

## Apartment complexes and well-being: Interior natural elements shape stress and belonging

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| ARTICLE INFO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | ABSTRACT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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| <p><i>Article history:</i><br/>Received March 25, 2026<br/>Received in revised form April 20, 2026<br/>Accepted July 22, 2026<br/>Available online September 01, 2026</p> <p><i>Keywords:</i><br/>Apartment complexes<br/>Natural elements<br/>Perceived stress<br/>Sense of belonging<br/>Well-being</p> <p><b>*Corresponding author:</b> Safial Aqbar Zakaria<br/>School of Housing, Building and Planning,<br/>Universiti Sains Malaysia<br/>Email: <a href="mailto:ssafial@usm.my">ssafial@usm.my</a><br/>ORCID: <a href="https://orcid.org/0000-0002-8299-6387">https://orcid.org/0000-0002-8299-6387</a></p> | <p><i>High-density residential apartment complexes have become a dominant residential form in rapidly urbanizing cities, increasing residents' reliance on interior environments for emotional regulation and psychological stability. Although natural elements are widely recognized as beneficial for well-being, empirical evidence linking interior biophilic features to well-being in residential settings remains limited. Prior research has largely focused on outdoor green exposure or workplace environments and has often examined stress reduction alone, leaving the combined roles of stress alleviation and sense of belonging underexplored within apartment complexes. This study investigates how interior natural elements influence well-being through perceived stress and sense of belonging in high-density apartment complexes in Haikou, China. Survey data were collected from 454 working-age residents and analyzed using partial least squares structural equation modeling. The results show that interior natural elements significantly alleviate perceived stress and strengthen belongingness, both of which positively predict well-being. Although a direct association between natural elements and well-being is observed, the primary influence operates through these psychological pathways. By integrating stress-based and belonging-based mechanisms within a unified residential model, this study clarifies how interior natural design supports mental health in high-density apartment complexes and highlights its relevance for promoting well-being in rapidly urbanizing contexts.</i></p> |

## Introduction

Residential environments constitute a critical everyday context in which psychological well-being is continuously shaped and negotiated (Morales-Bravo and Navarrete-Hernandez 2022). In high-density urban settings, where residents spend substantial time within confined built spaces, the presence of natural elements such as vegetation, water features, and landscaped open areas has been increasingly regarded as a potential buffer against psychological strain (Liu et al.

2022; White et al. 2021). Prior research has linked exposure to natural environments with reduced stress and improved affective states, yet much of this evidence derives from public green spaces, parks, or workplace settings (Li et al. 2023; Yao, Zhang, and Gong 2021). Comparatively less attention has been directed toward residential apartment complexes, where environmental exposure is routine, proximate, and embedded in daily life, particularly within rapidly urbanizing Chinese cities characterized by vertical housing

and compact spatial arrangements (Guo et al. 2021; H. Hu et al. 2025).

Despite the growing incorporation of natural features into residential design, the conceptualization of their psychological impact remains fragmented (Allard-Poesi, Matos, and Massu 2022; Meagher 2020). Existing studies frequently privilege single-outcome models, focusing either on stress reduction or on subjective well-being, while overlooking the potential role of social-psychological constructs such as sense of belonging (Bai et al. 2025; Rugel et al. 2019). Moreover, empirical investigations often assume indirect or restorative mechanisms without systematically examining whether environmental perceptions exert independent and concurrent influences on psychological strain, social attachment, and well-being (Bai et al. 2025; Rugel et al. 2019). As a result, the structural relationships among natural elements, perceived stress, sense of belonging, and well-being remain insufficiently specified within residential contexts (Allen et al. 2021).

To address these gaps, this study investigates the direct structural relationships among perceived natural elements, perceived stress, sense of belonging, and well-being within an apartment complex located in Haikou, Hainan Province, China (Allard-Poesi, Matos, and Massu 2022; Tae, Jeong, and Chon 2022). Using questionnaire survey data and structural equation modeling, the study tests a model in which environmental perception, psychological strain, and social attachment are treated as parallel predictors of well-being (Guo et al. 2021; Yang et al. 2020). The findings demonstrate that perceived natural elements are significantly associated with lower perceived stress, stronger sense of belonging, and higher levels of well-being, while both perceived stress and sense of belonging exhibit significant direct effects on well-being (Han et al. 2022; Wang et al. 2023). By clarifying the concurrent roles of psychological and social processes in residential settings, this study contributes empirical evidence from a high-density tropical urban context and advances a more differentiated understanding of how natural design strategies support well-being in contemporary apartment living (Ancora et al. 2022; Guo et al. 2021).

## Literature review

### Natural elements and well being

In this study, natural elements are operationalized through two dimensions derived from the Biophilic Interior Design Matrix (BID-M): Actual Natural Features and Natural Shapes and Forms (McGee et al. 2019). Actual Natural Features refer to the direct presence of real natural components in apartment interiors, such as vegetation, daylight, and natural ventilation, reflecting the applied expression of the Biophilia Hypothesis (Kellert 2008; Wilson 2010). Natural Shapes and Forms denote the indirect representation of nature through biomorphic patterns, organic geometries, and nature-inspired textures that symbolically evoke ecological characteristics (McGee et al. 2019; McGee and Park 2022). The linkage between these dimensions and well-being is theoretically supported by Attention Restoration Theory and Stress Reduction Theory. ART posits that environments rich in natural cues facilitate recovery from directed attention fatigue through soft fascination and perceptual coherence (R. Kaplan and Kaplan 1989; S. Kaplan 1995), while SRT suggests that exposure to natural characteristics promotes affective calmness and physiological stress recovery (Ulrich et al. 1991; Xing et al. 2025). Accordingly, both direct and indirect natural elements embedded in apartment interiors are expected to positively contribute to office workers' psychological well-being.

H1: Natural Elements significantly impacts Well Being.

### Perceived stress

Perceived stress refers to individuals' subjective appraisal of life demands as unpredictable and uncontrollable relative to their coping capacity (Evans and Cohen 1987; Yin et al. 2019). Within Stress Reduction Theory, stress reflects heightened physiological arousal and negative affect, whereas supportive natural environments promote emotional recovery and reduced stress responses (Shaffee and Shukor 2018; Ulrich et al. 1991). In interior contexts, Actual Natural Features and Natural Shapes and Forms core dimensions of biophilic interior design (McGee et al. 2019), grounded in the Biophilia Hypothesis (Kellert 2008; Wilson 2010) provide restorative cues that are theoretically associated with lower perceived stress. Reduced perceived stress, in turn, is linked to improved emotional balance and higher well-being, while

elevated stress undermines psychological functioning and life satisfaction (Kartol et al. 2024; Ulrich et al. 1991).

H2: Natural Elements significantly impacts perceived stress.

H3: Perceived stress significantly impacts Well Being.

#### Sense of belonging

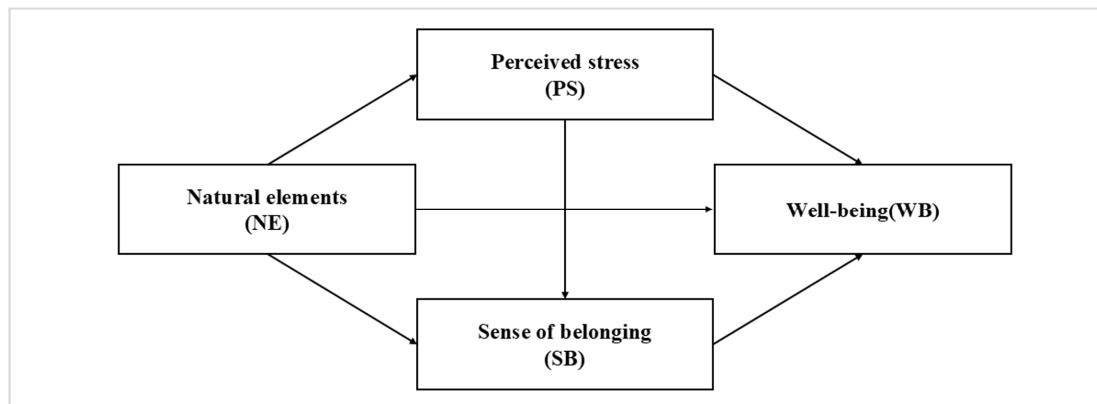
Sense of belonging refers to an individual's perceived acceptance, value, and emotional connection within a social or spatial context (Baumeister and Leary 2007; Gillis and Gatersleben 2015). In residential settings, it reflects affective attachment and perceived fit between residents and their living environments. Interior natural elements, including Actual Natural Features and Natural Shapes and Forms, may strengthen this bond (Mcgee 2018). Drawing on the Biophilia Hypothesis, natural characteristics evoke familiarity and comfort, enhancing emotional stability and belonging in high-density apartments (Kellert 2008; Wilson 2010; Ríos-Rodríguez et al. 2024).

Sense of belonging is a fundamental psychological need and a strong predictor of well-being (Baumeister and Leary 2007; Counted et al. 2025). Stronger belonging is associated with greater life satisfaction, whereas unmet belonging contributes to distress. Perceived stress, defined as the appraisal of demands as overwhelming, may undermine belonging by weakening emotional security (Evans and Cohen 1987; Yılmaz Koğar and Koğar 2024). Elevated stress is linked to anxiety and reduced connectedness, indicating a negative association between perceived stress and belonging (Acoba 2024). Accordingly, belonging is expected to positively relate to well-being, while perceived stress is negatively associated with belonging.

H4: Natural Elements significantly impacts sense of belonging.

H5: Sense of belonging significantly impacts well being.

H6: Perceived stress significantly impacts sense of belonging



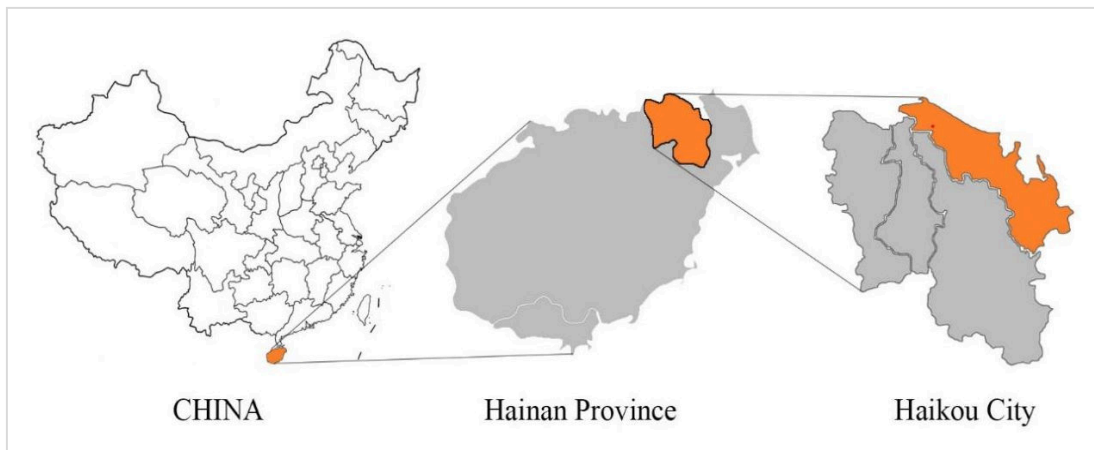
**Figure 1.** The conceptual pathway between the study variables

## Methods

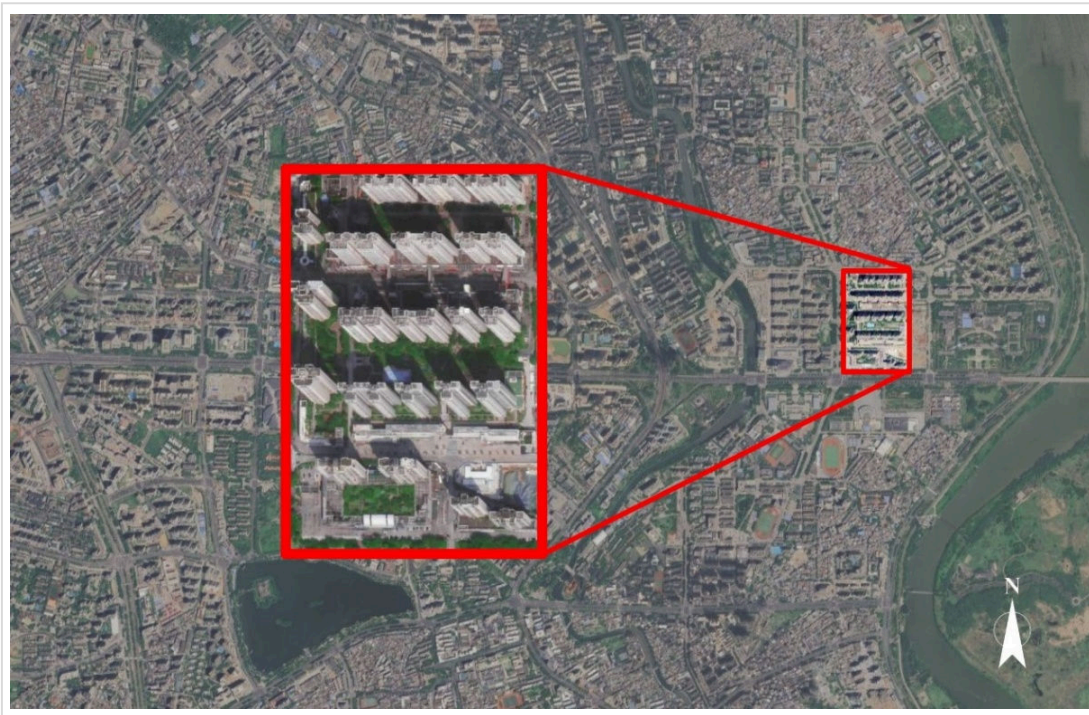
### Study context

This study was conducted in Haikou, China, a rapidly urbanizing tropical city characterized by high-density, high-rise residential development (Pu and Xia 2023). Due to the hot-humid climate and vertically concentrated living patterns, residents rely heavily on indoor environments for comfort and psychological regulation (Jiaxi Hu et al. 2024; Kong et al. 2019).

A three-stage spatial screening process identified Shengda Jingdu Residential Complex in Meilan District as the study site, selected for its residential concentration, stable management, and relatively homogeneous working-age population. Given prolonged indoor exposure and limited contact with nature, interior natural elements represent critical resources influencing perceived stress and psychological experience (Kong et al. 2019; Kumari and Dubey 2023).



**Figure 2.** Map of Meilan district of Haikou city, Hainan Province, China



**Figure 3.** Map of the Shengda Jingdu Apartment complex

#### Measurement

Data were collected through questionnaire survey examining natural element design, perceived stress, belongingness, and psychological health. The survey included sociodemographic information and validated scales measuring core constructs.

Natural element design was adapted from the Biophilic Interior Design framework (Kellert 2008; McGee 2018; McGee et al. 2019). Perceived stress was measured using established scales (Afacan, 2023; Shahid et al. 2011). Sense of

belonging captured emotional attachment to the residential environment (HAGERTY and PATUSKY 1995; Malone, Pillow, and Osman 2012; Mellinger et al. 2024), and well-being reflected global life satisfaction and emotional balance (Diener 1984; Diener et al. 1985). All items used a five-point Likert scale. The instrument was reviewed and pilot-tested to ensure validity and reliability (Nunnally and Bernstein 1994; Polit and Beck 2006).

## Procedure

Structural relationships were examined using Partial Least Squares Structural Equation Modeling (PLS-SEM), given its suitability for theory-driven predictive models involving multiple latent variables and mediating pathways (Joseph F. Hair et al. 2019; Joe F. Hair, Howard, and Nitzl 2020; Joseph F. Hair et al. 2021). The analysis proceeded in two stages. The measurement model was first evaluated to confirm construct reliability and validity. Subsequently, the structural model was assessed by estimating path coefficients ( $\beta$ ), explanatory power ( $R^2$ ), and effect sizes ( $f^2$ ). The statistical significance of hypothesized direct and indirect effects was determined through bootstrapping with 5,000 resamples (Joseph F. Hair et al. 2019).

## Results and discussion

### Respondents' profile

A total of 454 valid responses were obtained from residents aged 18–40. Most participants were female (68.3%), Chinese (96.3%), and

tertiary educated (88.5%); 61.5% were married and 54.8% had children. The largest age group was 26–30 years (43.2%), and most households reported monthly incomes of RMB 4,001–7,000 (40.3%).

### Measurement model

Table 1 presents the results of the measurement model assessment, including indicator loadings, internal consistency reliability, convergent validity, and discriminant validity.

All standardized factor loadings ranged from 0.703 to 0.872, exceeding the recommended threshold of 0.70, thereby confirming acceptable indicator reliability. Cronbach's alpha values varied between 0.722 (ANF) and 0.897 (PS), while composite reliability (CR) values ranged from 0.827 to 0.924, all surpassing the recommended cutoff of 0.70, indicating satisfactory internal consistency across constructs. Convergent validity was supported by Average Variance Extracted (AVE) values between 0.545 and 0.708, exceeding the minimum criterion of 0.50.

**Table 1.** Reliability and convergent validity results

| Construct | Item | FL    | Cronbach's alpha | CR    | AVE   |
|-----------|------|-------|------------------|-------|-------|
| ANF       | ANF2 | 0.757 | 0.722            | 0.827 | 0.545 |
|           | ANF3 | 0.732 |                  |       |       |
|           | ANF4 | 0.74  |                  |       |       |
|           | ANF5 | 0.724 |                  |       |       |
| NSF       | NSF1 | 0.769 | 0.779            | 0.858 | 0.603 |
|           | NSF2 | 0.828 |                  |       |       |
|           | NSF3 | 0.8   |                  |       |       |
|           | NSF4 | 0.703 |                  |       |       |
| PS        | PS1  | 0.837 | 0.897            | 0.924 | 0.708 |
|           | PS2  | 0.841 |                  |       |       |
|           | PS3  | 0.872 |                  |       |       |
|           | PS4  | 0.839 |                  |       |       |
|           | PS5  | 0.818 |                  |       |       |
| SB        | SB1  | 0.809 | 0.774            | 0.869 | 0.688 |
|           | SB2  | 0.856 |                  |       |       |
|           | SB3  | 0.823 |                  |       |       |
| WB        | WB1  | 0.831 | 0.896            | 0.923 | 0.707 |
|           | WB2  | 0.85  |                  |       |       |
|           | WB3  | 0.832 |                  |       |       |
|           | WB4  | 0.84  |                  |       |       |
|           | WB5  | 0.85  |                  |       |       |

Discriminant validity was assessed using the Heterotrait–Monotrait (HTMT) ratio. As shown in table 2, all HTMT values ranged from 0.321 to 0.786, remaining below the conservative threshold of 0.85. These results collectively demonstrate that the constructs exhibit adequate reliability, convergent validity, and discriminant

validity, thereby supporting the robustness of the measurement model for subsequent structural analysis.

**Table 2.** Results of HTMT ratios

|     | ANF   | NSF   | PS    | SB    |
|-----|-------|-------|-------|-------|
| ANF |       |       |       |       |
| NSF | 0.786 |       |       |       |
| PS  | 0.342 | 0.321 |       |       |
| SB  | 0.4   | 0.383 | 0.599 |       |
| WB  | 0.347 | 0.351 | 0.654 | 0.734 |

#### Structural model assessment

Table 3 reports the structural model results. All hypothesized relationships are statistically significant and supported. Natural Elements (NE) positively influence Perceived Stress (PS) ( $\beta = 0.307$ ,  $p < 0.001$ ), Sense of Belonging (SB) ( $\beta = 0.202$ ,  $p < 0.001$ ), and Well-Being (WB) ( $\beta =$

0.072,  $p < 0.05$ ). Although the direct effect of NE on WB is comparatively weaker, it remains statistically significant. Perceived Stress significantly predicts SB ( $\beta = 0.443$ ,  $p < 0.001$ ) and WB ( $\beta = 0.358$ ,  $p < 0.001$ ), indicating substantial explanatory strength. In addition, SB exerts a strong positive effect on WB ( $\beta = 0.411$ ,  $p < 0.001$ ), highlighting its pivotal role in enhancing well-being. All variance inflation factor (VIF) values are below the recommended threshold, indicating no multicollinearity concerns. Collectively, these findings confirm that all proposed hypotheses are supported.

**Table 3.** Results of the structural model assessment

|    | Relationship | $\beta$  | T     | P    | f-square | VIF   | Decision (Support /Not support) |
|----|--------------|----------|-------|------|----------|-------|---------------------------------|
| H1 | NE-> PS      | 0.307*** | 6.029 | 0    | 0.104    | 1     | Support                         |
| H2 | NE -> SB     | 0.202*** | 4.537 | 0    | 0.052    | 1.104 | Support                         |
| H3 | NE -> WB     | 0.072*   | 1.881 | 0.03 | 0.009    | 1.161 | Support                         |
| H4 | PS -> SB     | 0.443*** | 9.585 | 0    | 0.251    | 1.104 | Support                         |
| H5 | PS -> WB     | 0.358*** | 7.463 | 0    | 0.182    | 1.381 | Support                         |
| H6 | SB -> WB     | 0.411*** | 8.161 | 0    | 0.233    | 1.412 | Support                         |

Note: Items measuring perceived stress (PS) were reverse-coded prior to analysis

#### Discussions

Recent studies have increasingly emphasized the psychological significance of residential environments in high-density urban contexts, particularly regarding stress regulation and well-being (H. Hu et al. 2025; Liu et al. 2022; White et al. 2021). Within this expanding body of research, the present study examines how interior natural elements influence well-being through perceived stress and sense of belonging among apartment residents in Haikou. Consistent with emerging residential evidence (Ancora et al. 2022; Guo et al. 2021), the findings indicate that natural elements embedded in apartment interiors function as psychologically meaningful environmental cues that alleviate stress and strengthen relational attachment. In turn, both stress mitigation and enhanced belonging significantly contribute to well-being.

The significant association between natural elements and stress alleviation aligns with recent empirical work demonstrating that exposure to nature-related cues reduces psychological strain in residential settings (Han et al. 2022; Liu et al. 2022). Although restorative theories were originally developed in outdoor contexts, recent scholarship has confirmed that natural features integrated into daily living environments can produce comparable affective benefits (Jinhua Hu et al. 2022; Kong et al. 2019). In high-density

housing, where prolonged indoor exposure is common, interior biophilic attributes may compensate for limited direct access to outdoor green space (Guo et al. 2021). The present findings therefore extend contemporary residential research by demonstrating that biophilic interior elements operate as routine stress-buffering resources within compact apartment living.

The positive relationship between natural elements and sense of belonging further supports recent calls to incorporate social-psychological constructs into environmental well-being models (Bai et al. 2025; Rugel et al. 2019). While much of the existing literature has prioritized stress reduction or affective restoration as primary mechanisms (Allard-Poesi, Matos, and Massu 2022; Meagher 2020), growing evidence suggests that environmental perceptions simultaneously shape attachment, identity, and relational meaning (Counted et al. 2025; Ríos-Rodríguez et al. 2024). The current results indicate that interior natural features contribute not only to emotional recovery but also to residents' sense of connection and acceptance within their living environment.

This finding resonates with recent scholarship emphasizing that belonging operates as a critical determinant of psychological stability and life satisfaction (Counted et al. 2025; Wang et al. 2023).

Notably, belonging demonstrates a comparatively strong effect on well-being, exceeding the direct influence of natural elements. This pattern corroborates recent residential studies showing that social-relational mechanisms often mediate environmental influences on mental health (Han et al. 2022; Wang et al. 2023). The relatively modest direct path from natural elements to well-being suggests that environmental design exerts its primary influence through internal psychological processes rather than through immediate global life evaluations. Such findings respond to recent critiques that residential environmental research has overemphasized direct-effect models while neglecting concurrent psychological pathways (Allen et al. 2021; Bai et al. 2025).

Theoretically, this study advances recent biophilic residential research by integrating stress and belonging as parallel explanatory mechanisms within a unified structural framework. While prior studies have often examined stress reduction or attachment separately (Allard-Poesi, Matos, and Massu 2022; Rugel et al. 2019), the present findings demonstrate their concurrent operation in high-density apartment interiors. By providing empirical evidence from a rapidly urbanizing tropical city (H. Hu et al. 2025; Pu and Xia 2023), the study contributes contextual insight to the growing literature on residential environmental psychology in China (Guo et al. 2021; Han et al. 2022).

From a practical perspective, the results suggest that apartment design strategies in dense urban settings should prioritize perceptible natural cues that support both emotional regulation and relational attachment. Enhancing daylight access, incorporating indoor vegetation, and embedding organic forms may reduce stress and foster belonging simultaneously. In climates such as Haikou's hot-humid environment, where indoor reliance is heightened (Jiaxi Hu et al. 2024; Kong et al. 2019), optimizing interior natural elements become particularly salient for psychological well-being. Rather than treating biophilic design as decorative enhancement, planners and developers should recognize its function as a psychologically grounded intervention capable of strengthening residents' emotional stability and attachment to place.

Several limitations warrant consideration. The cross-sectional design restricts causal inference and does not capture longitudinal adaptation

processes. The reliance on self-reported measures may introduce perceptual bias. Additionally, the single-site sampling limits generalizability to other climatic or socio-cultural contexts. Future research should adopt longitudinal or experimental designs, incorporate objective environmental assessments, and examine potential demographic or contextual moderators to refine understanding of stress and belonging pathways in residential interiors.

## Conclusions

Building on recent residential environmental research, this study reconceptualizes biophilic interior design as a psychologically supportive strategy for high-density housing rather than merely an aesthetic enhancement. The findings indicate that interior natural elements influence residents' well-being primarily through stress alleviation and strengthened sense of belonging, positioning these two constructs as central psychological mechanisms linking everyday environmental cues to mental health outcomes (Bai et al. 2025; Guo et al. 2021; Liu et al. 2022). By demonstrating that biophilic attributes embedded in routine apartment interiors shape emotional regulation and relational attachment, the study provides empirical support for a health-oriented understanding of residential design in rapidly urbanizing contexts (H. Hu et al. 2025; Kong et al. 2019).

The comparatively modest direct effect of natural elements on well-being suggests that environmental quality does not automatically translate into global life evaluation; rather, its influence is mediated by internal psychological processes. This finding responds to recent critiques that residential environmental research has overly emphasized direct associations while under-specifying concurrent psychological pathways (Allen et al. 2021; Rugel et al. 2019). Moreover, the strong predictive role of belonging underscores that relational attachment to living space constitutes a critical determinant of well-being, complementing stress-based restorative mechanisms (Counted et al. 2025; Wang et al. 2023). Together, these results clarify that emotional recovery and spatial identification operate simultaneously in shaping residents' psychological outcomes.

From a practical standpoint, the findings call for a shift in apartment design priorities, treating daylight access, indoor vegetation, and organic spatial forms as routine investments in residents' psychological resilience rather than decorative additions. In high-density urban environments characterized by prolonged indoor exposure and limited contact with outdoor nature, embedding perceptible natural cues within interior spaces represents a feasible and evidence-based strategy for promoting sustainable well-being. Overall, this study advances contemporary residential environmental research by empirically grounding the psychological value of biophilic interior design and clarifying how interior natural elements contribute to more supportive and mentally healthy living environments.

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#### Author(s) contribution

**Yang Du** contributed to the research concepts preparation, methodologies, investigations, data analysis, visualization, articles drafting and revisions.

**Safial Aqbar Zakaria** contribute to the research concepts preparation and literature reviews, data analysis, of article drafts preparation and validation.

**Ling Zhang** contribute to methodology, supervision, and validation.

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