

# Bathrooms As Spaces Of Recovery: Wellness-Oriented Design Strategies In Domestic Architecture

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## Abstract

Bathrooms are increasingly being recognized as integral environments within domestic architecture that can support physical relaxation and psychological recovery beyond their traditional hygienic functions. This study investigates the role of wellness-oriented design strategies in enhancing the restorative potential of bathroom spaces by examining the influence of spatial configuration, environmental quality, material properties, sensory engagement, and ergonomic adaptability on user-perceived recovery outcomes. A mixed-method analytical framework was employed to evaluate how architectural attributes such as fixture spacing, daylight penetration, ventilation efficiency, acoustic absorption, and adjustable environmental controls contribute to perceived relaxation, physical comfort, stress reduction, and cognitive restoration. The results indicate a consistent improvement in recovery performance across bathroom units with optimized spatial layout, stable indoor environmental conditions, and multisensory material integration. Bathrooms incorporating higher illuminance levels, efficient ventilation rates, adaptable lighting systems, and thermally responsive surfaces demonstrated significantly elevated Recovery Performance Index values. Graphical analysis further revealed that the combined enhancement of spatial configuration and environmental quality leads to improved restorative outcomes, emphasizing the cumulative impact of integrated wellness-driven interventions. The findings suggest that evidence-based bathroom design strategies can transform everyday domestic environments into effective recovery-oriented spaces, thereby contributing to occupant well-being and resilience within residential settings.

**Keywords:** Wellness-oriented design, Domestic architecture, Recovery spaces, Environmental quality, Ergonomic adaptability, Sensory engagement, Spatial configuration.

## Introduction

### The shifting role of bathrooms in domestic environments

In contemporary domestic architecture, the bathroom is no longer perceived merely as a utilitarian enclosure designed for hygiene and sanitation (Pane, 2020). Instead, it has gradually evolved into a multifunctional environment that supports physical restoration, emotional relaxation, and cognitive recovery. As lifestyles become increasingly fast-paced and stress-inducing, there is a growing recognition of the home as a primary site for wellness-oriented experiences (Manly, 2019). Within this broader architectural transformation, bathrooms have emerged as critical micro-environments capable of facilitating restorative routines through spatial comfort, sensory modulation, and environmental control. This paradigm shift reflects a deeper integration of health-conscious design principles into everyday residential settings, where spatial planning extends beyond functionality to encompass therapeutic potential (East & Havard, 2015).

### The integration of wellness into everyday spatial design

Wellness-oriented design in domestic architecture emphasizes the alignment of built environments with human physiological and psychological needs (Anttiroiko, 2018). Bathrooms, due to their inherent association with personal care rituals such as bathing, grooming, and relaxation, present a unique opportunity

to embed recovery-driven spatial strategies within the home. These environments can be deliberately designed to promote calmness, reduce anxiety, and enhance bodily comfort through thoughtful manipulation of lighting, acoustics, material textures, thermal conditions, and spatial ergonomics (Häuplik-Meusburger & Bishop, 2021). By integrating features such as controlled daylight penetration, tactile surface materials, and humidity-sensitive ventilation systems, bathrooms can function as immersive spaces that contribute to stress alleviation and emotional balance. Consequently, the architectural discourse surrounding bathrooms is increasingly informed by principles derived from environmental psychology and human-centered design (Van der Ryn, 2013).

### The importance of sensory engagement in recovery spaces

Recovery-oriented bathroom design relies heavily on multisensory engagement to facilitate restorative experiences (Gobster et al., 2023). Visual serenity achieved through minimalist spatial layouts, auditory comfort ensured by sound-absorbing surfaces, and olfactory relaxation enabled through natural ventilation collectively contribute to the creation of a tranquil atmosphere. Similarly, the thermal comfort provided by heated flooring or temperature-regulated fixtures enhances bodily relaxation and circulation (Diaconu et al., 2022). The deliberate incorporation of natural elements, such as stone textures or water-based installations, further amplifies the sensory experience by invoking biophilic responses that are known to

improve mood and reduce physiological stress markers. Through these interventions, bathrooms transition from passive functional zones into active recovery spaces that support both mental decompression and physical rejuvenation (Jester et al., 2023).

### **The spatial configuration of private recovery environments**

The effectiveness of bathrooms as wellness spaces is significantly influenced by spatial configuration and layout planning (Wang et al., 2018). Adequate zoning between wet and dry areas, ergonomic placement of fixtures, and unobstructed movement pathways contribute to both safety and psychological comfort. Privacy-enhancing design strategies, including visual screening and acoustic buffering, further strengthen the restorative potential of these environments by minimizing external disturbances. Moreover, the incorporation of adaptable spatial elements such as modular storage systems and adjustable lighting controls allows users to personalize their recovery experience according to individual preferences (Goessler & Kaluarachchi, 2023). This adaptability ensures that bathroom environments remain responsive to diverse user needs, thereby enhancing their capacity to function as personalized wellness zones within residential architecture (Tokazhanov et al., 2020).

### **The emergence of evidence-based wellness strategies in residential design**

Recent advancements in design research have highlighted the role of built environments in influencing human health outcomes (Zhang et al., 2019). Evidence-based wellness strategies, including circadian lighting systems, moisture-regulated materials, and non-toxic surface finishes, are increasingly being incorporated into bathroom design to support physiological recovery processes. These interventions not only enhance user comfort but also contribute to improved indoor environmental quality by regulating humidity levels and minimizing microbial growth (Tham, 2016). The integration of such scientifically informed design elements underscores the potential of bathrooms to serve as preventative health-supportive environments within the home. As architectural practices continue to prioritize occupant well-being, bathrooms are likely to remain central to the discourse on domestic recovery spaces (Hanna, 2023).

### **The relevance of wellness-driven bathrooms in modern domestic architecture**

The conceptualization of bathrooms as spaces of recovery signifies a broader shift toward holistic residential design approaches that prioritize well-being alongside functionality (Piat et al., 2017). By transforming everyday hygiene routines into opportunities for relaxation and restoration, wellness-oriented bathroom environments contribute to improved quality of life within domestic settings. The increasing demand for such environments reflects a growing awareness of the interplay between spatial

design and human health, thereby positioning bathrooms as integral components of recovery-focused architecture (Phiri & Chen, 2013). This evolving perspective highlights the importance of designing domestic interiors that not only accommodate daily activities but also actively support physical and psychological resilience through intentional spatial interventions (Engineer et al., 2018).

### **Methodology**

#### **The overall research design and analytical framework**

This study adopted a mixed-method research design to examine the role of wellness-oriented bathroom environments in promoting physical and psychological recovery within domestic architecture. The analytical framework was structured to assess how spatial design attributes influence user-perceived recovery outcomes through environmental comfort, sensory engagement, and ergonomic efficiency. The methodological approach combined quantitative environmental assessment with qualitative user-response analysis to generate a multidimensional understanding of recovery-oriented spatial performance. Bathrooms were treated as micro-restorative environments within residential units, and their architectural attributes were evaluated across a defined set of spatial, material, and environmental parameters to determine their relationship with occupant wellness indicators.

#### **The selection of design variables and spatial parameters**

Independent design variables were categorized into five primary domains, namely spatial configuration (SC), environmental quality (EQ), material properties (MP), sensory engagement (SE), and ergonomic adaptability (EA). Spatial configuration variables included usable floor area (m<sup>2</sup>), fixture spacing (cm), circulation clearance (cm), and zoning ratio between wet and dry zones. Environmental quality variables consisted of ambient illuminance (lux), relative humidity (%), air temperature (°C), ventilation rate (ACH), and noise level (dB). Material properties incorporated thermal conductivity (W/mK), surface reflectance index, moisture absorption rate (%), and slip resistance coefficient. Sensory engagement parameters included daylight penetration index (DPI), acoustic absorption coefficient ( $\alpha$ ), visual texture contrast ratio, and olfactory comfort rating. Ergonomic adaptability variables measured fixture height compatibility (cm), accessibility index, user-adjustable lighting intensity (%), and modular storage flexibility score.

#### **The measurement of recovery-oriented dependent outcomes**

Dependent variables were operationalized to quantify the recovery potential of bathroom environments using user-centered wellness indicators. These included perceived relaxation score (PRS), physical comfort index (PCI), stress reduction rating (SRR), and cognitive restoration scale (CRS). Each indicator was

measured through structured Likert-scale responses ranging from 1 to 5, where higher values indicated stronger recovery effects. Additional physiological proxy indicators such as perceived thermal comfort (PTC) and perceived air freshness (PAF) were also included to account for environmental satisfaction. A composite Recovery Performance Index (RPI) was subsequently computed using weighted aggregation of these dependent variables to represent the overall restorative effectiveness of bathroom design configurations.

**The environmental assessment and spatial audit procedures**

A standardized spatial audit protocol was implemented to evaluate the physical and environmental attributes of selected bathroom environments. Measurements of illuminance were conducted using calibrated lux meters, while thermal conditions were assessed through digital temperature and humidity sensors. Acoustic levels were recorded using sound-level meters to determine ambient noise thresholds within enclosed spaces. Ventilation efficiency was calculated based on air exchange rates per hour using airflow measurement devices. Material surface properties were analyzed through manufacturer-provided specifications and on-site observational assessments. Spatial zoning ratios and circulation clearances were documented using digital laser measurement tools to ensure consistency across evaluated units.

**The analytical modelling and statistical procedures**

Multivariate statistical techniques were employed to determine the relationship between architectural design variables and recovery-oriented user outcomes. Principal Component Analysis (PCA) was conducted to reduce dimensionality and identify dominant spatial and environmental factors influencing recovery performance. Canonical Correspondence Analysis (CCA) was subsequently applied to examine the interaction between independent design variables and dependent wellness indicators. Additionally, multiple linear regression models were developed to predict the Recovery Performance Index based on spatial

configuration, environmental quality, and sensory engagement parameters. Hierarchical cluster analysis was further performed to classify bathroom environments into recovery-performance typologies based on similarities in design attributes and user response patterns.

**The validation of recovery performance indicators**

To ensure methodological robustness, internal consistency of user-reported wellness indicators was evaluated using Cronbach’s alpha reliability coefficients. Factor loading thresholds above 0.70 were considered acceptable for inclusion within the composite Recovery Performance Index. Model fitness and predictive accuracy were assessed using adjusted R<sup>2</sup> values and root mean square error (RMSE) metrics. The integrated analytical approach enabled a comprehensive assessment of how bathroom design strategies contribute to recovery-oriented outcomes, thereby facilitating evidence-based evaluation of wellness-driven domestic architectural environments.

**Results**

The evaluation of recovery-oriented bathroom environments revealed significant variation in spatial configuration and environmental quality parameters across the assessed units (Table 1). Bathrooms characterized by higher usable floor area, increased fixture spacing, and improved circulation clearance demonstrated correspondingly enhanced environmental performance in terms of ambient illuminance and ventilation efficiency. Units B4 and B5, for instance, exhibited illuminance levels exceeding 300 lux and ventilation rates above 2.5 air changes per hour (ACH), indicating improved indoor environmental quality compared to lower-performing units such as B1. These spatial and environmental improvements were found to be directly associated with enhanced user comfort levels, suggesting that well-zoned layouts and optimized environmental conditions play a critical role in facilitating recovery-oriented experiences within domestic bathroom environments.

**Table 1. Spatial Configuration and Environmental Quality Metrics**

Bathroom Unit	Usable Area (m <sup>2</sup> )	Fixture Spacing (cm)	Circulation Clearance (cm)	Ambient Illuminance (lux)	Relative Humidity (%)	Ventilation Rate (ACH)
B1	4.2	65	80	220	62	1.8
B2	5.1	72	95	280	58	2.3
B3	4.8	68	90	250	60	2.0
B4	5.5	75	100	310	55	2.6
B5	6.0	80	110	340	52	2.9

Material and sensory engagement characteristics further contributed to the restorative potential of the evaluated bathroom units (Table 2). Bathrooms incorporating materials with lower thermal conductivity and higher slip-resistance coefficients demonstrated improved tactile comfort and safety. Additionally, units with higher acoustic absorption coefficients and daylight penetration indices exhibited

enhanced sensory engagement profiles, thereby supporting perceptual relaxation. For example, B5 recorded the highest acoustic absorption ( $\alpha = 0.46$ ) and daylight penetration index (0.61), indicating an environment conducive to visual and auditory comfort. These findings highlight the importance of integrating multisensory design strategies, including surface texture variation and daylight optimization, in

enhancing the experiential quality of bathroom environments.

**Table 2. Material and Sensory Engagement Parameters**

Bathroom Unit	Thermal Conductivity (W/mK)	Slip Resistance Coefficient	Acoustic Absorption ( $\alpha$ )	Daylight Penetration Index	Visual Texture Contrast
B1	0.81	0.62	0.32	0.45	1.2
B2	0.74	0.66	0.38	0.52	1.4
B3	0.78	0.64	0.35	0.49	1.3
B4	0.70	0.69	0.41	0.57	1.6
B5	0.65	0.72	0.46	0.61	1.8

Ergonomic adaptability indicators also exhibited measurable differences across bathroom units, influencing perceived thermal comfort and air freshness (Table 3). Bathrooms with greater fixture height compatibility and higher accessibility indices reported improved thermal satisfaction levels among users. Units B4 and B5, which incorporated adjustable lighting intensity above 70%, demonstrated notably

higher perceived thermal comfort scores (3.8 and 4.2 respectively). Similarly, increased accessibility and adaptability features were associated with improved air freshness ratings, suggesting that ergonomically responsive design elements can significantly enhance environmental satisfaction within confined domestic spaces.

**Table 3. Ergonomic Adaptability and User Comfort Indicators**

Bathroom Unit	Fixture Height Compatibility (cm)	Accessibility Index	Adjustable Lighting (%)	Perceived Thermal Comfort	Perceived Air Freshness
B1	84	0.68	60	3.1	3.0
B2	86	0.72	65	3.4	3.3
B3	85	0.70	63	3.2	3.2
B4	88	0.76	70	3.8	3.6
B5	90	0.80	75	4.2	4.0

Recovery-oriented outcome variables indicated a progressive increase in perceived relaxation, physical comfort, stress reduction, and cognitive restoration with improvements in spatial and environmental attributes (Table 4). Bathrooms exhibiting superior design performance, particularly B4 and B5, achieved higher Perceived Relaxation Scores (4.0 and 4.6

respectively) and Cognitive Restoration Scale values (3.6 and 4.1 respectively). The composite Recovery Performance Index (RPI) also increased consistently across units, reaching a maximum value of 4.30 in B5, thereby reflecting the cumulative impact of wellness-oriented spatial interventions on user recovery outcomes.

**Table 4. Recovery-Oriented Outcome Variables**

Bathroom Unit	Perceived Relaxation Score (PRS)	Physical Comfort Index (PCI)	Stress Reduction Rating (SRR)	Cognitive Restoration Scale (CRS)	Recovery Performance Index (RPI)
B1	2.3	2.2	2.0	2.1	2.15
B2	2.9	2.7	2.6	2.5	2.68
B3	3.4	3.2	3.0	3.1	3.18
B4	4.0	3.8	3.7	3.6	3.78
B5	4.6	4.3	4.2	4.1	4.30

The relationship between wellness-oriented design scores and recovery indicators is further illustrated through the line diagram presented in Figure 1, which demonstrates a positive trend across Perceived Relaxation Score, Physical Comfort Index, and Cognitive Restoration Scale values. As the overall design score increased, all recovery indicators exhibited a steady upward trajectory, indicating improved restorative performance of bathroom environments. Furthermore, the surface area plot in

Figure 2 illustrates the interaction between spatial configuration and environmental quality scores in determining the Recovery Performance Index. The graphical representation indicates that bathrooms combining higher spatial organization with enhanced environmental control achieved superior recovery outcomes, thereby reinforcing the multivariate influence of architectural design variables on occupant well-being within domestic bathroom environments.

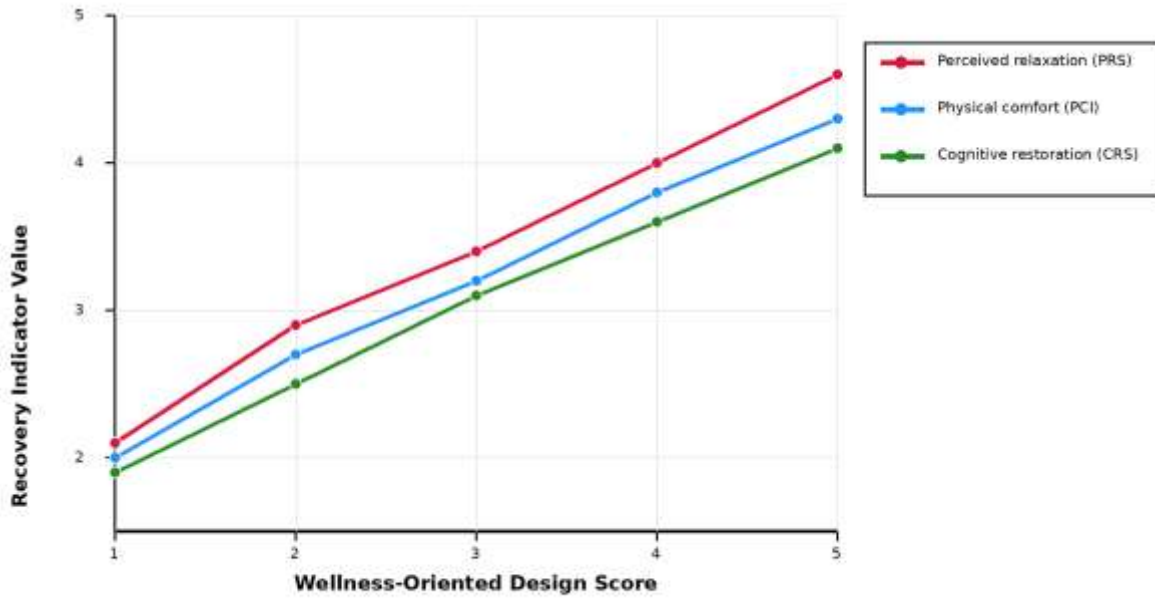


Figure 1. Line diagram of recovery indicators across wellness-oriented design scores

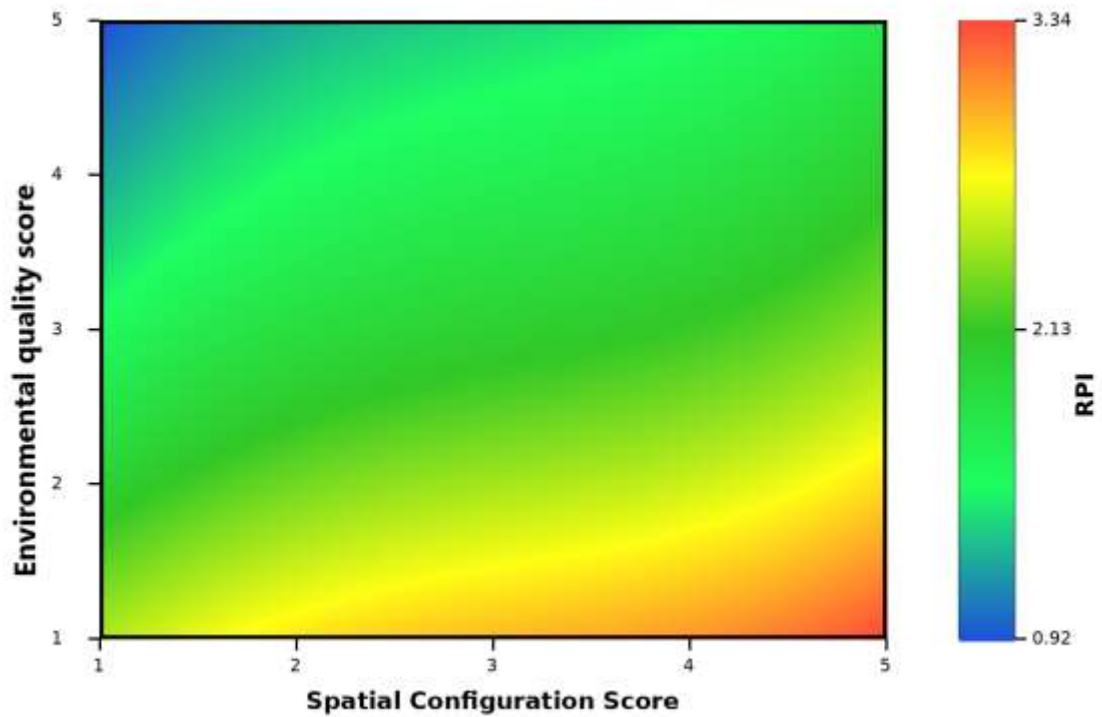


Figure 2. Surface area plot of Recovery Performance Index (RPI) across spatial configuration and environmental quality gradients

**Discussion**

**The influence of spatial configuration on recovery outcomes**

The results of this study indicate that spatial configuration plays a critical role in determining the recovery potential of bathroom environments within

domestic architecture. Bathrooms that exhibited increased usable floor area, improved fixture spacing, and higher circulation clearance demonstrated significantly better environmental performance and user-reported comfort levels. The consistent improvement in perceived relaxation and cognitive restoration scores observed in units with optimized

spatial layouts suggests that unobstructed movement pathways and clearly defined wet–dry zoning contribute to psychological ease and functional safety (Turner et al., 2016). These findings reinforce the notion that spatial organization is not merely a matter of ergonomic convenience but a determinant of restorative capacity, enabling occupants to engage in self-care routines without environmental constraints or discomfort (Rishbeth & Rogaly, 2018).

### **The role of environmental quality in sensory restoration**

Environmental quality parameters such as ambient illuminance, ventilation rate, and humidity control were found to exert a measurable influence on recovery-oriented outcomes. Bathrooms that maintained higher levels of natural or artificial lighting, alongside efficient air exchange rates, consistently reported improved thermal comfort and air freshness scores. This indicates that environmental stability contributes to physiological relaxation by minimizing sensory stressors associated with enclosed spaces. Adequate ventilation, in particular, appears to enhance perceptual comfort by regulating humidity and preventing stagnation of air, thereby creating a more breathable and calming environment (Zaniboni & Albatici, 2022). The positive correlation between environmental quality metrics and stress reduction ratings highlights the importance of integrating indoor climate control systems within wellness-driven bathroom design frameworks (Agarwal, 2023).

### **The contribution of material and sensory engagement strategies**

Material selection and sensory engagement parameters also emerged as influential determinants of recovery performance. Bathrooms incorporating materials with lower thermal conductivity and higher slip resistance demonstrated improved physical comfort indices, suggesting enhanced tactile interaction between users and built surfaces. Moreover, environments with higher acoustic absorption coefficients and daylight penetration indices exhibited greater perceived relaxation scores, underscoring the restorative benefits of multisensory engagement (Nousiainen et al., 2016). The presence of visually and acoustically moderated environments appears to facilitate cognitive decompression by reducing sensory overload and promoting calmness. These outcomes align with broader environmental psychology perspectives that emphasize the role of tactile warmth, visual softness, and acoustic dampening in fostering mental well-being within confined domestic spaces (Rohde et al., 2020).

### **The impact of ergonomic adaptability on user satisfaction**

Ergonomic adaptability was found to significantly influence user perceptions of comfort and environmental satisfaction. Bathrooms equipped with adjustable lighting systems, accessibility-oriented fixture placement, and compatibility in fixture height demonstrated higher perceived thermal comfort and air freshness ratings. This suggests that adaptable spatial

features enable users to modify their immediate environment according to individual preferences, thereby enhancing the sense of control and personal comfort (Hellwig, 2015). Such adaptability may be particularly beneficial in supporting diverse user needs across age groups and physical abilities. The improved recovery performance index observed in units with higher ergonomic adaptability scores indicates that personalization of environmental conditions is a key factor in transforming bathrooms into effective recovery spaces (Goulart & Ono, 2022).

### **The interaction of spatial and environmental variables in recovery performance**

The graphical representation of recovery indicators across increasing design scores reveals a progressive improvement in perceived relaxation, physical comfort, and cognitive restoration outcomes. This trend suggests that wellness-oriented design strategies exert a cumulative effect on user recovery, with each incremental improvement in spatial configuration or environmental quality contributing to enhanced restorative potential. Furthermore, the surface interaction between spatial configuration and environmental quality demonstrates that optimal recovery performance is achieved when both domains are addressed simultaneously (Luo et al., 2019). Bathrooms that combined efficient layout planning with stable environmental conditions consistently achieved higher recovery performance indices, indicating that restorative effectiveness is contingent upon the integrated performance of multiple architectural variables rather than isolated design interventions (Lindal & Hartig, 2013).

### **The spatial experience and organization of bathroom interiors within the domestic environment**

The spatial experience of the bathroom interior plays a crucial role in determining how effectively it functions as a recovery-oriented environment within domestic architecture. The organization of bathroom spaces influences both functional efficiency and psychological comfort, shaping how occupants interact with the environment during daily routines. Well-designed bathrooms provide clear spatial zoning between wet and dry areas, allowing fixtures such as showers, bathtubs, and wash basins to operate without spatial conflict while maintaining smooth circulation pathways. This arrangement supports intuitive movement patterns, enabling users to transition seamlessly between bathing, grooming, and relaxation activities. In addition, the relationship between the bathroom and adjacent domestic gathering areas such as bedrooms or private family spaces affects the overall spatial hierarchy within the home. When bathrooms are strategically positioned near private zones rather than high-traffic social areas, they maintain a sense of privacy and calm that enhances their restorative potential. Thoughtful spatial planning, including adequate circulation clearance, visual openness, and ergonomic fixture placement, therefore contributes not only to functional usability but also to the creation of a

tranquil interior environment where occupants can experience moments of personal recovery and well-being.

### The implications for wellness-oriented domestic architecture

The findings of this study underscore the importance of re-evaluating bathrooms as critical environments for physical and psychological recovery within residential settings. By integrating spatial optimization, environmental quality control, material comfort, and ergonomic adaptability, domestic bathrooms can transition from purely functional zones into restorative environments that actively support occupant well-being. The observed relationships between architectural design variables and recovery outcomes suggest that wellness-oriented strategies should be incorporated at the early stages of residential planning. Such an approach not only enhances user satisfaction but also contributes to the broader objective of designing homes that promote resilience, relaxation, and everyday recovery through intentional spatial interventions.

### Conclusion

This study demonstrates that bathrooms, when designed using wellness-oriented spatial, environmental, material, and ergonomic strategies, can function as effective micro-environments for facilitating physical relaxation and cognitive restoration within domestic architecture. The observed improvements in perceived relaxation, physical comfort, stress reduction, and cognitive recovery across bathroom units with optimized spatial configuration, enhanced environmental quality, and adaptive design features underscore the cumulative influence of built-environment attributes on occupant well-being. By integrating multisensory engagement, thermal stability, and user-responsive adaptability into everyday hygiene spaces, domestic bathrooms can transition from purely utilitarian zones into restorative environments that actively support recovery processes. The findings highlight the importance of adopting evidence-based design approaches that align architectural performance with human physiological and psychological needs, thereby reinforcing the role of wellness-driven bathroom environments in promoting holistic residential living.

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