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SENSORY STIMULATION AND OVERSTIMULATION CONTROL AS THE CRITICAL THERAPEUTIC DESIGN DETERMINANTS IN PSYCHIATRIC WARD SETTINGS: EVIDENCE FROM NORTHERN NIGERIA

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ABSTRACT

Sensory regulation and environmental stimulation management are theorised as primary determinants of therapeutic quality in psychiatric ward design, yet the relative ranking of design elements and their independent contributions to patient recovery has rarely been tested empirically, particularly in sub-Saharan Africa. A mixed-methods design integrating quantitative ward-level assessment with qualitative behavioural-spatial mapping was applied across 12 wards in three Federal Neuropsychiatric Hospitals (FNPHs). Six elements were assessed using the content-validated Therapeutic Design Index (TDI): connection to nature, natural lighting, colour psychology, spatial geometry, sensory stimulation, and minimisation of overstimulation. ANOVA tested inter-hospital differences; Pearson correlation and multiple regression related design elements to general patient recovery (N = 275 patients; 12 ward-level units). The model explained 96.0% of outcome variance ($R^2 = 0.960$, adjusted $R^2 = 0.912$). Sensory stimulation ($r = 0.876$, $\beta = 1.154$, $p = .008$) and minimisation of overstimulation ($r = 0.804$, $\beta = 0.716$, $p = .048$) were the strongest positive predictors, whereas spatial geometry was a significant negative predictor ($\beta = -1.347$, $p = .007$). Hospitals differed significantly on all elements (all $p \leq .025$) except connection to nature ($F = 2.540$, $p = .088$), reflecting uniformly low biophilic provision. Sensory stimulation and overstimulation control are the dominant therapeutic design determinants in Northern Nigerian psychiatric wards, while poorly configured spatial geometry acts as an anti-therapeutic constraint. This element-level evidence hierarchy, the first for any FNPH in Northern Nigeria, offers a resource-sensitive framework for prioritising ward design investment and reform.

Keywords: therapeutic design elements, sensory stimulation, spatial geometry, psychiatric ward design, Federal Neuropsychiatric Hospitals, Northern Nigeria.

1. INTRODUCTION

The relationship between architectural design elements and patient recovery outcomes in psychiatric ward settings is a contested and nuanced area of evidence. While the global therapeutic architecture literature establishes, in aggregate, that ward environments influence patient wellbeing and clinical trajectories, the question of which specific design elements exert the strongest independent effects on psychiatric recovery and how those elements rank relative to one another has been addressed only partially and primarily in high-income healthcare settings (Ulrich et al., 2018; Chrysikou, 2022). This gap is consequential: in resource-constrained healthcare systems where capital investment must be prioritised, architects, clinicians, and facility managers

require an evidence-based hierarchy of design elements to guide effective, cost-efficient ward improvement.

The psychiatric ward environments of Federal Neuropsychiatric Hospitals (FNPHs) in Northern Nigeria present a research context of particular urgency. Three FNPHs FNPH Kaduna, FNPH Maiduguri, and FNPH Sokoto serve as the principal inpatient psychiatric infrastructure for 19 states with a combined population of over 100 million people, a treatment gap approaching 90%, and a mental health burden compounded by conflict, displacement, and poverty (WHO, 2023). Despite the scale and severity of psychiatric need in this context, no study has empirically examined how specific ward design elements relate to patient recovery outcomes or identified which elements represent the highest clinical and architectural priority for intervention.

This study addresses that gap through a disaggregated element-level analysis of six therapeutic design domains such as connection to nature, natural lighting, colour psychology, spatial geometry, sensory stimulation, and minimisation of overstimulation across 12 wards in three FNPHs, using ANOVA, Pearson correlation, and multiple regression analysis. The study is grounded in three intersecting theoretical frameworks: Ulrich's (1984, 2018) Supportive Design Theory which identifies sensory inputs, social support, and perceived control as the primary mechanisms of environmental recovery support; Antonovsky's (1996) Salutogenic Design model which emphasises environmental comprehensibility, manageability, and meaningfulness; and Evidence-Based Design (EBD; Ulrich et al., 2018) which requires that architectural decisions be grounded in credible empirical evidence of outcome effects. Together, these frameworks predict that the therapeutic hierarchy of design elements will not be uniform: elements directly targeting sensory regulation and environmental stressor management will outperform those targeting aesthetic enrichment or distant nature connection in their direct effects on psychiatric recovery.

By generating the first empirically derived ranking of therapeutic design elements in an FNPH context, this study makes three contributions: Firstly, it extends the EBD evidence base to a sub-Saharan African psychiatric setting for which no comparable data previously existed; secondly, it identifies sensory stimulation and overstimulation control as the dominant therapeutic design levers in this context and thirdly, it generates a resource-sensitive element-level prioritisation framework directly applicable to ward design investment decisions in Northern Nigeria and comparable LMIC psychiatric settings.

2. LITERATURE REVIEW

The physical environment of a psychiatric ward is increasingly recognised as an active component of care rather than a neutral backdrop to treatment. Ulrich’s (1984) Supportive Design Theory identifies positive distractions as a primary stress-reduction mechanism, and later systematic reviews have identified specific design elements as priorities for psychiatric settings (Connellan et al., 2013; Chrysikou, 2019). This section reviews the evidence for six of these elements: connection to nature, natural lighting, colour psychology, spatial geometry, sensory stimulation, and minimisation of overstimulation. Each has a documented relationship with patient stress, behaviour or recovery in the literature reviewed below. The section then turns to the research gap

in Northern Nigeria's Federal Neuropsychiatric Hospitals (FNPHs), where the relative therapeutic effects of these elements have not been empirically tested (Olagunju et al., 2018).

2.1 The Six Therapeutic Design Elements: Evidence Base

2.1.1 Connection to Nature

Biophilic design which is the deliberate integration of natural elements into the built environment has a well-established evidence base across healthcare settings. Ulrich's (1984) landmark study showed that surgical patients with window views of nature recovered significantly faster than those facing a brick wall. Nieberler-Walker et al. (2023) demonstrated that hospital gardens reduced patient stress and improved mood. Browning et al. (2020) enumerated 14 biophilic design patterns with documented health benefits, including sensory variability, natural light and airflow, and presence of water. In psychiatric settings, Annerstedt et al. (2013) showed that simulated natural environments significantly reduced physiological stress markers. Despite this evidence, biophilic integration in low-resource settings remains challenging, with most evidence from high-income facilities with garden access and landscaped views (Adeoye et al., 2021; Agboola, 2024).

2.1.2 Natural Lighting

Natural light is the most empirically supported individual design element in healthcare environments. Beauchemin and Hays (1996) demonstrated significantly faster recovery from severe depression in sunlit hospital rooms. Benedetti et al. (2001) found that morning sunlight exposure shortened hospitalisation in bipolar depression by an average of 3.67 days. Alzoubi et al. (2010) showed that post-occupancy daylight quality significantly predicted patient satisfaction and recovery experience. Canazei et al. (2014) established that dynamic lighting (replicating the natural diurnal cycle) improves circadian rhythm stability, mood, and alertness in healthcare workers, with implications for patient outcomes. Natural light is particularly important in tropical climates such as Northern Nigeria's, where it is a year-round abundant resource that existing FNPH ward design largely fails to harness therapeutically.

2.1.3 Colour Psychology

The therapeutic application of colour in psychiatric environments has a long clinical and architectural history. Birren (1961) established that specific colour combinations significantly influence emotional states, with warm neutral tones associated with comfort and harsh institutional greens and greys associated with elevated stress. Dalke et al. (2006) demonstrated that colour combinations in hospital environments significantly affect patient anxiety levels. In psychiatric settings, Azeemi and Raza (2005) reviewed the evidence for chromotherapy (the use of specific colours to influence physiological and psychological states) finding consistent but context-dependent effects. The institutional green and off-white colour schemes prevalent in Nigerian healthcare facilities represent non-therapeutic colour environments with no grounding in evidence-based colour design.

2.1.4 Spatial Geometry

Spatial configuration (the arrangement, proportions, circulation patterns, and organisational logic of ward spaces) directly influences patient orientation, autonomy, and behavioural stability. Devlin (2014) established that spatial legibility and wayfinding clarity in healthcare facilities reduce patient anxiety. Carpman and Grant (2016) showed that spatial disorientation generates psychological stress in hospital patients independent of clinical condition. Chrysikou (2019)

documented that spatial configuration is a primary determinant of aggressive incidents and self-harm risks in psychiatric ward settings. Dead-end circulation patterns and congested transitional spaces common in colonial-era ward designs including those of Northern Nigerian FNPHs are specifically implicated in agitation and wandering behaviours (Evans, 2003; Ulrich et al., 2018).

2.1.5 Sensory Stimulation

Sensory stimulation which constitutes the deliberate provision of calibrated positive sensory engagement through visual interest, acoustic management, tactile surfaces, and olfactory control is identified in multiple systematic reviews as a high-priority therapeutic design element in psychiatric settings (Connellan et al., 2013; Chrysikou, 2019). Daykin et al. (2008) demonstrated that arts and environmental enrichment significantly reduce patient anxiety and improve mood in psychiatric inpatient settings. Brown et al. (2016) established that noise constitutes the most consistently reported source of patient distress in psychiatric wards, with direct effects on agitation, sleep quality, and medication adherence. Positive sensory stimulation including providing artwork, varied textures, and acoustic management; creates the "positive distractions" identified as the primary stress-reduction mechanism in Ulrich's (1984) Supportive Design Theory.

2.1.6 Minimisation of Overstimulation

Overstimulation control that has the management of excessive noise, visual clutter, crowding, and environmental stimuli is particularly critical in psychiatric ward populations characterised by elevated sensory sensitivity. Chrysikou (2019) identified overstimulation as a leading cause of agitation, self-harm risk, and treatment resistance in psychiatric wards. Bayramzadeh et al. (2020) demonstrated that noise levels above 50 dB in psychiatric environments were associated with significantly higher rates of aggressive incidents. Brown et al. (2016) documented that psychiatric patients consistently report noise as the most distressing environmental feature of inpatient wards. Spatial buffers between high-activity zones and rest areas, acoustic ceiling treatment, and patient-controlled environmental features are the principal evidence-based interventions for overstimulation management.

2.2 The FNPH Research Gap

Despite this established evidence base, no study has empirically ranked or tested the relative therapeutic effects of these six design elements in any Nigerian psychiatric facility. The three FNPHs in Northern Nigeria FNPH Kaduna, FNPH Maiduguri, and FNPH Sokoto have never been systematically assessed for their therapeutic design element quality. This absence of empirical baseline data prevents the development of context-specific, evidence-based design guidance and hinders advocacy for prioritised ward improvement investment (Olagunju et al., 2018). The present study fills this gap.

3. MATERIALS AND METHODS

3.1 Research Design

A concurrent triangulated mixed-methods design (Creswell & Plano Clark, 2018) was employed, integrating quantitative design element assessment and statistical analysis with qualitative behavioural-spatial observation. This design was selected because the research question requires both the statistical precision of ANOVA, correlation, and regression to rank design element effects, and the ecological depth of behavioural observation to contextualise and explain the mechanisms

of those effects (Morgan, 2014). The approach is consistent with the Building and Environment and Architectural Science Review precedent for mixed-methods performance assessment in health facilities (Chrysikou, 2019; Bayramzadeh et al., 2020).

3.2 Study Sites

The study encompassed all three FNPHs in Northern Nigeria: FNPH Kaduna (Barnawa), FNPH Maiduguri (Kware), and FNPH Sokoto. Twelve wards were assessed: Dater, Drugs, Female, and Male wards at each facility. These represent the complete inpatient ward portfolio of Northern Nigerian FNPHs, providing comprehensive coverage without site selection bias. The ward typologies included Dater (acute admission), Drugs (substance use), Female (gender-segregated female), and Male (gender-segregated male) which reflect the principal care pathways within each FNPH.

3.3 The Therapeutic Design Index (TDI)

The TDI is a purpose-built, validated composite assessment instrument developed for this study. Each of the six therapeutic design domains was assessed using a structured ward observation checklist with Likert-scale scoring from 1 (highly inadequate) to 5 (excellent), producing domain mean scores and a composite TDI for each ward. The instrument was validated through systematic literature review, expert panel content validity analysis using Content Validity Ratios (CVR; Lawshe, 1975), and cross-validated against Chrysikou's (2014) Therapeutic Design Index, the Healing Environment Assessment Protocol (HEAP), and the ASPECT post-occupancy evaluation tool. TDI composite scores are interpreted as: Poor (< 3.0), Fair (3.0–3.4), Good (3.5–4.0), and Excellent (4.1–5.0). Ward observation was conducted across morning (08:00–10:00), afternoon (12:00–14:00), and evening (16:00–18:00) periods to capture temporal variation in environmental conditions.

3.4 Patient Recovery Outcomes

A general recovery composite measure was constructed from three complementary patient-level data sources: (1) Patients' Behavioural Outcome — observer-rated assessment of patient behavioural stability and therapeutic engagement; (2) Recovery Indicator — derived from clinician-assessed functional improvement scores; and (3) Staff-Assessed Outcome — nursing staff evaluation of patient recovery trajectory within the ward observation period. Ward-level means were calculated from 275 patient records across 12 wards (FNPH Kaduna n = 67; FNPH Maiduguri n = 84; FNPH Sokoto n = 124), sampled via attrition-adjusted stratified random sampling using Cochran's (1977) formula.

3.5 Statistical Analysis

All quantitative analyses were conducted using IBM SPSS Statistics Version 26. One-way ANOVA with Tukey HSD post-hoc testing examined statistically significant differences in each design element's scores across the three FNPHs. Pearson correlation analysis (N = 12 ward-level units) examined bivariate relationships between each design domain mean score and the ward-level general recovery composite. Multiple linear regression analysis modelled the collective and individual predictive contributions of the six design domains to general recovery outcomes. Statistical significance was set at $\alpha = 0.05$. Qualitative behavioural-spatial mapping data were analysed thematically, organised around the six design domains, and integrated with quantitative findings at the interpretation stage.

4. RESULTS AND DISCUSSION

4.1 Design Element Performance Across All 12 Wards

Table 1 presents the mean domain scores for all six therapeutic design elements across the 12 assessed wards. The composite TDI score of 2.56 — denoting overall poor therapeutic performance — provides the baseline against which domain-level variation is assessed. Natural lighting (M = 3.09, SD = 0.41) was the only domain to achieve a fair-range mean. All other domains fell in the poor performance range: minimisation of overstimulation (M = 2.63, SD = 0.58), spatial geometry (M = 2.73, SD = 0.52), connection to nature (M = 2.42, SD = 0.50), colour psychology (M = 2.34, SD = 0.62), and sensory stimulation (M = 2.11, SD = 0.44). The gap between the best-performing domain (natural lighting, M = 3.09) and the worst-performing (sensory stimulation, M = 2.11) is 0.98 scale points; a clinically and architecturally meaningful difference that establishes the core therapeutic design deficit profile of Northern Nigerian FNPHs.

Table 1: Therapeutic Design Element Mean Scores Across 12 FNPH Wards

Ward	Nature	Lighting	Colour	Spatial	Sensory	Overstim.	TDI	Rating
Female, Facility C	2.75	3.36	3.13	3.56	2.94	3.64	3.23	Fair
Dater, Facility C	2.55	3.14	3.19	3.33	2.56	3.5	3.05	Fair
Male, Facility C	2.55	3.07	3.19	3.33	2.56	3.5	3.03	Fair
Male, Facility B	3.35	4.07	2.56	3.33	2.31	2.5	3.02	Fair
Drugs, Facility C	2.75	3.21	2.94	2.78	2.44	2.64	2.79	Poor
Dater, Facility B	2.7	3.21	1.69	2.56	2	2.5	2.44	Poor
Dater, Facility A	2.7	3.21	1.69	2.44	1.81	2.29	2.36	Poor
Drugs, Facility B	2.25	3	1.94	2.11	1.69	2.07	2.18	Poor
Female, Facility B	2.1	3	1.75	2.22	1.94	2.21	2.2	Poor
Female, Facility A	1.6	2.71	2.38	2.33	1.5	2.21	2.12	Poor
Drugs, Facility A	2	2.71	2.38	2.33	1.69	2.43	2.26	Poor
Male, Facility A	1.75	2.43	1.69	2.44	1.88	2.07	2.04	Poor
Composite Mean	2.42	3.09	2.34	2.73	2.11	2.63	2.56	Poor

Note. Nature = Connection to Nature; Lighting = Natural Lighting; Colour = Colour Psychology; Spatial = Spatial Geometry; Sensory = Sensory Stimulation; Overstim. = Minimisation of Overstimulation. TDI scale: Poor < 3.0; Fair 3.0–3.4; Good 3.5–4.0; Excellent 4.1–5.0. Scores are ward-level means on a 1–5 Likert scale.

4.2 Descriptive Statistics by Design Element

Table 2 presents descriptive statistics for all six design domains and the composite TDI. The composite TDI demonstrated low inter-ward variability (SD = 0.37, range = 1.19), confirming that

all 12 wards cluster within a narrow band of poor therapeutic performance. Colour psychology recorded the highest inter-ward variability (SD = 0.62), indicating that colour application differed more substantially across wards than any other design element, ranging from 1.69 (three Kaduna wards and Drugs Maiduguri) to 3.19 (Dater and Male Sokoto). Sensory stimulation recorded the lowest inter-ward variability (SD = 0.44), confirming uniformly poor sensory environment quality across all sites. The skewness and kurtosis values indicate approximately normal or slight positive skew for most domains, supporting the validity of parametric statistical procedures.

Table 2: Descriptive Statistics for Six Therapeutic Design Domains

Domain	N	Range	Min	Max	M	SD	Skew	Kurt
Connection to Nature	12	1.75	1.6	3.35	2.42	0.5	-0.04	-0.17
Natural Lighting	12	1.64	2.43	4.07	3.09	0.41	0.89	2.6
Colour Psychology	12	1.5	1.69	3.19	2.34	0.62	0.17	-1.75
Spatial Geometry	12	1.45	2.11	3.56	2.73	0.52	0.53	-1.5
Sensory Stimulation	12	1.44	1.5	2.94	2.11	0.44	0.48	-0.81
Minimisation of Overstim.	12	1.57	2.07	3.64	2.63	0.58	1	-0.61
Composite TDI	12	1.19	2.04	3.23	2.56	0.37	-0.57	-0.79

Note. M = Mean; SD = Standard Deviation; Skew = Skewness; Kurt = Kurtosis. Composite TDI = mean of six domain scores.

4.3 ANOVA: Inter-Hospital Differences in Design Element Scores

Table 3 presents the one-way ANOVA results testing for statistically significant differences in each design element's scores across the three FNPHs. Five of the six design elements demonstrated statistically significant inter-hospital differences. Natural lighting ($F = 12.665$, $p = .000$), spatial geometry ($F = 13.923$, $p = .000$), and minimisation of overstimulation ($F = 20.663$, $p = .000$) all achieved highly significant differences, indicating that the three FNPHs differ substantially in these dimensions of therapeutic quality. Colour psychology ($F = 7.981$, $p = .001$) and sensory stimulation ($F = 4.116$, $p = .025$) also differed significantly. Therapeutic outcome measures ($F = 31.155$, $p = .000$) differed significantly across hospitals, consistent with the inter-hospital variation in design element quality. Connection to nature did not differ significantly across hospitals ($F = 2.540$, $p = .088$), confirming that biophilic provision was uniformly low across all three FNPHs regardless of facility.

Table 3: ANOVA Results: Inter-Facility Differences in Therapeutic Design Element Scores

Design Element	F	p	Decision	Priority
Connection to Nature	2.54	0.088	Not Significant	Low
Natural Lighting	12.665	0	Significant ***	High
Colour Psychology	7.981	0.001	Significant **	High
Spatial Geometry	13.923	0	Significant ***	High
Sensory Stimulation	4.116	0.025	Significant *	Critical
Minimisation of Overstim.	20.663	0	Significant ***	Critical
Therapeutic Outcome Measures	31.155	0	Significant ***	—
Design–Outcome Relationship	2.298	0.143	Not Significant	—

*Note. *p < .05; **p < .01; ***p < .001. Priority column reflects post-hoc designations based on regression significance (see Table 5).*

4.4 Correlation Analysis: Design Elements and General Recovery

Table 4 presents Pearson correlations between each of the six design element scores and the ward-level general patient recovery composite. All six design elements demonstrated positive correlations with general recovery, confirming the directional consistency of the therapeutic relationship — higher design element quality is consistently associated with better recovery outcomes. Sensory stimulation ($r = 0.876$, $p < .01$) and minimisation of overstimulation ($r = 0.804$, $p < .01$) recorded very strong significant correlations. Spatial geometry ($r = 0.674$, $p < .05$) and colour psychology ($r = 0.649$, $p < .05$) recorded strong significant correlations. Connection to nature ($r = 0.571$) and natural lighting ($r = 0.406$) recorded moderate correlations that did not reach statistical significance at the bivariate level, an important finding that differentiates the correlation and regression rankings of design elements.

Table 4: Pearson Correlations Between Therapeutic Design Elements and General Patient Recovery

Design Element	r	p	Correlation Strength
Sensory Stimulation	0.876	p = .000**	Very Strong
Minimisation of Overstim.	0.804	p = .002**	Very Strong
Spatial Geometry	0.674	p = .017*	Strong
Colour Psychology	0.649	p = .023*	Strong
Connection to Nature	0.571	p = .052 n.s.	Moderate
Natural Lighting	0.406	p = .190 n.s.	Moderate

*Note. *p < .05; **p < .01. n.s. = not statistically significant at α = .05. Very Strong = r ≥ 0.80; Strong = r 0.60–0.79; Moderate = r 0.40–0.59.*

4.5 Regression Analysis: Predictive Hierarchy of Design Elements

Table 5 presents the regression model summary and Table 6 the standardised coefficients identifying the independent predictive contribution of each design element to general recovery outcomes. The model demonstrated exceptional explanatory power: $R^2 = 0.960$ (adjusted $R^2 = 0.912$, SE = 0.148), indicating that the six design elements collectively explain 96.0% of the variation in ward-level general patient recovery outcomes. This R^2 value is among the highest reported in the health environments research literature for comparable ward-level assessment studies.

Table 5: Regression Model Summary: Six Design Elements Predicting General Recovery

Model	R	R^2	Adjusted R^2	Std. Error	df
Six TDI Domains → General Recovery	0.98	0.96	0.912	0.148	6, 5

Note. F(6, 5) = 20.000 (estimated from R^2 and df). Dependent variable: ward-level general patient recovery composite (N = 12 wards).

Table 6: Regression Coefficients: Predictive Hierarchy of Six Design Elements for General Recovery

Design Element	B	β	SE	t	p	Rank	Decision
Sensory Stimulation	1.308	1.154	0.304	4.298	0.008	1st	Significant (positive)
Spatial Geometry	-1.307	-1.347	0.296	-4.413	0.007	2nd*	Significant (negative)
Minimisation of Overstim.	0.618	0.716	0.237	2.602	0.048	3rd	Significant (positive)
Connection to Nature	0.328	0.325	0.313	1.048	0.343	4th	Not Significant
Colour Psychology	0.094	0.117	0.149	0.631	0.556	5th	Not Significant
Natural Lighting	0.064	0.052	0.372	0.172	0.87	6th	Not Significant
Constant	0.35	—	0.538	0.651	0.544	—	—

*Note. *Spatial geometry ranks 2nd by statistical significance (p = .007) but its negative β value indicates an anti-therapeutic effect at current FNPH performance levels. Rank indicates statistical significance ordering, not directional benefit. R^2 = 0.960; Adjusted R^2 = 0.912; F(6, 5) = 20.000, p < .001.*

4.6 Empirical Ranking of Design Elements by Therapeutic Influence

Table 7 synthesises the correlation, ANOVA, and regression findings into a consolidated empirical ranking of the six design elements by their therapeutic influence on general patient recovery. This ranking provides the primary applied output of the study — an evidence-based hierarchy for ward design investment prioritisation.

Table 7: Consolidated Empirical Ranking of Six Therapeutic Design Elements by Recovery Influence

Rank	Design Element	r	ANOVA p	β	Reg. p	Clinical Significance	Priority Tier
1	Sensory Stimulation	0.876**	0.025	1.154	0.008	Dominant positive predictor	Critical
2	Minimisation of Overstim.	0.804**	0	0.716	0.048	Strong positive predictor	Critical
3	Spatial Geometry	0.674*	0	-1.347	0.007	Anti-therapeutic at current levels	High
4	Colour Psychology	0.649*	0.001	0.117	0.556	Positive but non-significant in MR	High
5	Connection to Nature	0.571	0.088	0.325	0.343	Positive, non-significant	Moderate
6	Natural Lighting	0.406	0	0.052	0.87	Positive correlation, non-significant MR	Moderate

*Note. *p < .05; **p < .01 for Pearson r. r = Pearson correlation with general recovery composite. ANOVA p = one-way ANOVA significance across three FNPHs. β = standardised regression coefficient. Reg. p = regression p-value. MR = multiple regression. CRITICAL tier = statistically significant*

regression predictor; HIGH tier = statistically significant correlation only; MODERATE tier = positive but non-significant at both levels.

4.7 Qualitative Behavioural-Spatial Evidence

Behavioural-spatial mapping conducted in the highest-TDI ward at each FNPH: Dater Ward Kaduna (TDI = 2.36), Male Ward Maiduguri (TDI = 3.02), and Female Ward Sokoto (TDI = 3.23) provided convergent qualitative evidence for the quantitative rankings.

4.7.1 Dater Ward FNPH Kaduna (TDI = 2.36)

Behavioural observations in Dater Ward Kaduna revealed a strong negative spatial pattern: the central corridor functioned as the primary zone of agitation, pacing, and wandering, while the Prayer Room (the ward's lowest-stimulation zone) consistently supported calm and reflective behaviours. Patients systematically migrated toward window-proximate areas and naturally ventilated spaces, demonstrating behavioural preference for improved environmental conditions despite the absence of deliberate therapeutic design. The complete absence of therapeutic artwork (a primary sensory stimulation failure) produced visually monotonous ward surfaces that offered no positive distractions. Areas near toilet blocks and corridor intersections (characterised by congestion, noise, and movement intensity) recorded the highest agitation frequencies, directly confirming the quantitative finding that overstimulation control is a dominant recovery determinant.

4.7.2 Male Ward FNPH Maiduguri (TDI = 3.02)

The Male Ward Maiduguri displayed a more organised behavioural pattern consistent with its higher TDI score. Direct and purposeful movement between bed areas, dining room, prayer room, and recreational room indicated effective spatial legibility and reduced navigational stress. Calm and resting behaviours predominated in bed areas, particularly around window-adjacent beds with natural lighting access. Communal spaces (dining room and recreational room) served as active therapeutic zones where social interaction and engagement were sustained, supporting the role of spatial configuration in enabling therapeutic socialisation. Agitation was infrequent and concentrated along circulation routes rather than distributed throughout the ward, reflecting more effective spatial separation between activity and rest zones.

4.7.3 Female Ward FNPH Sokoto (TDI = 3.23)

The Female Ward Sokoto demonstrated the most therapeutically coherent behavioural pattern across all observed wards. Calm, resting, and social interaction behaviours predominated; agitation and withdrawal were occasional and localised, absent from the distribution patterns characteristic of lower-TDI wards. The ward's superior overstimulation control; reflected in its domain score of 3.64 (the highest across all 12 wards for this domain) was visibly manifest in organised movement flows, minimal corridor congestion, and sustained occupancy of communal and recreational areas. The sensory environment (while not exemplary) was markedly calmer than Kaduna equivalents, with less acoustic stress and better visual organisation. These observations directly confirm the quantitative finding that overstimulation control is the second-strongest recovery predictor.

4.8 Interpretation of the Findings

The quantitative and qualitative results above are interpreted below in the order of the empirical ranking in Table 7.

4.8.1 The dominance of sensory stimulation: theoretical and clinical significance

The identification of sensory stimulation as the strongest positive predictor of general recovery (β = 1.154, p = .008; r = 0.876), across both bivariate and multivariate analyses, is theoretically grounded and practically significant. Within Ulrich's (1984, 2018) Supportive Design Theory, sensory stimulation directly maps onto the first of the three proposed stress-reduction mechanisms: provision of positive distractions. Positive distractions (nature, artwork, aesthetically engaging environments, pleasant sounds) are hypothesised to engage patients in a non-demanding way that reduces stress, anxiety, and pain perception while promoting physiological relaxation (Ulrich, 1984; Daykin et al., 2008). The study's finding that sensory stimulation is simultaneously the strongest recovery predictor (r = 0.876) and the worst-performing design element (M = 2.11) represents a critical inverse relationship that crystallises the core therapeutic design failure of Northern Nigerian FNPHs: the wards provide the least of what patients' recovery most needs.

The practical implications are substantial. Sensory stimulation improvements (therapeutic artwork commissions, varied surface textures, acoustic ceiling treatment, and controlled olfactory management) represent among the most cost-effective design interventions available in healthcare settings. Daykin et al. (2008) demonstrated that visual arts programmes in psychiatric settings significantly reduced patient anxiety and improved mood at modest cost. The complete absence of therapeutic artwork documented across all four Kaduna wards, a finding directly visible in the sensory stimulation domain score of M = 1.69 for Drugs Ward Kaduna, represents a particularly accessible intervention point that facility management can address without capital investment.

4.8.2 Overstimulation control: the second critical determinant

The very strong correlation of minimisation of overstimulation with general recovery (r = 0.804, p < .01) and its emergence as a significant positive regression predictor (β = 0.716, p = .048) establish it as the second most therapeutically influential design element in the FNPH context. This finding converges with Chrysikou's (2019) systematic review identifying overstimulation as a leading cause of agitation, self-harm risk, and treatment resistance in psychiatric wards, and with Brown et al.'s (2016) demonstration that noise is consistently the most distressing environmental feature for psychiatric inpatients. The highest individual overstimulation control score recorded, in Female Ward Sokoto (M = 3.64), corresponded with the ward's highest TDI and the most positive behavioural pattern observed across the study (Section 4.7.3), providing direct ecological validation of the quantitative relationship.

The ANOVA finding that minimisation of overstimulation differed most significantly across hospitals (F = 20.663, p = .000, the highest F-value of any design element) indicates that the three FNPHs vary more in their overstimulation management than in any other design dimension. This inter-hospital variation suggests that overstimulation control is particularly sensitive to facility-level management decisions (spatial organisation of ward activity, staff protocols for noise management, and maintenance of communal space organisation) rather than being purely a function of building design. This finding has important practical implications: it suggests that ward-level operational improvements to overstimulation management can be achieved through management intervention and low-cost spatial adjustments without requiring major architectural capital expenditure.

4.8.3 Spatial geometry as an anti-therapeutic constraint

The significant negative regression coefficient for spatial geometry (β = −1.347, p = .007) is the most architecturally nuanced finding of this study and requires careful interpretation. Spatial

geometry achieved a strong positive bivariate correlation with general recovery ($r = 0.674$, $p < .05$), confirming that better-configured wards are associated with better outcomes. However, its negative regression coefficient in the multivariate model indicates that, at the current performance levels observed in Northern Nigerian FNPHs (where the composite spatial geometry mean of 2.73 reflects functional adequacy but therapeutic inadequacy), poor spatial configuration actively suppresses recovery outcomes when considered in combination with sensory and overstimulation factors.

This dual finding (positive bivariate correlation, negative regression coefficient) reflects suppressor variable dynamics in the multivariate model: spatial geometry's negative independent effect is partially masked at the bivariate level by its positive correlations with the other design domains. In architectural terms, this means that functionally organised wards (moderate spatial geometry scores) can still generate therapeutic harm through their specific spatial characteristics (dead-end corridors, congested transitional zones, and undifferentiated circulation patterns) that generate spatial stress, confusion, and restricted patient agency. Devlin (2014) and Carpman and Grant (2016) have established that spatial disorientation is an independent source of healthcare anxiety. Qualitative observations directly confirmed this: the highest agitation frequencies in Dater Ward Kaduna were concentrated precisely at dead-end circulation zones and corridor intersections (Section 4.7.1), spatial features reflected in the ward's spatial geometry score of 2.44.

4.8.4 Natural lighting: the correlation–regression paradox

The finding as shown on Table 7 shows that natural lighting recorded the second-strongest bivariate correlation with HADS outcomes in the related study ($r = 0.763$) but the weakest regression coefficient for general recovery in this study ($\beta = 0.052$, $p = .870$) represents a methodologically important finding that has both statistical and design implications. At the bivariate level, natural lighting is a strong predictor of HADS-specific emotional outcomes; at the multivariate level, when controlling for sensory stimulation and overstimulation control, its independent contribution to general recovery is attenuated to non-significance. This pattern reflects multicollinearity between natural lighting and the sensory domains (wards with better natural lighting also tend to have better sensory environments), meaning that the regression model assigns the shared variance to the stronger predictors (sensory stimulation and overstimulation control) rather than to natural lighting.

This does not diminish the clinical importance of natural lighting. It indicates that natural lighting's primary recovery effect is mediated through its contribution to sensory environment quality, a theoretically plausible pathway: better natural light is experienced by patients as a positive sensory input (positive distraction in Ulrich's framework) and as reduced institutional monotony. The design implication is that natural lighting improvements are most therapeutically effective when integrated as part of a comprehensive sensory environment strategy, rather than implemented in isolation.

4.8.5 Design element prioritisation framework for resource-constrained settings

The empirical ranking generated by this study (sensory stimulation, overstimulation control, spatial geometry correction, colour psychology, connection to nature, and natural lighting integration) provides the first evidence-based design element hierarchy for psychiatric ward improvement in Northern Nigeria and, by extension, for comparable low- and middle-income psychiatric facility contexts in sub-Saharan Africa.

This hierarchy has direct resource allocation implications. In settings where capital and maintenance budgets are severely constrained, the priority order suggests the following intervention sequence: first, sensory stimulation improvements (therapeutic artwork, acoustic management, tactile surface variation: lowest capital cost, highest empirical return); second, overstimulation control improvements (spatial buffering between activity and rest zones, noise reduction protocols, corridor management: achievable through management intervention and low-cost partitioning); third, spatial geometry corrections (removal of dead-end circulation, improved spatial legibility, differentiation of activity and rest zones: moderate capital cost but high therapeutic return given the anti-therapeutic effect of current configurations); and fourth, colour psychology, nature connection, and natural lighting integration as budget permits. This prioritisation ensures that the most resource-efficient therapeutic gains are realised first, enabling evidence-based phased ward improvement within existing FNPH budget structures.

4.8.6 Implications for architectural science and building performance research

For the building and environment and architectural science research communities, this study makes three methodological and substantive contributions. First, it demonstrates the validity of the ward-level unit of analysis for health environment research in low-resource settings where individual-level longitudinal designs are logistically constrained; the R^2 of 0.960 confirms that ward-level aggregation is a statistically powerful approach for environmental performance assessment. Second, it establishes that the correlation-to-regression shift in element significance, whereby natural lighting's strong bivariate correlation is attenuated in multivariate regression, has architectural design implications beyond the statistical, informing an integration model for therapeutic design elements that differs from the additive model implicit in most evidence-based design frameworks. Third, it provides an empirically grounded performance baseline against which post-occupancy evaluation of future ward design interventions in Northern Nigerian FNPHs can be assessed.

5. CONCLUSION

This study provides potentially the first empirically derived ranking of six therapeutic design elements by their contribution to psychiatric patient recovery in Northern Nigerian Federal Neuropsychiatric Hospitals (FNPHs). The six elements together explained 96.0% of the variation in ward-level general recovery ($R^2 = 0.960$; adjusted $R^2 = 0.912$). Sensory stimulation ($\beta = 1.154$, $p = .008$) and minimisation of overstimulation ($\beta = 0.716$, $p = .048$) were the strongest positive predictors, while spatial geometry ($\beta = -1.347$, $p = .007$) acted as a significant anti-therapeutic constraint at current performance levels. The central insight is that sensory regulation and overstimulation control were stronger predictors of general recovery than biophilic integration and natural lighting, which challenges the primacy those elements hold in the high-income therapeutic architecture literature. In the FNPH context, where sensory environments are dominated by noise, overcrowding, monotonous surfaces, and the absence of therapeutic artwork, the sensory stimulation deficit is so profound that correcting it is likely the highest-leverage design intervention available. These findings provide an evidence base for a resource-sensitive ward improvement strategy that can move Northern Nigerian psychiatric wards from institutional spaces toward therapeutic healing environments.

6. RECOMMENDATIONS

Three recommendations follow. First, FNPH management and design teams should prioritise sensory stimulation, through therapeutic artwork, acoustic management, and varied surface

textures, together with overstimulation control, through spatial buffering between activity and rest zones, noise protocols, and corridor management, since both are likely to be achievable through management action and low-cost adjustment. Second, spatial configuration should be modified by removing dead-end circulation, improving legibility, and separating activity from rest zones, with colour, nature connection, and natural lighting integrated as budgets permit and, where possible, as part of a combined sensory strategy. Third, health planners and funders should adopt this hierarchy as the basis for phased refurbishment and for briefing new facilities, and should commission post-occupancy evaluation using the TDI to establish whether these interventions improve recovery. The most deficient element is not necessarily the most theoretically prominent, and in Northern Nigeria it is sensory stimulation. Future research should test whether this hierarchy holds across other low- and middle-income psychiatric settings or shifts as the most severe deficits are corrected, using larger samples and patient-level or multilevel designs.

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