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PROMOTING HEALTH THROUGH SUSTAINABLE INTERIOR ENVIRONMENTS IN APARTMENT COMPLEXES: COLOUR, LIGHT, SPACIOUSNESS, AND THE ROLE OF HOME ATTACHMENT

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Abstract

High-density apartment living presents unique challenges to residents' health and well-being, particularly in rapidly urbanizing contexts such as China. Drawing on Environmental Stress Theory (EST) and Biophilic Interior Design (BID), this study investigates how three key interior features—colour, light, and spaciousness (CLS)—affect residents' health rate through both direct sensory impacts and the emotional mechanism of home attachment, defined as emotional reliance on one's living space. A survey of 454 residents from apartment complexes in Haikou, China, was analyzed using structural equation modelling and multi-group analysis. Results indicate that colour and light have significant direct effects on health, whereas spaciousness influences health indirectly via home attachment. Gender differences were observed, with light exerting a stronger health effect for males than females. Findings extend EST by identifying home attachment as a coping mechanism and broaden BID's application beyond aesthetics, offering design guidance for sustainable apartments that enhance well-being.

Keywords: Colour, light and spaciousness, Environmental stress theory, Health rate, Home attachment, Sustainable apartments

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INTRODUCTION

Housing is increasingly recognized as a key social determinant of health and well-being (Foster et al., 2019; J. Y. Kim & Kim, 2022). Rapid urbanization and the prevalence of high-density housing have drawn attention to how interior design affects residents' physical and mental health (Colenberg & Jylhä, 2022; Huntsman & Bulaj, 2022). Nature-integrated indoor environments can alleviate stress and support psychological restoration (Colenberg & Jylhä, 2022), yet residents on higher floors often face limited access to nature, reducing such benefits (Larcombe et al., 2019). In China, where apartment complexes dominate urban housing, regulatory, spatial, and governance constraints exacerbate these challenges (Guo & Cui, 2025; Wu & Zhang, 2022), making health-promoting interior design a pressing priority in sustainable housing research.

Sensory design elements—especially colour, light, and spaciousness—significantly influence residential experiences and well-being (Ekhaese et al., 2025; Khanzadeh, 2024). Colour, light, and spaciousness not only serve functional purposes but also shape perception and emotion, enhancing mood and home attachment and creating restorative or stress-inducing spaces (McGee & Park, 2022; Morales-Bravo & Navarrete-Hernandez, 2022; Wei, 2024). However, little is known about how these elements interact with home attachment—the emotional reliance on one's living space. Given documented gender-based differences in environmental perception and affective responses, gender may act as a critical moderator linking interior design features to residents' emotional attachment and health outcomes (Costa et al., 2018; Knez, 2001; Liu et al., 2023). This study addresses this gap by examining the health effects of colour, light, and spaciousness in high-density apartments and the mediating role of home attachment, aligning with sustainability goals that promote psychological resilience and well-being. This provides a rationale for examining gender as a potential moderator in the present study.

Building on this rationale, the following research gaps are identified. First, little empirical work has examined how home attachment mediates the effects of specific residential features—particularly colour, light, and spaciousness, core dimensions of biophilic design—on health. Second, few studies have developed integrative models that assess these features' combined influence on home attachment and health in high-density urban housing. Third, while demographic differences in environmental perception (Costa et al., 2018) and in responses to light colour and mood (Knez, 2001) are documented, the moderating role of gender in these relationships remains underexplored. Addressing these gaps is vital for advancing inclusive, evidence-based interior design strategies that support sustainable residential well-being.

This study focuses on working adults aged 18–40, a demographic that typically spends substantial time in both occupational and residential settings,

making them particularly sensitive to the psychological and restorative functions of home environments (Evans & Cohen, 1987; Meagher & Cheadle, 2020). Accordingly, this study aims to (1) examine the effects of colour, light, and spaciousness on residents' health in apartment complexes; (2) investigate the mediating role of home attachment between these design features and health outcomes; and (3) assess gender differences in these relationships. The findings are expected to contribute to the literature by advancing theoretical understanding of the psychological pathways linking interior design to health, while offering practical guidance for sustainable residential design that fosters both physical and mental well-being.

LITERATURE REVIEW

Underlying Theory: EST and BID

This study adopts Environmental Stress Theory (EST) and Biophilic Interior Design (BID) to examine how sensory features influence residents' health. EST explains how sustained exposure to physical environmental stimuli triggers psychological and physiological responses, shaped by individual perceptions and coping thresholds (Evans & Cohen, 1987; Gifford, 2014). Stress arises when environmental demands exceed coping capacity, causing emotional, cognitive, or behavioural strain (Evans & Stecker, 2004). In residential settings, colour, light, and spaciousness are key stressors linked to chronic strain (Kamata et al., 2025; Morales-Bravo & Navarrete-Hernandez, 2022). Complementing this perspective, BID enhances well-being by integrating natural elements into built environments (Bolten & Barbiero, 2020; Kellert, 2008), promoting health through cognitive, emotional, and physiological engagement with nature. In residential contexts, natural colours, materials, and spatial forms can evoke positive emotional responses and contribute to holistic well-being (Bettaieb et al., 2023).

Previous studies on residential interior design and health

Previous studies have linked residential environments and biophilic interior design to health and well-being, yet most have examined housing quality, IEQ, or BID as broad concepts rather than specific interior features (Foster et al., 2019; Huntsman & Bulaj, 2022). Limited empirical research has jointly tested how colour, light, and spaciousness affect residents' health in high-density apartment complexes, particularly through psychological mechanisms such as home attachment. Although gender differences in environmental perception have been reported (Costa et al., 2018; Knez, 2001; Liu et al., 2023), little is known about whether gender moderates these interior design–attachment–health relationships. This study addresses these gaps by examining the effects of colour, light, and spaciousness on health through home attachment and by testing gender differences in apartment complexes.

Hypothesis development

CLS and Health

Colour evokes distinct emotional and physiological responses that shape residents' well-being, with warm tones often associated with relaxation and comfort, and cool tones linked to focus and alertness (Aguirre-Sosa et al., 2023). Light is equally critical, influencing visual comfort and circadian regulation; empirical evidence shows that natural light simulation and well-integrated light design can enhance psychological stability, improve well-being, and reduce cognitive fatigue (Obeidat et al., 2024). Similarly, spatial arrangements that promote openness and efficient circulation contribute to physical comfort and support positive psychological outcomes, indicating that CLS design strategies affect both environmental quality and residents' health (Obeidat et al., 2024). Based on this understanding, the following hypothesis is proposed:

H1a: colour is positively associated with residents' perceived health in apartment complexes.

H1b: light is positively associated with residents' perceived health in apartment complexes.

H1c: spaciousness is positively associated with residents' perceived health in apartment complexes.

Home attachment

Home attachment reflects a resident's emotional reliance on their living space, fostering a sense of identity and psychological satisfaction that supports positive mental health (Meagher, 2020; Meagher & Cheadle, 2020). Home attachment is strengthened by interior elements such as colour, which—due to its high degree of personalizability and emotional resonance—can enhance feelings of belonging and reinforce home attachment (Costa et al., 2018). Lighting enhances residents' home attachment in apartment complexes by improving spatial comfort, emotional well-being, and perceived safety (Peters & Halleran, 2020). In apartment complexes, spaciousness strengthens residents' home attachment by promoting comfort, social connectedness, and psychological health (Kleeman et al., 2022). Based on this understanding, the following hypothesis is proposed:

H2a: colour is positively associated with residents' home attachment in apartment complexes in interior design.

H2b: light is positively associated with residents' home attachment in apartment complexes in interior design.

H2c: spaciousness is positively associated with residents' home attachment in apartment complexes in interior design.

Home attachment also shapes comfort, stability, and overall psychological well-being (Meagher, 2020). Extensive research indicates that interior features such as colour, light, and spaciousness can promote well-being by fostering emotional engagement with the home (Costa et al., 2018; Meagher & Cheadle, 2020). However, the mediating role of home attachment in linking interior design features to health outcomes remains underexplored, despite evidence that emotionally resonant spaces enhance residents' comfort and stability (Meagher, 2020). Based on the above, the following hypotheses are proposed:

H3: Home attachment is positively associated with residents' health rates in apartment complexes.

H4a: Home attachment mediates the relationship between colour and health rates.

H4b: Home attachment mediates the relationship between light and health rates.

H4c: Home attachment mediates the relationship between spaciousness and health rates.

The moderating role of gender

Perceptions of interior design attributes, such as colour, light, and spatial configuration, are not uniform across demographic groups. Previous studies have identified significant differences in aesthetic preferences based on gender. For example, Liu et al. (2023) reported that male residents tend to prefer technologically dynamic and variable colour schemes, while female residents prefer softer, more uniform tones to convey emotional warmth. Women often perceive lighting as more emotionally salient and may show superior cognitive performance under certain conditions, with sex-based differences also evident in memory tasks depending on lighting context (Knez, 2001). Based on the above, the following hypotheses are proposed:

H4: Associations between study variables differ by gender.

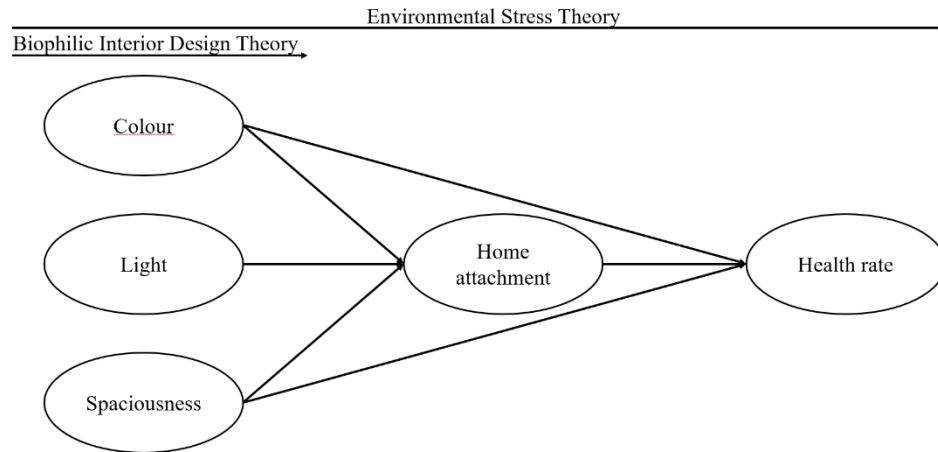


Fig.1. Theoretical model.
Source: Author's Summarize

RESEARCH METHODOLOGY

This study was conducted in the Shengda Jingdu Apartment Complex, a large-scale residential community located at the intersection of Guoxing Avenue and Meiyuan Road in Meilan District, Haikou City, Hainan Province, China. The complex consists of three development phases, comprising 3,279 households and approximately 8,253 residents, predominantly young and middle-aged individuals with stable socioeconomic conditions. A stratified random sampling method was used to ensure demographic and spatial representativeness across the three phases. Data were collected through face-to-face questionnaire surveys administered in apartments from February to March 2025, yielding 454 valid responses. The sample comprised 52.6% females and 47.4% males. The study focuses on working adults aged 18–40, a demographic often experiencing high work-related demands and relying on the home environment for psychological recovery and emotional stability. This demographic profile ensures relevance to the study's focus on gender differences and supports the multiple group analysis (MGA) in assessing moderation effects.

As all data were collected through self-reported questionnaires, common method bias was assessed before hypothesis testing. Harman's single-factor test showed that the first factor explained 33.019% of the total variance, below the 50% threshold (Podsakoff et al., 2003). In addition, all full collinearity VIF values were below 3.3, following Kock (2015). These results indicate that common method bias was unlikely to substantially affect the findings.

The questionnaire comprised two sections: demographic information and the main questionnaire items. Five variables were measured in total. Colour, light, and spaciousness were assessed using established scales from Cheng and

Marzuki (2023) and McGee et al. (2019). Home attachment was measured with items adapted from Scannell and Gifford (2010), while health rate was evaluated using scales from Chen et al. (2024) and Hedayati et al. (2020). All items in the questionnaire were scored on a 5-point Likert scale, ranging from ‘strongly disagree (1)’ to ‘strongly agree (5)’.

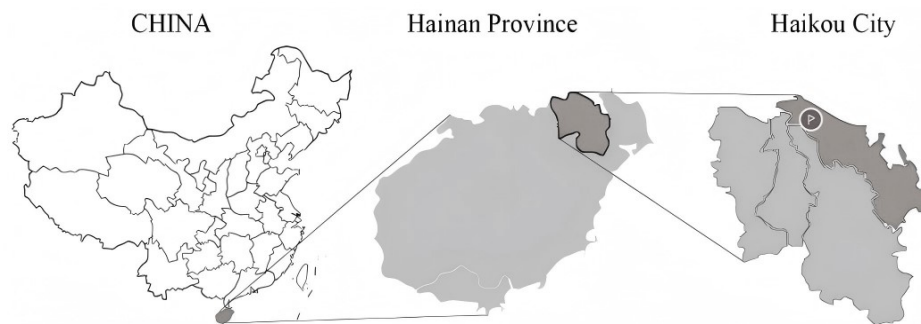


Fig.2. The Location of Hai Kou
(The authors by Google Map, 2026)

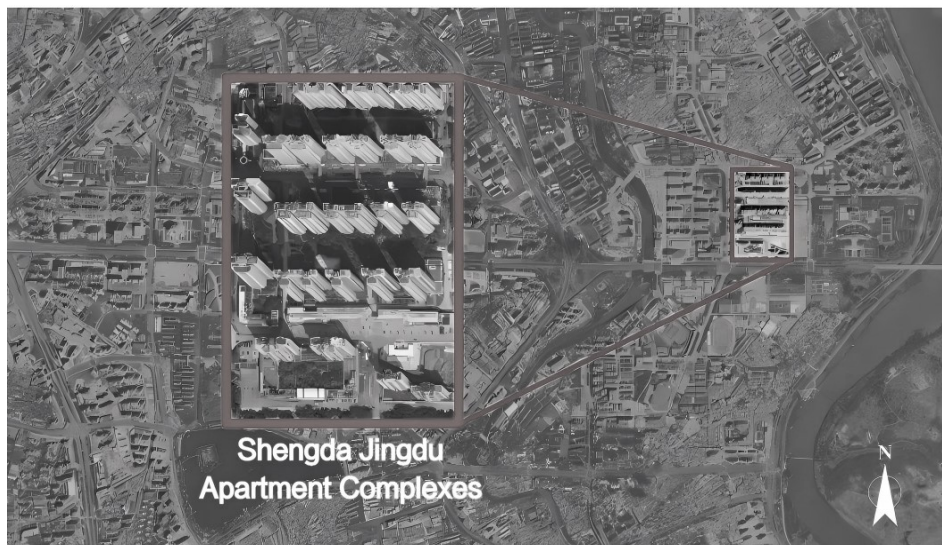


Fig.3. The Location of Shengda Jingdu Apartment Complexes
(The authors by Google Map, 2026)

RESULTS

Measurement Model Results

The reliability and validity of the constructs were assessed using SmartPLS outputs from the measurement model. All standardized factor loadings (0.712–

0.867) exceeded the recommended 0.708 threshold, confirming indicator reliability (Black & Babin, 2019; Hair et al., 2021; Henseler, 2009). Cronbach's alpha values ranged from 0.654 to 0.864, with most constructs exceeding the recommended 0.70 threshold. The slightly lower alpha (0.654) for spaciousness is acceptable given the construct's three-item scale and the exploratory nature of this study (Hair et al., 2019). Composite reliability values (0.812–0.903) for all constructs surpassed the 0.70 standard, demonstrating satisfactory internal consistency. Average Variance Extracted (AVE) values (0.543–0.682) exceeded the 0.50 criterion, indicating adequate convergent validity. Figure 5 presents the structural model for hypothesis testing.

Table 1: Reliability and Convergent Validity Results

Variable	Item	Loading	Alpha (α)	CR	AVE
Colour	C1	0.725	0.79	0.856	0.543
	C2	0.738			
	C3	0.765			
	C4	0.728			
	C5	0.729			
Light	L1	0.849	0.844	0.895	0.682
	L2	0.867			
	L3	0.8			
	L4	0.784			
Spaciousness	S1	0.775	0.654	0.812	0.59
	S2	0.774			
	S3	0.755			
Home attachment	HA1	0.797	0.862	0.9	0.644
	HA2	0.828			
	HA3	0.834			
	HA4	0.777			
	HA5	0.774			
Health rate	HR1	0.825	0.864	0.903	0.65
	HR2	0.712			
	HR3	0.816			
	HR4	0.844			
	HR5	0.827			

Source: Author's Calculation

Discriminant validity was assessed using the Heterotrait–Monotrait (HTMT) ratio. All HTMT values were below the 0.85 threshold, and the square root of each construct's AVE exceeded its correlations with other constructs (Fornell & Larcker, 1981; Hair et al., 2019, 2020, 2021), confirming satisfactory discriminant validity.

Table 2: Results of HTMT Ratios

	Colour	HA	HR	Light	Spaciousness
Colour					
HA	0.375				
HR	0.475	0.752			
Light	0.413	0.455	0.473		
Spaciousness	0.84	0.467	0.489	0.506	

Source: Author's Calculation

The coefficients of determination (R^2) for home attachment (0.209) and health rate (0.479) indicate weak-to-moderate explanatory power, according to the conventional thresholds of 0.25, 0.50, and 0.75 for weak, moderate, and substantial levels, respectively (Hair et al., 2019, 2020, 2021). The predictive relevance (Q^2) values of 0.131 for home attachment and 0.306 for health rate are above zero, confirming that the model has satisfactory predictive capability (Hair et al., 2019). Furthermore, the Goodness-of-Fit (GoF) index of 0.462 substantially exceeds the recommended cut-off value of 0.36 (Hedayati Marzbali et al., 2016), suggesting a high overall fit and explanatory adequacy of the model.

Table 3: Coefficient of determination, predictive relevance, and GOF of model calculation.

Variable	Items	PLS-SEM RMSE	LM RMSE	Q^2	R^2	AVE	GOF
Colour	-	-	-	-	-	0.543	
Light	-	-	-	-	-	0.682	
Spaciousness	-	-	-	-	-	0.59	
HA	HA1	0.89	0.903	0.131	0.209	0.644	0.462
	HA2	0.944	0.964				
	HA3	0.867	0.881				
	HA4	0.957	0.968				
	HA5	0.906	0.923				
HR	HR1	0.798	0.805	0.306	0.479	0.65	
	HR2	0.805	0.825				
	HR3	0.756	0.77				
	HR4	0.806	0.82				
	HR5	0.749	0.754				

Source: Author's Calculation

Structural Model Results

The structural model (Table 4) was assessed following the recommendations of Hair et al. (2021). Colour (H1a: $\beta = 0.162$, $p < 0.01$) and Light (H1b: $\beta = 0.125$, $p < 0.01$) had significant positive effects on Health Rate, whereas Spaciousness was not significant (H1c: $\beta = 0.036$, $p = 0.213$). All three features—Colour (H2a: $\beta = 0.110$, $p < 0.05$), Light (H2b: $\beta = 0.286$, $p < 0.01$), and Spaciousness (H2c: β

= 0.178, $p < 0.01$)—positively affected Home attachment, which also showed a strong positive association with Health Rate (H3: $\beta = 0.540$, $p < 0.01$).

Table 4: Results of Path Coefficient and Hypothesis Testing (Direct Effects)

HS	Relationship	β	T	P	95% CIs	f^2	VIF	Decision
H1a	Colour -> HR	0.162	2.76	0.003***	[0.068, 0.261]	0.031	1.629	Support
H1b	Light -> HR	0.125	2.485	0.006***	[0.042, 0.208]	0.023	1.297	Support
H1c	Spaciousness -> HR	0.036	0.798	0.213	[-0.041, 0.109]	0.001	1.706	Not support
H2a	Colour -> HA	0.11	1.813	0.035*	[0.007, 0.206]	0.009	1.614	Support
H2b	Light -> HA	0.286	5.422	0***	[0.195, 0.369]	0.086	1.194	Support
H2c	Spaciousness -> HA	0.178	3.285	0.001***	[0.091, 0.269]	0.024	1.666	Support
H3	HA -> HR	0.54	11.623	0***	[0.457, 0.611]	0.442	1.264	Support

$P < 0.05$ * $P < 0.01$ ***

Source: Author's Calculation

Furthermore, in the structural model assessment presented in table 6, mediating effects of home attachment were observed in the relationships between colour and health rate (H4: $\beta = 0.059$, $p < 0.05$), light and health rate (H5: $\beta = 0.154$, $p < 0.01$), and spaciousness and health rate (H6: $\beta = 0.096$, $p < 0.01$), indicating that home attachment plays a significant mediating role across all three design dimensions. According to Chin (1998), f^2 effect size values of 0.02, 0.15, and 0.35 are interpreted as small, moderate, and substantial.

Table 5: Results of Path Coefficient and Hypothesis Testing (Indirect Effects)

HS	Relationship	β	T	P	95% CIs	Decision
H4a	Colour -> HA -> HR	0.059	1.852	0.032	[0.004, 0.109]	Support
H4b	Light -> HA -> HR	0.154	4.803	0	[0.102, 0.209]	Support
H4c	Spaciousness -> HA -> HR	0.096	3.042	0.001	[0.048, 0.152]	Support

$P < 0.05$ * $P < 0.01$ ***

Source: Author's Calculation

MGA

An MGA was conducted in Smart PLS 4.0 to examine group differences, with measurement invariance confirmed using the MICOM procedure (Barroso et al., 2018; Henseler, 2009). Results showed gender as the strongest moderator, with light having a greater effect on health rate for males ($\beta = 0.250$, $p = 0.001$) than for females ($\beta = 0.073$, $p = 0.112$; PLS-MGA = 0.038).

Table 6: Comparison of model relationship by two groups using Henseler's MGA test

H S	Relatio nship	β	P	95% CIs	β	P	95% CIs	PLS- MGA	Supported
	Gender	Female			Male				
	Colour -> HA	0.064	0.186	[-0.062, 0.173]	0.202	0.018 *	[0.052, 0.364]	0.122	NO/YES
H 4	Colour -> HR	0.172	0.011 *	[0.052, 0.301]	0.099	0.114	[-0.028, 0.239]	0.253	YES/NO
	Light -> HR	0.073	0.112	[-0.029, 0.169]	0.25	0.001 ***	[0.122, 0.377]	0.038 *	NO/YES

$P < 0.05$ * $P < 0.01$ ***

Source: Author's Calculation

DISCUSSIONS

Drawing on EST and BID, this study shows that colour, light, and spatial configuration influence residents' health in different ways within apartment complexes. Consistent with EST, environmental demands can trigger psychological and physiological stress when they exceed coping capacity (Evans & Cohen, 1987; Evans & Stecker, 2004; Gifford, 2014). The findings show that light and colour directly improve perceived health, while spaciousness works indirectly through home attachment, confirming the role of residential attachment as a psychological mechanism under prolonged environmental exposure (Meagher & Cheadle, 2020).

The insignificant direct effect of spaciousness may indicate that spatial perception influences health only after being emotionally internalized through comfort and control. This aligns with Meagher and Cheadle (2020), who emphasize place attachment as a mediator of environmental experience, and with McGee et al. (2019), who suggest that spatial dimensions support restoration when combined with symbolic or functional cues. Thus, home attachment functions as a sustainability-relevant mechanism, whereby emotional and symbolic bonds with the home translate prolonged environmental exposure into health benefits, consistent with EST (Evans & Stecker, 2004; Kamata et al., 2025).

The multigroup analysis showed that only the light to health path was significantly moderated by gender, with a stronger effect among males. This may reflect women's higher dissatisfaction or expectations regarding light, reducing

their sensitivity to incremental improvements (Kim et al., 2013), whereas men may perceive improved light quality more directly as comfort and emotional regulation (Liu et al., 2023). Although colour showed gender-based variations, these differences were not statistically significant, suggesting that colour responses may depend more on individual aesthetic orientation and contextual experience than gender alone (Costa et al., 2018). Since emotional ties to home are shaped by layered sensory and symbolic interactions (Meagher & Cheadle, 2020), the findings support user-centered and demographically inclusive design rather than fixed gender assumptions.

The findings support sustainable residential design through optimized natural light, responsive colour schemes, and perceived spaciousness, while guiding policymakers to integrate evidence-based interior design into high-density housing programmes.

CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

This study found that colour and light directly enhance perceived health, while spaciousness exerts an indirect effect through home attachment, with light emerging as the most influential factor (Sholanke et al., 2021). This conclusion is based on the combined direct and indirect effects, with light showing a moderate direct effect on health ($\beta = 0.125$) and the largest indirect effect via home attachment ($\beta = 0.154$), resulting in the highest overall influence among the three design dimensions. Home attachment functions as a key psychological mechanism linking interior design to well-being (Meagher & Cheadle, 2020), and multigroup analysis suggests gender differences in sensitivity to light and colour, though not all were statistically significant. These findings underscore the value of personalized, gender-sensitive design strategies in promoting inclusive well-being within sustainable housing contexts (J. Kim et al., 2013; Liu et al., 2023).

This study also has certain limitations. First, this study's generalizability may be limited by its single-site sample in Haikou and reliance on self-reported measures, which are subject to contextual and response biases. Second, the cross-sectional design limits causal inference and prevents tracking changes in environmental perceptions and psychological outcomes over time. It also limits the ability to fully address endogeneity concerns. Future research could use longitudinal, experimental, or multi-source data to further validate the causal relationships among interior design features, home attachment, and residents' health. Third, this study focused on colour, light, and spaciousness, excluding other biophilic elements like materiality or sensory variability that may also impact well-being (McGee et al., 2019). Fourth, the empirical model focused on interior design features, home attachment, and gender differences, while broader socioeconomic and housing-related factors, such as household income, housing expenditure, housing affordability, housing prices, and cost of living, were not

included. Future research could incorporate these contextual variables to provide a more comprehensive explanation of how residential interior environments and broader living conditions jointly shape residents' health and well-being.

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REFERENCES

- Aguirre-Sosa, J., Dextre, M. L., Lozada-Urbano, M., & Vargas-Merino, J. A. (2023). Background of Peruvian gastronomy and its perspectives: An assessment of its current growth. *Journal of Ethnic Foods*, 10(1), 50. <https://doi.org/10.1186/s42779-023-00212-4>
- Barroso, A., González-López, Ó., Sanguino, R., & Buenadicha-Mateos, M. (2018). Analysis and Evaluation of the Largest 500 Family Firms' Websites through PLS-SEM Technique. *Sustainability*, 10(2), 557. <https://doi.org/10.3390/su10020557>
- Bettaieb, D. M., Mohammed, W., & Khawaji, S. (2023). Exploring Visual Biophilic Interior Design Features in Homes: An Experimental Study through a Virtual Environment Design. *The International Journal of Architectonic, Spatial, and Environmental Design*, 18(1), 45–73. <https://doi.org/10.18848/2325-1662/CGP/v18i01/45-73>
- Black, W., & Babin, B. J. (2019). Multivariate Data Analysis: Its Approach, Evolution, and Impact. In B. J. Babin & M. Sarstedt (Eds.), *The Great Facilitator* (pp. 121–130). Springer International Publishing. https://doi.org/10.1007/978-3-030-06031-2_16
- Bolten, B., & Barbiero, G. (2020). Biophilic Design: How to enhance physical and psychological health and wellbeing in our built environments. *Visions for Sustainability*, No 14 (2020). <https://doi.org/10.13135/2384-8677/3829>
- Colenberg, S., & Jylhä, T. (2022). Identifying interior design strategies for healthy workplaces – a literature review. *Journal of Corporate Real Estate*, 24(3), 173–189. <https://doi.org/10.1108/JCRE-12-2020-0068>
- Costa, M., Frumento, S., Nese, M., & Predieri, I. (2018). Interior Color and Psychological Functioning in a University Residence Hall. *Frontiers in Psychology*, 9, 1580. <https://doi.org/10.3389/fpsyg.2018.01580>
- Ekhaese, E., Hussain, W., Ndimako, O. O., Hussain, K., & Owoseni, A. (2025). Sensory sustainable homes, a study of the healthy happy home (3H) conceptual design model: An explanatory qualitative study. *Frontiers in Sustainable Cities*, 7, 1506672. <https://doi.org/10.3389/frsc.2025.1506672>
- Evans, G. W., & Cohen, S. (1987). *Environmental Stress.pdf*.
- Evans, G. W., & Stecker, R. (2004). Motivational consequences of environmental stress. *Journal of Environmental Psychology*, 24(2), 143–165. [https://doi.org/10.1016/S0272-4944\(03\)00076-8](https://doi.org/10.1016/S0272-4944(03)00076-8)
- Fornell, C., & Larcker, D. F. (1981). *Structural Equation Models with Unobservable Variables and Measurement Error: Algebra and Statistics*.

- Foster, S., Maitland, C., Hooper, P., Bolleter, J., Duckworth-Smith, A., Giles-Corti, B., & Arundel, J. (2019). High Life Study protocol: A cross-sectional investigation of the influence of apartment building design policy on resident health and well-being. *BMJ Open*, 9(8), e029220. <https://doi.org/10.1136/bmjopen-2019-029220>
- Gifford, R. (2014). Environmental Psychology Matters. *Annual Review of Psychology*, 65(1), 541–579. <https://doi.org/10.1146/annurev-psych-010213-115048>
- Guo, X., & Cui, X. (2025). GIS-Based Study on the Suitability of Site Selection for Community Complexes in Old Residential Areas in Xi'an, China. *Buildings*, 15(4), 551. <https://doi.org/10.3390/buildings15040551>
- Hair, J. F., Howard, M. C., & Nitzl, C. (2020). Assessing measurement model quality in PLS-SEM using confirmatory composite analysis. *Journal of Business Research*, 109, 101–110. <https://doi.org/10.1016/j.jbusres.2019.11.069>
- Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). *Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook*. Springer International Publishing. <https://doi.org/10.1007/978-3-030-80519-7>
- Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31(1), 2–24. <https://doi.org/10.1108/EBR-11-2018-0203>
- Hedayati Marzbali, M., Abdullah, A., & Maghsoodi Tilaki, M. J. (2016). The effectiveness of interventions in the built environment for improving health by addressing fear of crime. *International Journal of Law, Crime and Justice*, 45, 120–140. <https://doi.org/10.1016/j.ijlcj.2015.12.002>
- Henseler, J. (2009). The use of partial least squares path modeling in international marketing. In C. M. Ringle & R. R. Sinkovics, *Advances in International Marketing* (pp. 277–319). Emerald Group Publishing Limited. [https://doi.org/10.1108/s1474-7979\(2009\)0000020014](https://doi.org/10.1108/s1474-7979(2009)0000020014)
- Huntsman, D. D., & Bulaj, G. (2022). Healthy Dwelling: Design of Biophilic Interior Environments Fostering Self-Care Practices for People Living with Migraines, Chronic Pain, and Depression. *International Journal of Environmental Research and Public Health*, 19(4), 2248. <https://doi.org/10.3390/ijerph19042248>
- Kamata, T., Nakano, J., Fujii, R., Murakami, S., Ikaga, T., & Kawakubo, S. (2025). Survival time analysis of the relationship between the residential environment and residents' health status. *Building and Environment*, 267, 112305. <https://doi.org/10.1016/j.buildenv.2024.112305>
- Kellert, S. R. (2008). *Dimensions, elements, and attributes of biophilic design*.
- Khanzadeh, M. (2024). ENHANCING USER EXPERIENCE IN INTERIOR ARCHITECTURE THROUGH BIOPHILIC DESIGN: A CASE STUDY OF URBAN RESIDENTIAL SPACES. *New Design Ideas*, 8(1), 137–168. <https://doi.org/10.62476/ndi81137>
- Kim, J., De Dear, R., Cândido, C., Zhang, H., & Arens, E. (2013). Gender differences in office occupant perception of indoor environmental quality (IEQ). *Building and Environment*, 70, 245–256. <https://doi.org/10.1016/j.buildenv.2013.08.022>
- Kim, J. Y., & Kim, Y. O. (2022). Residents' Spatial-Usage Behavior and Interaction According to the Spatial Configuration of a Social Housing Complex: A

- Comparison between High-Rise Apartments and Perimeter Block Housing. *Sustainability*, 14(3), 1138. <https://doi.org/10.3390/su14031138>
- Kleeman, A., Hooper, P., Giles-Corti, B., & Foster, S. (2022). A new Australian dream? Exploring associations between apartment design attributes and housing satisfaction in three Australian cities. *Cities*, 131, 104043. <https://doi.org/10.1016/j.cities.2022.104043>
- Knez, I. (2001). EFFECTS OF COLOUR OF LIGHT ON NONVISUAL PSYCHOLOGICAL PROCESSES. *Journal of Environmental Psychology*, 21(2), 201–208. <https://doi.org/10.1006/jevp.2000.0198>
- Kock, N. (2015). Common method bias in PLS-SEM: A full collinearity assessment approach. In *International Journal of e-Collaboration* (Vol. 11, Number 4).
- Larcombe, D.-L., Etten, E. V., Logan, A. C., Prescott, S. L., & Horwitz, P. (2019). LIVING ON A HIGHER FLOOR LEVEL AS A DETERRENT TO A 'NATURISTIC' LIFESTYLE – RETHINKING DESIGN OF APARTMENT BUILDINGS.
- Liu, Y., Zhou, Z., & Xu, Y. (2023). *Design Element Preferences in Public Facilities: An Eye Tracking Study*. <https://doi.org/10.3390/land12071411>
- McGee, B., Park, N., Portillo, M., Bosch, S., & Swisher, M. (2019). DIY BIOPHILIA: DEVELOPMENT OF THE BIOPHILIC INTERIOR DESIGN MATRIX AS A DESIGN TOOL. *Journal of Interior Design*, 44(4), 201–221. <https://doi.org/10.1111/joid.12159>
- McGee, B., & Park, N.-K. (2022). Colour, Light, and Materiality: Biophilic Interior Design Presence in Research and Practice. *Interiority*, 5(1). <https://doi.org/10.7454/in.v5i1.189>
- Meagher, B. R. (2020). Ecologizing Social Psychology: The Physical Environment as a Necessary Constituent of Social Processes. *Personality and Social Psychology Review*, 24(1), 3–23. <https://doi.org/10.1177/1088868319845938>
- Meagher, B. R., & Cheadle, A. D. (2020). Distant from others, but close to home: The relationship between home attachment and mental health during COVID-19. *Journal of Environmental Psychology*, 72, 101516. <https://doi.org/10.1016/j.jenvp.2020.101516>
- Morales-Bravo, J., & Navarrete-Hernandez, P. (2022). Enlightening wellbeing in the home: The impact of natural light design on perceived happiness and sadness in residential spaces. *Building and Environment*, 223, 109317. <https://doi.org/10.1016/j.buildenv.2022.109317>
- Obeidat, A. M., Obeidat, A. M., & Assistant professor of interior design, Department of Interior Design, Faculty of Art and Design, Ajloun National University, Jordan. (2024). Interior Design Strategies for Improving Quality of Life: How Can Residential Spaces Reflect a Healthy Lifestyle and Psychological Comfort. *International Journal for Housing Science and Its Applications*, 45(4), 71–86. <https://doi.org/10.70517/ijhsa4547>
- Peters, T., & Halleran, A. (2020). How our homes impact our health: Using a COVID-19 informed approach to examine urban apartment housing. *Archnet-IJAR: International Journal of Architectural Research*, 15(1), 10–27. <https://doi.org/10.1108/ARCH-08-2020-0159>

- Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies. In *Journal of Applied Psychology* (Vol. 88, Number 5, pp. 879–903). American Psychological Association Inc. <https://doi.org/10.1037/0021-9010.88.5.879>
- Sholanke, A., Fadesere, O., & Elendu, D. (2021). The Role of Artificial Lighting in Architectural Design: A Literature Review. *IOP Conference Series: Earth and Environmental Science*, 665(1), 012008. <https://doi.org/10.1088/1755-1315/665/1/012008>
- Wei, H. (2024). *DecorPGNet: Functional Area Division and Layout Algorithm Model in Living Rooms of Chinese Apartment-Style Family Homes*. <https://doi.org/10.19080/CERJ.2024.15.555902>
- Wu, F., & Zhang, F. (2022). Rethinking China's urban governance: The role of the state in neighbourhoods, cities and regions. *Progress in Human Geography*, 46(3), 775–797. <https://doi.org/10.1177/03091325211062171>

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