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# The relationship between inpatient mental health ward design and aggression

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ABSTRACT

*Purpose:* This study aimed to examine the relationship between the physical design of mental health care facilities and the occurrence of aggressive behaviour.
*Methods:* A cross-national survey including a large number of forensic and non-forensic inpatient wards (n = 101) across seven National Health Service (NHS) trusts was conducted. A detailed Ward Features Checklist was designed and completed for each ward. These ward features were then compared on two dimensions with records of aggressive incidents on the wards. Clinical ward staff on participating wards (n = 191) also completed an online survey including questions from the Work Safety Scale (WSS) to assess subjective perceptions of safety at work.
*Results:* Physical aggression was associated with higher staffing and greater space availability (Ward Features Checklist Dimension 1: Incident Rate Ratio = 2.19); and increased comfort and facilities and external views of urban environments (Ward Features Checklist Dimension 2: Incident Rate Ratio = 1.24).
*Conclusion:* The findings here are amongst the first to challenge ideas about the relationship between staff-patient ratios, certain space characteristics and aggressive incidents. The observed associations are, however, underpinned by complex organisational and relational factors which need to be further explored to fully understand the overall context. There are implications for service user and staff safety training initiatives and for future mental health ward design.

## 1. Introduction

The majority of assaults on UK National Health Service (NHS) staff occur in mental health or learning disability settings (data from 2013/14, NICE guidance, 2015). The rate in this setting is more than double the number of assaults perpetrated against general hospital or ambulance staff which are already at problematic levels. The ward physical environment is often cited anecdotally by service users and professionals as a core contributing factor to the high levels of aggression within inpatient mental health settings. The NICE (2015) guideline for reducing aggression in inpatient wards recommends that the environment should be optimised by unlocking doors when possible; having a simple layout and enhanced decoration; and offering access to outside space and privacy. Despite such recommendations, a Care Quality Commission report (CQC, 2017) cited the poor physical environment as one of the most common safety concerns. The CQC found current inpatient wards were not designed sufficiently to meet service user needs and did not always allow for adequate observation.

Incidents of aggression on mental health inpatient wards may have wide ranging implications for service user and staff perceived safety (Haines, Brown, McCabe, Rogerson, & Whittington, 2017); therapeutic interactions and decisions made regarding care (Duxbury, 2002); service user and staff wellbeing (Papoulias, Csipke, Rose, McKellar, & Wykes, 2014); as well as potential economic costs associated with subsequent

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staff absences (recruiting bank staff, legal fees etc.)

The relationship between the physical environment and therapeutic (or more negative) outcomes is complex. There have been recent attempts to identify the key architectural elements which might influence outcomes such as aggression (Ulrich, Bogren, Gardiner, & Lundin, 2018) and to provide recommendations for designing specific types of hospital services such as forensic wards (Seppanen, Tormanen, Shaw, & Kennedy, 2018). However, the association between specific ward features and inpatient aggression remains unclear and this is reflected in the current, inconclusive literature base. There are a number of reasons as to why the current research base is not conclusive, despite the need for greater understanding in this area. Given the complex, multi-faceted nature of the ward environment it is near impossible to attribute causality. The majority of research is reactive to ward refurbishments during which multiple design features are changed simultaneously with few or no controls for confounding variables. Daffern et al. (Daffern, Mayer, & Martin, 2004) also highlight the potential for researcher bias when investigating the ward environment and how current methods may ignore important contextual factors. Some studies also measure proxy variables, for example the number of seclusions, which may not be valid indicators of aggression.

### 1.1. Ward characteristics and their potential impact on inpatient aggression

Despite these limitations, existing research provides some evidence to support the association between locked wards and inpatient aggression (Ulrich et al., 2018). For example, Duxbury (2002) estimated that approximately one quarter of incidents were as a result of environmental restrictions. Bowers (2009) also found this to be a factor in aggressive incidents. Other environmental factors are more relational, for example observability (Bowers, 2009; Shepley et al., 2016; Tyson, Lambert, & Beattie, 2002). This suggests that certain ward designs may prevent staff from adequately observing service users, which could subsequently prevent early detection or de-escalation of aggressive incidents. Conversely, wards which allow for excessive observation may infringe on service user's privacy, which could also exacerbate aggression.

More modern ward designs tend to favour large open day areas, in which nurse stations are situated centrally and facilitate better observation (Karlin & Zeiss, 2006; Shepley et al., 2016). It is possible, however that this could increase irritation due to noise and disturbance. Very specific interior design features such as the homely arrangement of furniture and the provision of plants and representational rather than abstract art decoration have been recommended to facilitate therapeutic interaction and reduce aggression (Jovanovic, Campbell, & Priebe, 2019; Ulrich et al., 2018).

Access to outdoor space is a highly valued ward feature; Shepley et al. (2016) emphasised the importance of both visual and physical access to outdoor space. It has also been identified as important for recovery and social interaction (Parr, Philo, & Burns, 2003). Other studies however, report that access to outdoor space did not decrease aggression (Nijman & Rector, 1999) and that its presence may be linked to seclusion rates (Van der Schaaf, Dusseldorp, Keuning, Janssen, & Noorthoorn, 2013). This may be due to a number of factors, including the limited staff availability to escort service users accessing outdoor areas.

Ward capacity, and specifically person density, is highlighted in the literature as an important correlate of inpatient aggression (Brooks, Mulaik, Gilead, & Daniels, 1994; Ng, Kumar, Ranclaud, & Robinson, 2001). It has also been linked to seclusion rates when more service users are in the building (Van der Schaaf et al., 2013). Although capacity is largely dictated architecturally by bed numbers, the relational and dynamic context created through having more service users and, subsequently more staff present on the wards, is more difficult to capture.

A number of studies have examined lighting on inpatient wards and there is a general recommendation for natural lighting (Shepley et al., 2016) that is soft and indirect (Karlin & Zeiss, 2006). Research examining the relevance of lighting, however is generally inconclusive (Evans, 2003) and further research is required to determine its association, if any, with inpatient aggression.

Similarly, there is limited research examining the relationship between inpatient aggression and noise. Bowers et al. (2011) did, however identify noise as one of the environmental antecedents to aggressive incidents on inpatient wards. There is a suggestion that prolonged exposure to noise may also be linked to staff burnout and there are recommendations for single occupancy rooms (Stichler, 2007) and the creation of spaces that reduce noise reverberation (Karlin & Zeiss, 2006) to reduce this problem.

### 1.2. Forensic and non-forensic inpatient wards

Standards for the physical design of forensic mental health wards have been published (RCPSYCH, 2014), but these mainly relate to enhancing security rather than the therapeutic impact of services, e.g. gate locks, ceiling design. General and forensic mental health wards may share some relevant characteristics but factors may also differ between the two environments. In addition, there is evidence that staff on forensic wards feel less safe at work than staff on non-forensic (acute) wards, despite acute wards recording higher levels of aggression than forensic wards in the previous six months (Haines et al., 2017). A report by the Care Quality Commission (CQC, 2017) identified acute wards as particularly high risk and attributed this to a number of factors including the high threshold of distress to warrant admission, which may affect interactions and subsequently levels of aggression. The average admission to an acute ward is 33 days (NHS Benchmarking Network, 2016), whilst that in secure settings is often more than a year and may be much longer (Rutherford & Duggan, 2008). Consequently, the ward dynamic on acute wards is consistently changing. The relevance of physical design to aggression rates in forensic and non-forensic wards will be examined further below.

### 1.3. Study aims

The aim was to examine the association between ward design characteristics and recorded inpatient aggression in forensic and non-forensic wards; in particular to test whether wards with characteristics previously shown to be linked to violence (e.g. high capacity/density, restricted space/locked wards, restricted observability, etc.) have higher levels of inpatient aggression, in comparison to wards without these features.

## 2. Materials and methods

### 2.1. Design, sampling and procedures

A cross-sectional design was adopted with ward as the unit of analysis. In total, 101 forensic and general adult mental health wards from 15 units over seven NHS trusts in England were included. These wards were selected to provide a comprehensive sample of mental health wards across the country. The sample includes some wards designed specifically for people with dementia or substance misuse but most wards provided care for patients with comorbid psychiatric disorders. Most forensic wards with a specified security level were designated as a Medium Secure Unit (MSU) which provides an intermediate level of security between high and low security units. All wards in the sample would have aspired to follow evidence-based best practice entailing a philosophy of trauma informed care and a combination of psychological and pharmacological treatment. Every patient will have had a named nurse allocated to lead on their care during any particular shift although they are free to interact with all available nurses during this time. Each ward was visited by a team of two researchers who recorded this information using a structured questionnaire, the Ward Features Checklist (Haines et al., 2017). The trust was also contacted by the researchers and

recorded aggressive incident data for each ward was requested. In addition, the link to an online survey questionnaire (including the questions from the Work Safety Scale (Hayes, Perander, Smecko, & Trask, 1998)) was circulated to enable assessment of staff perceived safety at work. Ward managers were asked to distribute the survey link to their staff by email. The staff population across all 101 wards was estimated to be approximately 1860 based on standard configurations and 191 responses were received (estimated 10.3% response rate) with an average of 1.89 responses per ward (including the wards with no returns). A mean safety score per ward was calculated based on the individual responses.

The study was granted ethical approval by the University of Liverpool ethics committee (ref: IPHS-1314-268) and was conducted between May 2014 and May 2015. Research governance approval was obtained for all participating trusts.

### 2.2. Measures: independent variables

#### 2.2.1. The Ward Features Checklist (WFC, Haines et al., 2017) (Appendix A)

The WFC was created by the research team to capture ward characteristics and consists of features identified through a review of the existing evidence base and in consultation with specialists in mental health ward design.

The WFC consists of 49 variables, 2 addressing researcher information (i.e. ID code, time and date of extraction) and 47 ward characteristics, as follows:

- n = 40 relating to physical environment - architectural, ambient and interior features such as temperature (°C), air flow (m/s) and ventilation type, light (Lux), noise (db), physical space of relevant areas ($m^2$), access to toilets, type of flooring, number and type of windows, views, walls' colours, room brightness (fc), and patients' ability to control the environment (e.g. open windows, change temperature, lock/unlock bedroom doors); and
- n = 7 relating to other, more general ward characteristics (i.e. ward function, service user gender, average length of stay, staff and service user occupancy).

The checklist was piloted on a mental health ward to assess its feasibility and certain validity aspects. Wall colour was categorised based on subjective assessment by the raters. The inter-rater reliability exercise between individual raters was considered inadequate for the pilot, so it was decided that the checklist would be completed by two researchers separately on each ward, then results agreed on the basis of discussion between the two raters.

The majority of data collection (e.g. colour scheme, number of rooms) was based on visual observation by each rater, but the following equipment was used for certain features:

- Laser distance estimator and tape measure – to capture ward dimensions and availability of space (in $m^2$) for the main communal day area and one standard bedroom for each ward. Researchers agreed standardised principles of estimation when architectural features such as curved wall and ceilings were present.
- Light meter – to record levels of natural light (in *Lux*). Two readings were taken in the middle of the dayroom with artificial lighting turned on and off respectively.
- Sound meter – to assess noise levels (in *dB*). Three readings at 10 min intervals in the middle of the dayroom. The standardisation procedures used for assessing sound were adhered to.
- Thermometer – to record ward temperature (in $^{\circ}C$) compared to the outside temperature.

#### 2.2.2. Work Safety Scale (WSS, Hayes et al., 1998)

The WSS (Hayes et al., 1998) is a 50 item validated measure consisting of five constructs relevant to staff perceptions of safety: (1) job safety, (2) co-worker safety, (3) supervisor safety, (4) management safety practices, and (5) satisfaction with safety policies/programs.

The WSS is reported to possess adequate psychometric properties (Hayes et al., 1998) including acceptable internal consistency and convergent and discriminant validity. Respondents rated their agreement with a series of statements on a five point Likert scale, ranging from 'Strongly Disagree' to 'Strongly Agree'. Higher scores on the WSS indicate a stronger sense of perceived safety at work for each of the above mentioned dimensions.

### 2.3. Outcome variable: recorded aggressive incidents

Official NHS incident data for each participating ward was provided for the six months prior to the researchers' data collection point. Aggression was defined as verbal aggression, physical aggression or property damage. Due to difficulties accessing data for a number of wards (n = 17), these were subsequently excluded from the final analysis. The incident data requested was anonymous and aggregated for each ward, detailing only the category of aggression (i.e. physical, verbal or property damage) and number of perpetrators per ward.

### 2.4. Statistical analyses

#### 2.4.1. Categorical principle component analysis (CATPCA, Linting et al., 2007)

CATPCA was conducted on the data to identify robust and meaningful factors and to reduce the 47 features (independent variables) relating to the ward environment into dimensions, thus reducing the complexity of the regression analysis. By utilising this technique, ward features with different levels of measurement could be included and, without assuming a linear relationshop between variables, those that were highly correlated (i.e. those with a strong tendency to occur together) were identified. Features were excluded from the analysis where 85% or more wards returned the same value (low variation across the wards). The remaining ward features were then grouped into 2 component dimensions (identified in the analysis with an Eigenvalue >1). Forty four per cent of the variance in the WFC was explained by these two dimensions explained. The two dimensions were related to the outcome variable in the regression model. The WFC features that did not fit into the two dimensions were entered into the regression model as individual variables. Table 1 below lists the ward features/independent variables included in each of the 2 dimensions, entered individually or excluded from the model.

1) Staffing and space (Eigenvalue = 3.353)

A high score on this dimension represents: fewer beds; higher staff to service user ratios on day and night shifts; more dayroom and bedroom space per service user; and more toilets per service user.

2) Comfort and facilities (Eigenvalue = 2.314)

A high score on this dimension can be interpreted as: higher indoor temperature; lower noise levels; fewer rooms open to service users in the day; the opportunity to participate in games with other service users (dichotomous response); access to Occupational Therapy; type of flooring; and ward currently below service user capacity.

These two dimensions and ten individual variables were then entered into a negative binomial regression analysis.

#### 2.4.2. Regression

Regression models were fitted to analyse the relationship between the independent variables and number of aggressive incidents.

Three models were fitted, one for each type of aggression (rates of verbal aggression, physical aggression and property damage). The

**Table 1**
CATPCA and WFC features/independent variables.

| Dimension 1: Staffing and Space | Dimension 2: Comfort and Facilities | Variables Entered Individually | Excluded Variables |
|---|---|---|---|
| • Fewer beds<br>• Higher staff patient ratios (dayshift)<br>• Higher staff patient ratios (nightshift)<br>• More dayroom space per patient<br>• More bedroom space per patient<br>• More toilets per patient | • Higher temperatures<br>• Quieter noise levels<br>• Fewer rooms open to patients in the day<br>• Opportunity for patients to play games together<br>• Occupational therapy<br>• The type of flooring<br>• Below full capacity of operation | • Brightness inside the ward<br>• View from the ward<br>• Patient gender<br>• Average length patient stay<br>• Average ceiling height<br>• Patients have own toilet<br>• Number of windows<br>• Main colour of walls<br>• Patient can open windows<br>• Patients can control temperature | • Staff have own toilets<br>• Year of last refurbishment<br>• Year of last redecoration<br>• Floor level (Ground floor/ upper floor)<br>• Single gender toilets<br>• Patients have single rooms<br>• Bedrooms can be locked by patients<br>• Entertainment Available (TV/ DVD/Computer Games) |

analysis used negative binomial regressions as the dependent variables were non- normally distributed count variables. Independent variables were entered into the model by forward selection, adding one variable at a time and examining its contribution to the prediction of the dependent variable. Variables that made a significant contribution ($p < .05$) remained in the model and insignificant variables were removed.

## 3. Results

### 3.1. Descriptive statistics: levels of aggression

Table 2 outlines the mean recorded incident numbers by aggression category for forensic and non-forensic general adult acute wards. Forensic wards recorded significantly lower levels of physically and verbally aggressive incidents than non-forensic/acute wards. Overall, single sex wards had significantly higher levels of verbal aggression than mixed sex wards; however this difference from mixed sex wards was statistically significant for male only wards.

In relation to property damage, there were fewer significant differences between ward types; only MSU wards had significantly lower levels of aggression related to property than acute wards.

### 3.2. The association between ward characteristics and aggressive incidents

Table 3 presents the results of three regression models, one for each incident type. The table shows the estimated effects of the independent variables by type of incident when all other variables in the model are controlled for. The models predict the count of incidents recorded on each ward. Patient capacity was used as an offset variable to account for variations in ward size; this effectively produced a model to predict the rates of incidents per service user space. The beta co-efficients reflect the degree of change predicted in the dependent variable for every 1 unit change in that variable if all other variables remain constant. To aid interpretation, the co-efficients have been exponentiated to produce Incident Rate Ratios (IRR) which can be interpreted as the rate of change in the outcome incidents following a unit increase in a predictor variable calculated as a factor of (IRR-1) * 100. For example, an IRR of 2.0 indicates that for each unit increase in the predictor variable, the rate of the incidents increases by 100%.

**Table 2**
Recorded aggressive incidents by ward type ($\bar{x}$, SD).

| | Forensic wards (N = 57) | Non-forensic wards (N = 41) |
|---|---|---|
| Physical incidents* | 16.21 (18.81) | 54.66 (102.29) |
| Verbal incidents | 26.79 (53.31) | 35.07 (51.88) |
| Property incidents | 3.14 (5.22) | 3.87 (5.6) |

*$p < .05$.

The three interval variables (the two ward features dimensions, staffing and space and comfort and facilities, and the Average Work Safety Scale (WSS) score have been standardised such that a 1 unit change represents an increase or decrease of 1 SD from the mean. This enables comparison of the relative influence of variables measured on different scales.

Table 3 also provides model fit statistics. The likelihood ratio statistics indicate that all three models improved the prediction of incidents when compared to an empty, intercept only model. The deviance/df and Pearson's $X^2$/df ratios are all close to 1 signifying that the negative binomial distribution was appropriate for all analyses.

#### 3.2.1. Incidents of physical aggression

A higher score on the 'staffing and space' dimension was indicative of significantly higher rates of recorded physical incidents. Specifically, a 1 (SD) increase in dimension score reflected a 119% increase in incident rates ($p < .001$).

Similarly, wards which scored high on the 'comfort and facilities' dimension also had significantly higher rates of physical incidents. The influence of this dimension however was weaker; a 1SD increase in dimension score represented a 24% increase in physical incident rate ($p < .05$). The external view available from the ward was significantly associated with rates of physical incidents. Wards with an external view of both green space and man-made structures recorded significantly higher rates of physical incidents compared to wards with exclusively green space views (123% higher compared to views of 'greenery, $p < .01$).

Significantly lower levels of physical incidents were recorded on wards where staff reported high WSS scores. A 1 SD increase in the average staff WSS score resulted in a predicted decrease in physical incidents of 44% ($p < .05$). Non-forensic wards had significantly higher rates of recorded physical aggression incidents compared to forensic wards (202% higher, $p < .001$).

#### 3.2.2. Incidents of verbal aggression

The verbal incidents model presents similar results to the physical incidents model.

A higher score on the 'staffing and space' dimension was indicative of significantly higher rates of recorded verbal incidents to an even greater extent. This model suggests that a 1 SD increase in the dimension score reflects a 155% increase in recorded verbal incidents ($p < .001$). Unlike the physical incidents model however, the 'comfort and facilities' dimension was not a significant predictor of verbal incidents.

Again, wards with views of exclusively man-made structures and mixed man-made and green space views recorded higher rates of verbal incidents compared to wards with exclusively green space views. Similarly to the physical incidents model, a 1 SD increase in the average staff WSS score resulted in a predicted decrease in verbal incidents of 52% ($p < .05$). As with the model to predict physical aggression, non-forensic wards had significantly higher rates of recorded verbal aggression incidents compared to forensic wards (76% higher, $p < .05$).

#### 3.2.3. Incidents of property damage

As with physical aggression, high scores on the two ward features dimensions were both associated with significant increases in property incidents.

**Table 3**
Summary of the model to predict recorded incidents.

| *Model Predictor* | | Physical Aggression | | | Verbal Aggression | | | Property Incidents | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | B | SE | IRR | B | SE | IRR | B | SE | IRR |
| Ward Function (Base = Forensic) | Non-forensic | 1.106*** | 0.28 | 3.02 | 0.568* | 0.28 | 1.76 | | | |
| Gender of patients (Base = Mixed) | Male | −1.106** | 0.36 | 0.33 | | | | | | |
| | Female | −0.136 | 0.38 | 0.87 | | | | | | |
| View from ward (Base = Greenery) | Concrete/building | 0.713* | 0.33 | 2.04 | 1.015* | 0.43 | 2.76 | | | |
| | Mixed | 0.806** | 0.29 | 2.23 | 0.873* | 0.33 | 2.39 | | | |
| Dimension: Staffing and Space | – | 0.784*** | 0.12 | 2.19 | 0.935*** | 0.13 | 2.55 | 0.847*** | 0.211 | 2.33 |
| Dimension: Comfort and Facilities | – | 0.218* | 0.09 | 1.24 | | | | 0.292* | 0.148 | 1.34 |
| Ward Average WSS | – | −0.584* | 0.28 | 0.56 | −0.737* | 0.3 | 0.48 | −1.078* | 0.536 | 0.34 |
| ***Model Fit Statistics*** | | | | | | | | | | |
| Likelihood Ratio (vs intercept only model) | | 46.17*** | | | 14.5* | | | 16.26** | | |
| Deviance/df | | 1.35 | | | 1.41 | | | 1.00 | | |
| Pearson Chi Square/df | | 0.90 | | | 1.04 | | | 0.95 | | |

*p < .05.
**p < .01.
***p < .001.

The 'staffing and space' dimension was a more powerful predictor with a 1 SD increase predicting a 133% increase in reported property incidents whilst 1 SD increase in the comfort and facilities dimension score predicted a 34% increase in incidents.

As identified in the other models, the WSS score was associated with a significant reduction in property incidents. Property incident rates were lower by a factor of 66% for each SD increase in average WSS. NHS ward function (forensic or non-forensic), gender of service user population and external view from the ward were not significant explanatory variables in the property incident model.

## 4. Discussion

This study explored associations between ward characteristics and inpatient aggression rates across a wide range of mental health wards in NHS settings in England. This aim built on long-standing stakeholder views, policy recommendations and mixed previous evidence regarding ward design and its potential negative influence on inpatient aggression.

Some significant links between aspects of the physical environment and aggression rates were identified. Higher 'staffing and space' dimension scores were indicative of higher reported physical, verbal and property incidents. This particular dimension contains both physical and functional features that may be assumed to be positive ward characteristics: fewer service user beds (and subsequently fewer service users on the ward); higher staff-to-service user ratios (potentially indicating a greater capacity to care for and meet service users' needs quicker); and more physical space per service user (greater room for autonomy and privacy). These results are counter intuitive and do not fit with the majority of research that has linked high ward capacity with inpatient aggression and proxy measures such as number of seclusions (Brooks et al., 1994; Ng et al., 2001). To our knowledge, evidence pointing to an increasing association between staffing levels and incidents has been reported in papers reporting results from the UK City 128 study (Bowers & Crowder, 2012; Kartha & McCrone, 2019). Perhaps a greater staff-to-service user ratio may be a consequence of a greater number of observations taking place reflecting a higher level of service user distress and could affect the ward atmosphere. A higher staff presence may also inadvertently create a particular dynamic in which service users do not feel safe, and this may be reflected in interactions.

It is more difficult to interpret results from the 'comfort and facilities' dimension; higher scores on this dimension were also indicative of higher physical and property incident rates. The variables on this dimension (higher indoor temperature; lower noise levels; fewer rooms with open access (i.e. not locked); opportunity to participate in games; access to Occupational Therapy; type of flooring and ward below service user capacity) do not constitute exclusively positive or negative features, so it is harder to make inferences. The CATPCA technique only identified variables that were closely correlated without regard to how positive or negative these features may be appraised theoretically. Flooring, for example, appears to be a contested ward feature. Carpets have been removed in the communal areas of most wards in line with infection control regulations, however hard flooring may have ramifications in terms of affecting the ward temperature and noise. The findings regarding the comfort and facilities dimension may therefore be useful information for those involved in the design of mental health wards.

Wards with exclusively green or rural views reported significantly less physical and verbal incidents than wards with mixed rural and industrial views. This corroborates the findings of Shepley et al. (Shepley et al., 2016) which demonstrated the importance of visual (as well as physical) access to outdoor space. Rural views may be perceived to be more pleasant and potentially more relaxing than viewing man-made structures (Ulrich et al., 2018). The combination of unimpeded landscape views (prospects) observed from an enclosed space (refuge) has been identified as an aesthetic ideal maximising human wellbeing based on evolutionary principles by Appleton (1975/1996; Dosen & Ostwald, 2016). This research team however previously found that rural views were associated with lower levels of perceived staff safety (Haines et al., 2017).

The results indicate that forensic wards recorded significantly lower rates of physical and verbal aggressive incidents, in comparison to acute (non-forensic) wards in the sample. This may be for a number of reasons. The potential link between the restrictive nature of wards and inpatient aggression has been identified in previous research (Bowers, 2009; Duxbury, 2002). Despite some consistency in restrictive features across both forensic and non-forensic wards, such as locked doors and secure buildings, relationally there are differences. In particular illness acuity and patient turnover rates are higher on acute wards and previous research has identified high service user turnover as being associated with inpatient aggression (Bowers et al., 2009). Forensic wards by their nature may also be provided with greater resources than acute wards, due to the level of perceived risk, which may in turn increase their capacity to prevent inpatient aggression. Another possibility is that staff on forensic wards are not recording all incidents of aggression; this could be attributable to limited time and resources, or to the reporting culture on each ward. These hypotheses would benefit from further exploration.

It is interesting to note that although acute wards recorded higher levels of physical and verbal incidents, mental health staff working on these wards also reported a greater sense of feeling safe at work, compared to staff on forensic wards (Haines et al., 2017). These findings from an occupational setting are incongruent with evidence about the effects of previous victimisation in everyday life. For example, the 2013/14 Crime Survey for England and Wales found that those who had been a victim of a crime in the last year feel more unsafe than those who have not. They are more likely to think that rates of crime have risen; to

have a high level of anxiety regarding crime; and to think they would be a victim of crime again, in comparison to non-victims. This would suggest that there are relational processes in place that affect staff perception of safety at work on acute wards, given the levels of inpatient aggression they are experiencing.

Finally, it is worth noting that higher average WSS scores were associated with lower levels of all aggressive incident types. This measure specifically captures the safety practices of the individual, their co-workers, managers and ward/trust policies. This emphasises the importance of trust and ward policies and procedures; when individuals believe that their organisation takes staff safety seriously this is indicative of increased perceived safety (Haines et al., 2017) and of lower aggressive incident rates.

### 4.1. Limitations

A number of limitations must be considered in interpreting the findings above. With regard to measurement validity, a number of tools (described in the method) were not sensitive enough to accurately capture certain variables on the WFC. For example, tools used to capture space were impeded by curved walls or very high ceilings. In these circumstances, researchers made the measurement as accurately as possible with some agreed principle of estimation. The colour dimension is particularly subjective and no structured system was used here to capture the exact hue or intensity of the feature being recorded. This clearly limits the certainty attached to this important aspect of the study.

The researchers also acknowledge that given the cross-sectional nature of the research design, wards were surveyed at one particular time point which may not necessarily reflect routine practice or climatic conditions for that ward. For example, wards may have been allocated extra staffing in order to facilitate observations when service users are particularly distressed. It is also important to note that the number of staff survey responses were distributed unevenly across all wards and mean safety scores for some wards are based on very small samples. It should also be noted that the overall estimated WSS response rate was 10% and, whilst it was higher than this on some wards, the sample cannot be assumed to be representative of the relevant population. In particular, staff who felt unsafe may have been more likely to have responded when given the opportunity. Changes in both actual and perceived aggression on the wards can be a result of a multitude of confounding variables, such as service user diagnosis and medication, factors that we did not account for. The relationships between environmental ward features and aggression presented here are therefore not causal.

The issues of relevant variables and sample heterogeneity must also be considered when interpreting the findings here. Our research instruments captured many potentially relevant environmental variables on a large number of wards but, as with all scientific investigation of complex social phenomena, there will be many unknown factors which have not been included in our analysis. These factors remain unknown and their exclusion should be borne in mind when considering the models tested here. Similarly, we decided not to test separate models for the forensic and non-forensic wards as there was sufficient commonality between them as forms of highly-structured in-patient mental health services. Whilst this maximised the statistical power of our analysis, we acknowledge also that there is an argument to test separate models in the two settings. Such an alternative analysis might either produce different results or confirm the findings here.

Finally, it should be noted that the aggression data source only captured incidents that have been formally reported by staff and as such may have underestimated the number of aggressive incidents that actually occurred. In addition, an element of subjectivity in reporting should be acknowledged. The definition of verbal aggression, in particular, will vary between staff and could lead to different judgements on what and when to record an event.

### 4.2. Implications

This research adds to the existing literature base by providing further insight into the salient features of the physical environment on mental health wards and their complex relationship with aggression. The results highlighted above suggested that some ward characteristics which may typically be perceived to be positive (such as low service user populations, high staffing ratios and more space) were here actually associated with higher recorded aggressive incident levels. These findings have implications for service user and staff safety training initiatives and for discussions about mental health ward design in the future.

This poses a need for a considered response to deal with the increasing population use of mental health services by reducing length of stays and having clear pathway options established at admission, as opposed to creating more inpatient beds. This research places emphasis on how having a skilled work force or highly staffed patient areas alone cannot deliver against this goal in a “safe” way without space being seen to be as therapeutic. Therefore new and large spacious wards may still in some way offer challenges to support the therapeutic link within the patient/treatment dyad. The opinion drawn here offers some insight and should prompt wider consideration into the positive and negative impact of policy guidance.

The clearest example is how infection control issues linked to the floor covering and architectural ideals of open spaces/high ceilings of placements appear to meet the safety agenda from one side of the consideration but bring with them practical challenges linked to noise, reverberation and temperature. The push for areas to be designed and built as having “multi use” areas would benefit from wider longitudinal review. This ethos of flexible use has within it the genuine goal of increasing accessibility and promoting more therapeutic spaces with wider scope of access. But this needs to be understood in a pragmatic way and be balanced against the potential that such an ethos may be creating areas that are not suitable for any one aspect of the multiple use ideal. If this is true, areas may often end up gravitating to “single use” rooms and creating the opposite of what they were designed to promote.

The results also suggest that the levels of recorded aggressive incidents do not necessarily correlate with how safe staff feel as previously reported (Haines et al., 2017). It could be hypothesised that increases in base staffing levels can bring with it what could be vicarious type anxieties for staff joining the ward as they may know extra staff above this links to some level of disorder/difficulty/challenge within that ward at that point in time. Therefore the underlying reasons for this require further exploration, potentially using qualitative methodologies. Future research including bigger samples, more detailed socio-demographics and focusing on the service user experience could aid greater understanding in this area; for example investigating service user’s perceived safety in relation to the ward environment and comparing their experiences and perceptions to those of staff.

In conclusion, certain ward characteristics do appear to be linked to aggressive incident rates. However, due to the complexity of the relationship between physical ward characteristics, relational and organisational dynamics on wards, it remains difficult to identify specific aspects that could be addressed in order to reduce levels of inpatient aggression.

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## Authors' contributions

All authors made substantial contributions to the conception and design of the work. RM and AB led on data acquisition, MR led on data analysis and AH-D and RW led on interpretation of the data.

## Declaration of competing interest

The authors report no conflicts of interest.

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