and wellbeing in the prison system of England and Wales. The study makes several contributions to the existing literature. Firstly, while prior studies have examined the association between greenspace and wellbeing while controlling for prison characteristics, this research also controls for various characteristics of prison populations. Secondly, the study provides a broader assessment of the potential importance of greenspace by considering its relationship with a new set of indicators directly linked to prisoner self-reported indicators of wellbeing, in addition to self-harm and violence. Thirdly, it investigates conditions under which an increase in greenspace may exercise particularly meaningful effects on prisoner wellbeing.

The findings of this study reinforce previous evidence that greenspace appears to be important in promoting wellbeing. All estimations demonstrate significant associations with wellbeing, captured by self-harm, prison violence, and various aspects of prisoner-reported wellbeing. Additionally, several prisoner characteristics are identified as important factors (such as a high presence of young or unsentenced prisoners) which are associated with lower levels of wellbeing. Depending on the outcome variable, sentence length, low number of visits, and an ethnically diverse prison population are also found to be important. As for prison characteristics, an important finding is that overcrowding is significantly negatively associated with self-reported wellbeing. Our analysis of conditions under which an increase in greenspace is likely to foster particularly strong effects focuses on interactions between greenspace and the percentage of unsentenced prisoners, percentage of young prisoners, and overcrowding. Our findings are uniform in finding that increases in greenspace appear to have stronger effects in prisons that are characterised by a high presence of unsentenced prisoners, a high percentage share of young prisoners, and a high level of overcrowding.

The findings of this study have implications for both scholarship and policy-making in relation to prisoner misconduct and wellbeing. The theoretical implications are two-fold. First, prison systems, pre-prison characteristics of inmates and negative individual in-custody experiences are commonly seen as the primary drivers of misconduct and ill-being. Although our study confirms that these factors are important, we also find that greenspace is significantly associated with wellbeing. This strongly suggests that theories need to be extended by incorporating effects of broader prison characteristics such as greenspace that are not directly related to the set of prison(er) characteristics normally considered. Our findings showing that greenspace also interacts with several prison(er) characteristics underline the importance of such a consideration. The second theoretical implication pertains to the necessity of cultivating a more nuanced understanding of the underlying interconnections between various dimensions of prisoner wellbeing and misconduct. Our findings demonstrate that facets concerning the self-reported wellbeing of prisoners appear to serve as important inputs in processes generating

self-injury and violence. Further investigation is essential to appraise the significance of these associations and identify additional variables that may also play a contributory role in these processes.

The primary policy implication of this research is that greenspace may be a key element in supporting prisoner wellbeing. The estimated significant association of greenspace with wellbeing materialises in all our estimations, irrespective of the nature of the dependent variable, the inclusion of the wider set of control variables and whether or not we allow for interrelationships between input and output wellbeing variables. We appreciate that a general increase of greenspace in prisons is expensive and logistically challenging. However, our novel finding that an increase in greenspace appears to be particularly effective under certain conditions is of key importance. Our findings suggest that if opportunities to increase greenspace are limited, then this alteration should be prioritised for prisons with a high percentage of unsentenced prisoners, many young prisoners, and/or high levels of overcrowding. Likewise, where a change in the population held in a particular prison is being considered, its (potential) provision of greenspace should be considered before it is used for the accommodation of young or unsentenced prisoners.

References

- Arbach-Lucioni, K., Martinez-Garcia, M. & Andres-Pueyo, A. (2012) Risk factors for violent behavior in prison inmates. *Criminal Justice and Behavior*, vol. 39.9, p. 1219-1239
- Berg, M.T. & DeLisi, M. (2006) The correctional melting pot: Race, ethnicity, citizenship, and prison violence. *Journal of Criminal Justice*, vol. 34(6), p. 631-642
- Bertram C and Rehdanz K (2015) The role of urban green space for human well-being. *Ecological Economics* 120: 139-152.
- Caes, G.G. & McGuire, W.J. (1985) Prison violence: The contribution of crowding versus other determinants of prison assault rates. *Journal of Research in Crime and Delinquency*, vol. 22(1), p. 41-65
- Caravaca-Sanchez, F., Wolff, N. & Teasdale, B. (2019) Exploring associations between interpersonal violence and prison size in Spanish prisons. *Crime & Delinquency*, vol. 65(14), p. 2019-2043
- De Claire, K. & Dixon, L. (2017) The effects of prison visits from family members on prisoners' well-being, prison rule breaking, and recidivism: A review of research since 1991. *Trauma Violence*, vol. 18(2), p. 185-199
- DelSesto, M. (2022) Therapeutic horticulture and desistance from crime. *The Howard Journal of Crime and Justice*, vol. 61, p. 444-462
- Farrier A, Baybutt M and Dooris M (2019) Mental health and wellbeing benefits from a prisons horticultural programme. *International Journal of Prisoner Health* 15(1): 91-104.
- Fazel, S., Hayes, A.J., Bartellas, K., Cleric, M. & Trestman, R. (2016) Mental health of prisoners: Prevalence, adverse outcomes, and interventions *Lancet Psychiatry*, vol. 3, p. 871-881

Franklin, T.W., Franklin, C.A. & Pratt, T.C. (2006) Examining the empirical relationship between prison crowding and inmate misconduct: A meta-analysis of conflicting research results. *Journal of Criminal Justice*, vol. 34, p. 401-412

Gilchrist K, Brown C and Montarzino A (2015) Workplace settings and wellbeing: Greenspace use and views contribute to employee wellbeing at peri-urban business sites. *Landscape and Urban Planning* 138: 32-40.

Goncalves, L.C., Goncalves, R.A., Martins, C. & Dirkzwager, A.J.E. (2014) Predicting infractions and health care utilisation in prisons. *Criminal Justice and Behavior*, vol. 41(8), p. 921-942

Harer, M.D. & Steffensmeier, D.J. (1996) Race and prison violence. *Criminology*, vol. 34(3), p. 323-355

Hawton, K., Linsell, L., Adeniji, T., Sariaslan, A., & Fazel, S. (2014). Self-harm in prisons in England and Wales: an epidemiological study of prevalence, risk factors, clustering, and subsequent suicide. *The Lancet*, 383(9923), 1147-1154.

HMIP (2019) *Inspection Framework* HMIP, London

Houlden V, Weich S, Porto de Albuquerque J, Jarvis S and Rees K (2018) The relationship between greenspace and the mental wellbeing of adults: A systematic review. *PloS one* 13(9): e0203000.

Huebner, B.M. (2003) Administrative determinants of inmate violence: A multilevel analysis. *Journal of Criminal Justice*, vol. 31, p. 107-117

James P, Tzoulas K, Adams MD, Barber A, Box J, Breuste J, Elmqvist T, Frith M, Gordon C, Greening KL, Handley J, Haworth S, Kazmierczak AE, Johnston M, Korpela K, Moretti M, Niemelä J, Pauleit S, Roe MH, Sadler JP and Ward Thompson C (2009) Towards an integrated understanding of green space in the European built environment. *Urban Forestry & Urban Greening* 8(2): 65-75.

Jewkes, Y, D Moran & J Turner (2019) "Just add water": Prisons, therapeutic landscapes and healthy blue space *Criminology and Criminal Justice* 10.1177/1748895819828800

Krols, J., Aerts, R., Vanlessen, N., Dewaelheyns, V., Dujardin, S., & Somers, B. (2022). Residential green space, gardening, and self-reported stress and depression: a cross-sectional study of garden owners in northern Belgium. *Landscape And Urban Planning*.

Lahm, K.F. (2008) Inmate-on-inmate assaults: A multilevel examination of prison violence. *Criminal Justice and Behavior*, vol. 35(1), p. 120-137

Li H, Zhang X, You C, Chen X, Cao Y and Zhang G (2021) Can Viewing Nature Through Windows Improve Isolated Living? A Pathway Analysis on Chinese Male Prisoners During the COVID-19 Epidemic. *Frontiers in Psychiatry* 12: 720722

Liebling, A., Durie, L., Stiles, A., Tait, S. (2011). Revisiting prison suicide: The role of fairness and distress. In Liebling, A., Maruna, S. (Eds.), *The effects of imprisonment* (pp. 209-231). New York, NY: Routledge.

Meyers, T.J., Wright, K.A., Young, J.T.N. & Tasca, M. (2017) Social support from outside the walls: Examining the role of relationship dynamics among inmates and visitors. *Journal of Criminal Justice*, vol. 52, p. 57-67

Moore, E. O. (1981). A prison environment's effect on health care service demands. *Journal of Environmental Systems* 11 (1): 17-34.

Moran, D & J Turner (2019) Turning over a new leaf: The health-enabling capacities of nature contact in prison *Social Science and Medicine* 231 62-69

Moran, D (2019) Back to nature? Attention Restoration Theory and the restorative effects of nature contact in prison *Health & Place* 57 35-43

Moran, D, P I Jones, J A Jordaan & A E Porter (2021a) Does nature contact in prison improve wellbeing? Mapping land cover to identify the effect of greenspace on self-harm and violence in

prisons in England and Wales. *Annals of the American Association of Geographers* 111 (6): 1779-1795 DOI:10.1080/24694452.2020.1850232

Moran, D, P I Jones, J A Jordaan & A E Porter (2021b) Nature contact in the carceral workplace: Greenspace and staff sickness absence in prisons in England and Wales. *Environment and Behavior* DOI:00139165211014618

Moran, D, P I Jones, J A Jordaan & A E Porter (2022) Does prison location matter for prisoner wellbeing? The effect of surrounding greenspace on self-harm and violence in prisons in England and Wales. *Wellbeing, Space and Society*

Nadkarni, N.M., Hasbach, P.H., Thys, T., Crockett, E.G., and L. Schnacker. 2017. Impacts of nature imagery on people in severely nature-deprived environments. *Frontiers in Ecology and the Environment* 15:395-403.

Patel, V., Flisher, A.J., Hetrick, S. & McGorry, P. (2007) Mental health of young people: A global public-health challenge. *The Lancet*, vol. 369(9569), p. 1302-1313

Pickard, H. (2015) Self-harm as violence: When victim and perpetrator are one. In: Marway, H., Widdows, H. (eds.) *Women and violence. Genders and sexualities in the social sciences*. Palgrave Macmillan, London

Pritchard A, Richardson M, Sheffield D and McEwan K (2020) The Relationship Between Nature Connectedness and Eudaimonic Well-Being: A Meta-analysis. *Journal of Happiness Studies* 21(3): 1145-1167.

Quick, E., Iselin, A-M., DeCoster, J. & Fasone, H. (2023) Pre-prison and indigenous predictors of institutional misconduct. *International Journal of Offender Therapy and Comparative Criminology*, vol. 67(1), p. 105-125

Reddon, J. R., & Durante, S. B. (2019). Prisoner exposure to nature: Benefits for wellbeing and citizenship. *Medical Hypotheses*, 123, 13-18.

Reidy, T.J. & Sorensen, J.R. (2018) The influence of sentence length on the commission of serious and violent prison infractions by female inmates. *Criminal Justice and Behavior*, vol. 45.9, p. 1420-1434

Sang, Å. O., Knez, I., Gunnarsson, B., & Hedblom, M. (2016). The effects of naturalness, gender, and age on how urban green space is perceived and used. *Urban Forestry & Urban Greening*, 18, 268-276.

Schenk, A.M. & Fremouw, W.J. (2012) Individual characteristics related to prison violence: A critical review of the literature. *Aggression and Violent Behavior*, vol. 17, p. 430-442

Slade K. (2017) Dual harm: An exploration of the presence and characteristics for dual violence and self-harm. *Journal of Criminal Psychology*, vol. 8(2), p. 97-111

Steiner, B. (2016) Measuring and explaining inmate misconduct. Chapter in Wooldredge, J. & Smith, P. (2016) *The Oxford Handbook of Prisons and Imprisonment*.

Steiner, B., Butler, H.D. & Ellison, J.M. (2014) Causes and correlates of prisons inmate misconduct: A systematic review of the evidence. *Journal of Criminal Justice*, vol. 42, p. 462-470

Twill, S. E., Purvis, T., & Norris, M. (2011). Weeds and seeds: Reflections from a gardening project for juvenile offenders. *Journal of Therapeutic Horticulture*, 21(1), 6-17.

Toman, E.L., Cochran, J.C., Cochran, J.K. & Bales, W.D. (2015) The implications of sentence length for inmate adjustment to prison life. *Journal of Criminal Justice*, vol. 43, p. 510-521

Valentine, C. L., Mears, D. P., & Bales, W. D. (2015). Unpacking the relationship between age and prison misconduct. *Journal of Criminal Justice*, 43(5), 418-427.

Van der Linden, S. (2015) Green prison programmes, recidivism and mental health: A primer. *Criminal Behaviour and Mental Health*, vol. 25, p. 338-342

Wolff, N. (2016) A general model of harm in correctional settings. Chapter in Wooldredge, J. & Smith, P. (2016) *The Oxford Handbook of Prisons and Imprisonment*

Table 1. Effects of Greenspace & prison(er) characteristics on self-harm and violence

	1	2	3	4	5	6	7	8	9	10	11	12
	Dependent variable: Self-harm			Stand. Beta coefficients	Dependent variable: violence amongst prisoners			Stand. Beta coefficients	Dependent variable: violence towards prison staff			Stand. Beta coefficients
Greenspace	-0.40 b (0.16)	-0.36 b (0.16)	-0.50 a (0.18)	-0.34	-0.12 a (0.04)	-0.11 a (0.04)	-0.11 b (0.05)	-0.12	-0.06 a (0.029)	-0.06 b (0.03)	-0.06 b (0.03)	-0.19
High % unsentenced	0.06 (0.05)	0.04 (0.05)			0.05 a (0.01)	0.05 a (0.01)	0.06 a (0.01)		0.012 (0.009)	0.017 c (0.009)	0.016 c (0.009)	0.13
Age 18-21	0.26 b (0.10)	0.33 a (0.10)	0.26 a (0.12)	0.21	0.49 a (0.12)	0.50 a (0.12)	0.45 a (0.11)	0.50	0.09 a (0.03)	0.09 a (0.03)	0.10 b (0.039)	0.37
Age 22-29	0.52 b (0.22)	0.57 b (0.21)	0.64 b (0.24)	0.27	0.38 a (0.08)	0.39 a (0.08)	0.39 a (0.08)	0.24	0.14 a (0.035)	0.13 a (0.03)	0.11 b (0.04)	0.21
% British nationality	0.28 a (0.07)				0.06 (0.04)		0.08 b (0.03)	0.075	0.008 (0.02)			
Ethnic fractionalisation		-0.31 b (0.12)	-0.37 a (0.11)	-0.25		-0.02 (0.05)				0.04 (0.027)		
Average length sentence	-0.06 (0.05)	-0.05 (0.05)			0.003 (0.01)	0.007 (0.01)				-0.02 b (0.008)	-0.017 b (0.009)	-0.15
Low_outside	0.002 (0.14)	0.05 (0.14)			0.05 (0.04)	0.054 (0.04)				0.01 (0.02)		
Difficulty_visits	1.10 b (0.55)	1.21 b (0.53)	1.14 b (0.51)	0.19	0.34 (0.22)	0.35 c (0.21)				0.13 (0.09)		
Female prison	0.64 a (0.20)	0.63 a (0.20)	0.50 a (0.18)	0.35								
Young Offender Institute					0.33 a (0.12)	0.33 a (0.12)	0.36 a (0.11)	0.43				
High Security					-0.06 a (0.02)	-0.054 a (0.02)	-0.05 a (0.015)	-0.08				
Cat C trainer									-0.03 (0.009)	-0.028 c (0.01)	-0.024 b (0.01)	-0.21
Century old			-0.13 b (0.06)	-0.25			-0.013 (0.015)				0.007 (0.01)	
Opcap_pop			-0.01 (0.07)				-0.006 (0.02)				-0.013 (0.01)	
Nr of prisoners			-0.07 (0.06)				0.007 (0.01)				-0.008 (0.01)	
F	4.84 (0.00)	4.64 (0.00)	5.48 (0.00)		25.23 (0.00)	28.15 (0.00)	26.57 (0.00)		7.55 (0.00)	9.25 (0.00)	7.08 (0.00)	
R-square	0.40	0.41	0.45		0.84	0.84	0.85		0.49	0.51	0.50	
Nr. of obserations	0.89	89	90		95	95	96		94	94	93	

Robust standard errors in parentheses. a $p < 0.01$, b $p < 0.05$, c < 0.10 . Standardised beta coefficients apply to the models underlying columns (3), (7) and (11).

Table 2. Effects of Greenspace & prison(er) characteristics on self-reported indicators of well-being

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Dependent variable: Mental health & emotional problems				Stand. Beta coeff.	Dependent variable: pc1_mental health		Stand. Beta coeff.	Dependent variable: unsafe & not respected		Stand. Beta coeff.	Dependent variable: pc1_multidimensional		Stand. Beta coeff.
Greenspace	-0.14 b (0.05)	-0.13 b (0.05)	-0.10 b (0.05)	-0.14 b (0.05)	-0.23	-2.52 a (0.68)	-1.68 b (0.74)	-0.24	-0.18 b (0.09)	-0.17 b (0.07)	-0.21	-1.76 b (0.90)	-2.43 b (1.07)	-0.32
High % unsentenced		0.04 b (0.02)	0.03 (0.019)	0.035 c (0.019)	0.16		0.60 a (0.21)	0.23						
Age 18-21		-0.10 a (0.03)	-0.05 c (0.03)	-0.06 b (0.03)	-0.14		-0.68 (0.54)			0.16 a (0.05)	0.23			
Age 22-29		-0.06 (0.08)	-0.003 (0.07)	-0.08 (0.07)			3.39 a (1.03)	0.27						
% British nationality		0.19 a (0.04)					2.54 a (0.59)	0.33					1.28 b (0.51)	0.15
Ethnic fractionalisation			-0.17 a (0.04)	-0.19 a (0.04)	-0.31					0.23 a (0.07)	0.28			
Average length sentence		-0.02 (0.014)	-0.01 (0.02)											
Low_outside		-0.015 (0.04)	0.004 (0.04)											
Difficulty_visits		0.13 (0.17)	0.19 (0.17)											
Female prison	0.26 a (0.03)	0.24 a (0.03)	0.23 a (0.03)	0.20 a (0.02)	0.56	0.75 c (0.46)	0.74 b (0.38)	0.18						
Local prison	0.06 a (0.02)	0.05 b (0.02)	0.05 b (0.02)	0.04 b (0.02)	0.22				0.12 a (0.03)	0.09 a (0.03)	0.27	0.65 c (0.34)	0.48 (0.33)	
High security									0.11 a (0.03)	0.08 b (0.03)	0.15	1.17 a (0.32)	0.88 b (0.33)	0.17
Cat C trainer														
Century old				-0.035 b (0.017)	-0.15					0.05 c (0.027)	0.16			
Opcap_pop				-0.05 a (0.017)	-0.17		-0.42 b (0.23)	-0.11		-0.09 a (0.02)	-0.25		-1.16 a (0.42)	-0.28
Nr of prisoners														
F	29.85 (0.00)	18.53 (0.00)	19.13 (0.00)	19.53 (0.00)		7.343 (0.00)	9.91 (0.00)		15.05 (0.00)	13.71 (0.00)		9.48 (0.00)	6.18 (0.00)	
R-square	0.52	0.66	0.65	0.70		0.15	0.43		0.29	0.50		0.20	0.28	
Nr. of observations	103	96	96	95		95	89		96	89		96	94	

Robust standard errors in parentheses. a p<0.01, b p<0.05, c p<0.10. Standardised beta coefficients apply to the models underlying columns (4), (7), (10) & (13)

Table 3. Self-harm, prison violence and prisoner wellbeing

Dep variable	Self-harm	Violence amongst prisoners	Violence towards staff
Mental health	0.89 a (0.31)	0.27 a (0.09)	0.10 b (0.04)
Pc1_mental health	0.06 a (0.015)	0.04 a (0.007)	0.01 a (0.003)
Unsafe & not respected	0.27 (0.15) c	0.17 a (0.06)	0.08 a (0.025)
Pc1_multidimensional	0.044 a (0.012)	0.014 c (0.008)	0.008 b (0.003)

Robust standard errors in parentheses. a $p < 0.01$, b $p < 0.05$, c $p < 0.10$. Rows report coefficients of bivariate regressions of self-harm and violence on self-reported indicators of wellbeing.

Table 4. Greenspace, mental health, self-harm and violence: OLS and 3SLS results

	1	2	3	4	5	6
Estimator	OLS	3SLS	OLS	3SLS		
Dep. variable	Self-harm	Self-harm	Violence amongst prisoners	Violence amongst prisoners	Violence towards prison staff	Violence towards prison staff
Greenspace	-0.49 b (0.20)	-2.70 b (1.10)	-0.12 a (0.04)	-0.17 a (0.04)	-0.07 a (0.02)	-0.08 a (0.02)
Mental health	0.57 c (0.32)	-3.94 b (1.79)	0.14 b (0.07)	0.06 (0.11)	0.08 b (0.04)	-0.02 (0.16)
High % unsentenced			0.04 a (0.01)	0.04 b (0.02)		
Age 18-21	0.32 a (0.11)	0.01 (0.19)	0.51 a (0.11)	0.51 a (0.09)	0.17 a (0.02)	0.16 a (0.03)
Age 22-29	0.50 b (0.21)	0.16 (0.33)	0.35 a (0.08)	0.33 a (0.09)	0.13 b (0.04)	0.13 a (0.04)
% British nationality	0.17 b (0.08)	0.72 b (0.35)				
Average length sentence					-0.02 a (0.008)	-0.02 a (0.007)
Low_outside			0.08 b (0.04)	0.08 b (0.04)		
Difficulty_visits	1.05 b (0.49)	2.79 b (1.41)	0.37 c (0.19)	0.36 b (0.15)		
Opcap_pop					-0.03 a (0.013)	-0.02 c (0.013)
Chi^square 1 st stage (3SLS)		49.91		63.03		51.28
Chi^2 2 nd stage (3SLS)		16.27		11.09		10.04
R-square (OLS) Chi^2 square (3SLS)	0.44	24.35	0.87	613.45	0.56	125.19
N	89	89	91	91	91	91

Robust standard errors in parentheses. a p<0.01, b p<0.05, c p<0.10. Only variables are reported that carry significant coefficients in (some of the) estimations. Estimations also include the other control variables underlying Table 1.

Table 5. Greenspace, pc1_mental health, pc1_multidimensional, self-harm and violence: summary of OLS & 3SLS results

	1	2	3	4	5	6	7	8	9	10	11	12
Dep variable	Self-harm				Violence amongst prisoners				Violence towards prison staff			
Estimator	OLS	3SLS	OLS	3SLS	OLS	3SLS	OLS	3SLS	OLS	3SLS	OLS	3SLS
Greenspace	-0.40 a (0.14)	-0.80 b (0.40)	-0.24 b (0.11)	0.47 (0.42)	-0.10 b (0.04)	-0.09 b (0.0045)	-0.11 a (0.04)	-0.26 b (0.13)	-0.07 b (0.03)	-0.024 (0.06)	-0.06 b (0.03)	-0.18 b (0.07)
Pc1_mental health	0.035 a (0.016)	-0.01 (0.07)			0.02 a (0.006)	0.06 b (0.03)			0.008 b (0.004)	0.06 a (0.02)		
Pc1_multidimensional			0.018 (0.014)	0.17 a (0.06)			0.005 (0.006)	0.01 (0.01)			-0.008 (0.03)	-0.04 (0.023)
Chi ² 1 st stage (3SLS)		44.31		40.28		59.14		49.15		74.07		68.00
Chi ² 2 nd stage (3SLS)		11.98		17.39		12.02		18.00		10.60		16.08
R-square (OLS) Chi ² square (3SLS)	0.49	75.49	0.41	78.86	0.85	541.01	0.84	435.77	0.55	68.90	0.48	73.24
N	87	87	86	86	95	95	95	95	93	93	92	92

Robust standard errors in parentheses. a p<0.01, b p<0.05, c p<0.10.

Figure 1. Drivers of prisoner wellbeing

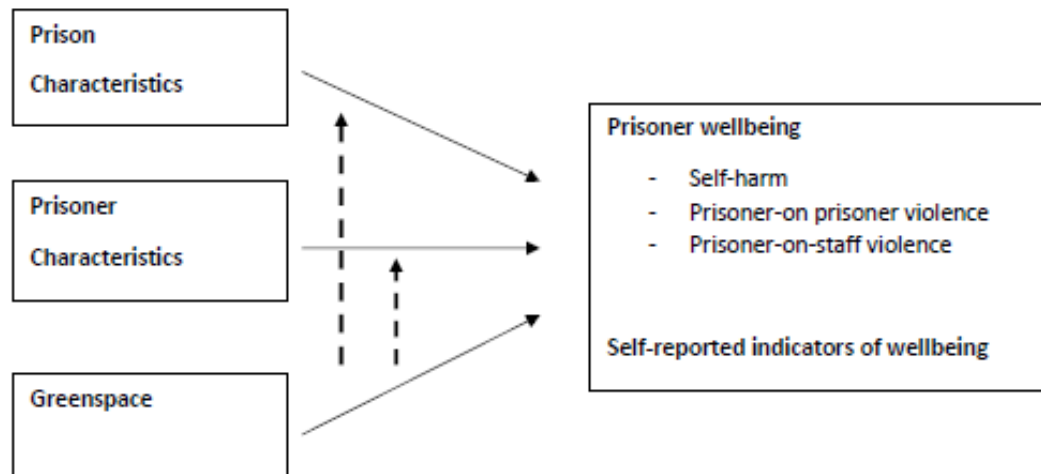


Figure 2. Predictive margins of interaction between greenspace and high % unsentenced prisoners

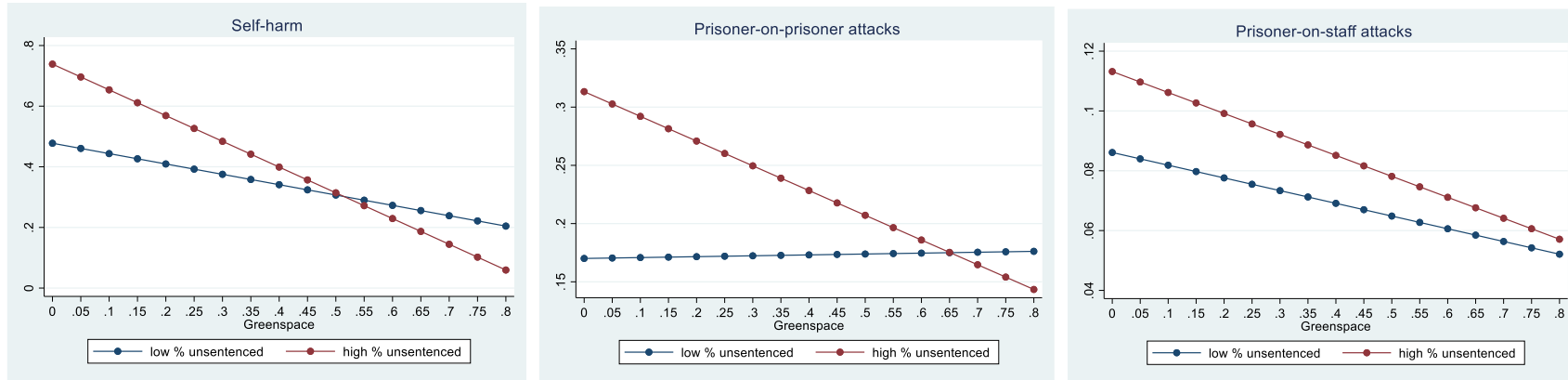


Figure 3. Predictive margins of interaction between greenspace and % prisoners age 18-21

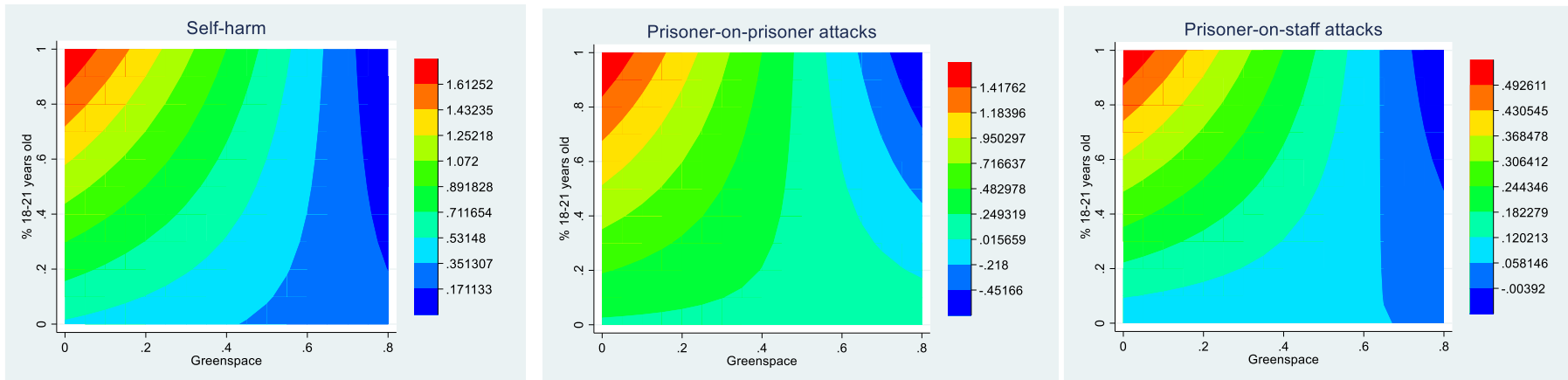


Figure 4. Predictive margins of interaction between greenspace and high % of unsentenced prisoners

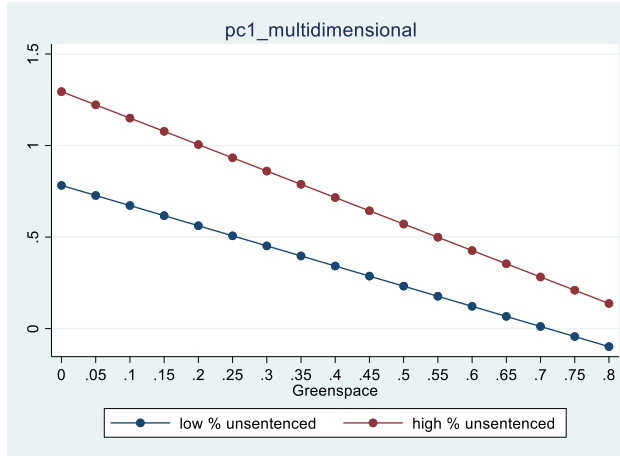
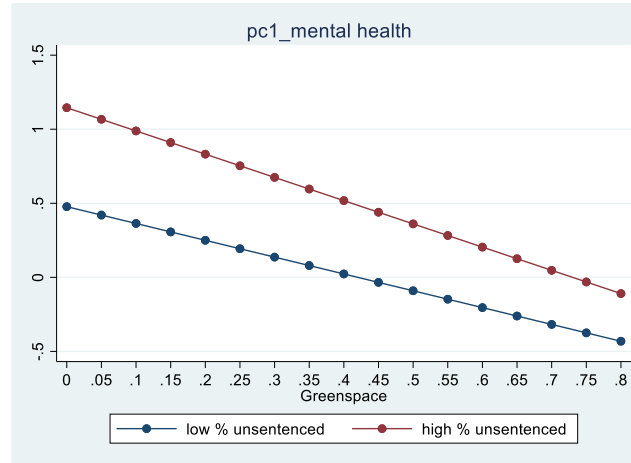
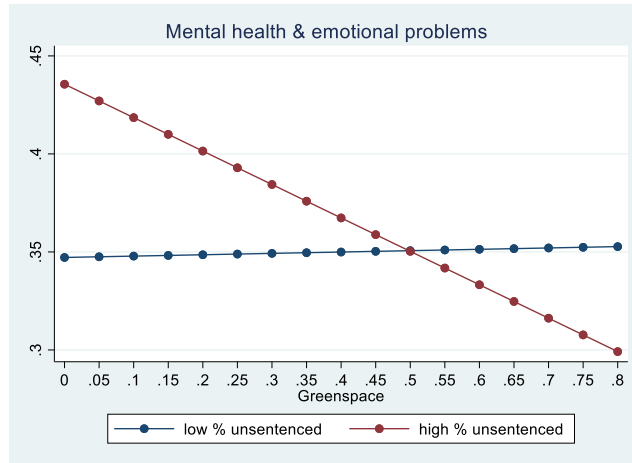


Figure 5. Predictive margins of interaction between greenspace and % prisoners age 18-21

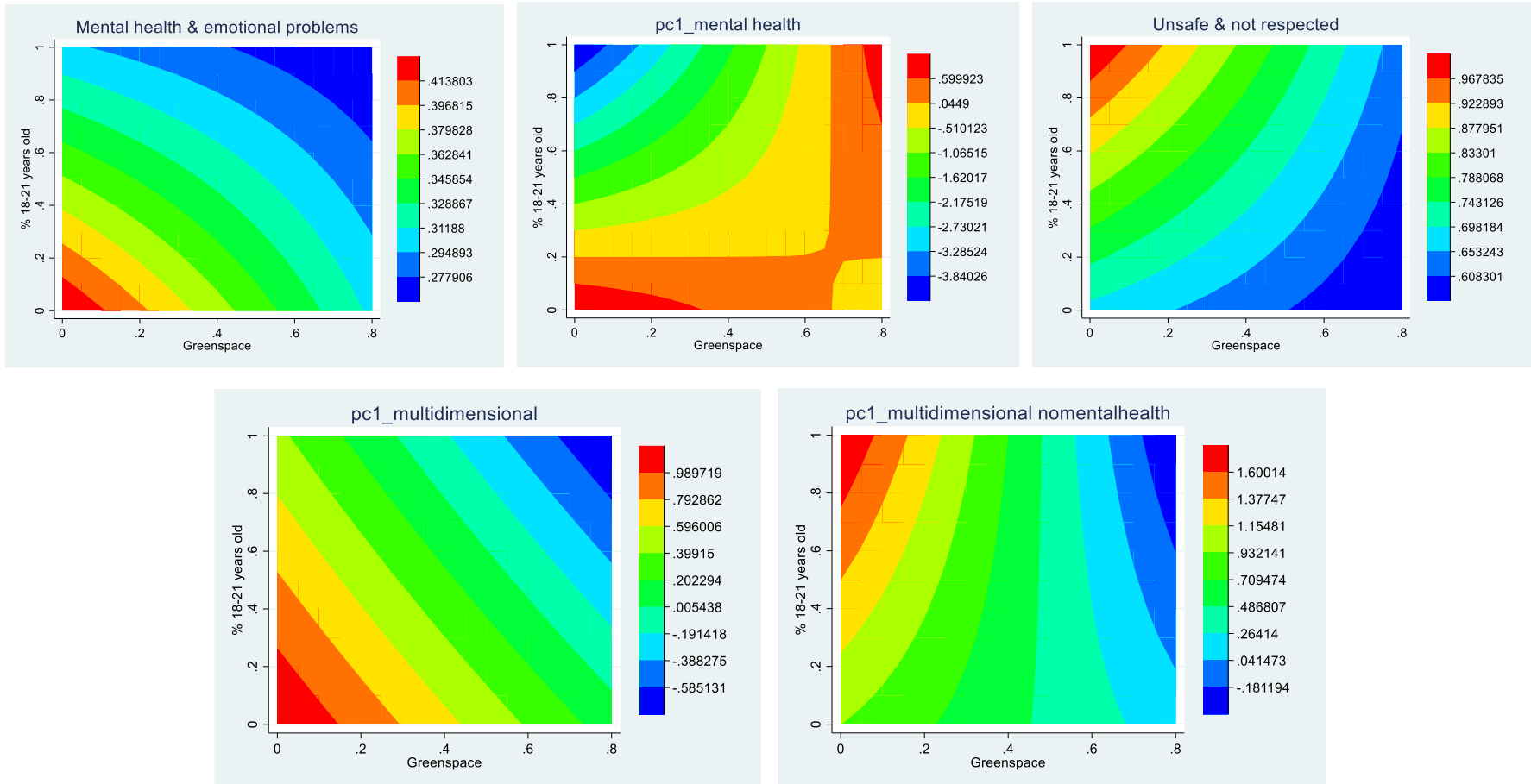


Figure 6. Predictive margins of interaction between greenspace and overcrowding

