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The psychological mediations of green window view exposure on campus and freshman adaptation: a cross-sectional study in Nanjing, China

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Campus green window views function as vital micro-scale urban forests for students, offering mental health benefits. However, the quantitative links between perceived green window view characteristics and the psychological adaptation of university freshmen, along with the underlying mediations, are not well established. This study examined these relationships by assessing three perceived green window view characteristics—Naturalness, Visual Scale, and Stewardship—from dormitories, classrooms, and libraries at Nanjing Forestry University's Baima Campus. Data were collected from first-year freshmen via an online questionnaire, which measured perceived green window view exposure, student adaptation to college (SAC), perceived stress (PS), positive and negative affect (PAff/NAff), and sociodemographic factors. We employed Spearman's correlation to analyze associations. Structural equation modeling (SEM) was used to test the mediating roles of perceived stress, positive affect, and negative affect. Results revealed that the dormitory visual scale (Dorm_VS) has a significant direct association with freshmen's adaptation. Mediation analysis identified significant pathways: dormitory visual scale (Dorm_VS) could reduce negative affect (NAff); library visual scale (Lib_VS) could increase positive affect (PAff); and classroom stewardship (CL_D) could lower both perceived stress (PS) and negative affect (NAff), which, in turn, was associated with student adaptation to college (SAC). Additionally, the classroom visual scale (CL_VS) could exhibit a marginally significant ($p < 0.1$) indirect association with freshmen's adaptation by increasing positive affect (PAff). Meanwhile, the classroom stewardship (CL_D) could also show a marginally significant ($p < 0.1$) indirect association with freshmen's adaptation by decreasing positive affect (PAff). In summary, the perceived green window view exposure in campus serves as a Nature-Based Solution (NbS), which reveals the core principle that the association of perceived greenery window views varies according to building function and is achieved through different psychological mediating pathways, by constructing a comprehensive model encompassing multiple buildings (dormitories, classrooms, libraries) and multiple perceived indicators (Naturalness, Visual Scale, Stewardship). These findings offer scientific insights for precision green space planning in sustainable campus and urban development.

KEYWORDS

freshman adaptation, green window view exposure, mediation analysis, psychological mediation, structural equation modeling, urban forests

1 Introduction

Commencing higher education represents a key transition point in a young person's life, and adaptation issues can become a challenge for many freshmen (Campbell et al., 2022). According to the data from Statistical Communique on National Economic and Social Development of the People's Republic of China in 2024, there were 10.689 million admissions to ordinary and vocational undergraduate and junior college programs (including ordinary undergraduate, vocational undergraduate, and higher vocational) in 2024, an increase of about 2.56% year-on-year (National Bureau of Statistics, 2025). This indicates that more and more freshmen (on average 18 years of age as first-year students) leave their home environment for the first time and do so for a prolonged period to pursue their higher education degree. This change in environment, combined with academic, social, and financial pressures, can be stress-producing for “emerging adults” (Arnett, 2000; Dyson and Renk, 2006) and impact the physical health and wellness of students (Rawson et al., 1994; Zhang et al., 2022). Therefore, exploring effective strategies to enhance the adaptability of freshman students is of significant practical importance for their smooth transition into new academic and living environments, and it has far-reaching impacts on their long-term mental health, academic achievements, and personality development.

University campuses feature abundant trees and green spaces, constituting an indispensable component of urban forests as urban ecosystems (Li et al., 2020; Chu et al., 2021), offering a plethora of ecosystem services to young students, playing an important role in both physical and mental benefits (Nguyen and Truong, 2024). The relationship between campus urban forests and student development and health has been extensively documented. Numerous studies indicate that campus green spaces possess restorative potential for psychological recovery and positive mental health among university students (Liu et al., 2018b; Gulwadi et al., 2019; Xu et al., 2024). Students with easy access to forest environments on campus typically experience fewer negative emotions such as stress, anger, and depression (Liprini and Coetzee, 2017; Alcock et al., 2025; Diehl et al., 2025). Particularly during the freshman transition phase, the presence of green spaces can alleviate stress caused by environmental changes and help students integrate into campus life more quickly (Geng et al., 2024). Similar studies have demonstrated that campus green spaces play a crucial role in promoting university freshmen's adaptability, enhancing student wellbeing, and contributing to social sustainability benefits, making them highly significant (Ying et al., 2023). Collectively, existing research on green spaces and college students' health and wellbeing has predominantly focused on outdoor settings. Experimental scenarios and interventions are more frequently conducted in outdoor environments and tend to emphasize activities requiring individual initiative to access and participate. This approach, however, stands in stark contrast to the indoor-centric routines of modern students.

It is noteworthy that there is a disconnect between the behavior of college students, who primarily stay indoors, and their perception of the campus green spaces (Liu et al., 2018a; Migl et al., 2023). As the new generation of youth navigating an era of urbanization and digitalization, prolonged use of smart devices and exposure to electronic screens have become commonplace, with most daily activities occurring indoors. According to Third National Time Use Survey Bulletin (No. 3)—Time Use of Participants in Major Activity Domains by Urban/Rural Areas, Gender, and Age Groups, residents' daily activities, calculated over a 7-day week, showed an average daily time of 7 h

and 9 min (National Bureau of Statistics, 2024). Due to heavy academic demands, the daily activities of university freshmen are primarily confined to indoor settings such as classrooms, dormitories, and libraries. Consequently, exposure to natural environments through windows has become a primary and frequent means of engagement (Zhang et al., 2024). The green window views—the amount and quality of green vegetation observable indoors through windows—constitutes the most accessible micro-scale urban forests for students. This provides a low-cost, highly convenient means for college students, burdened by academic pressures and limited outdoor time, to interact with nature (Kaplan, 2001; Liu et al., 2018a).

In recent years, as an important medium for accessing nature within indoor environments, the quality of window views has been widely demonstrated to have positive association with occupants' mental health, cognitive function, and emotional restoration (Sabet et al., 2023). Windows, serving as micro-restorative environments, provide a wide range of psychological and health benefits (Jiang, 2022). For example, hospital patients with access to natural views from their windows have been shown to recover faster and require less analgesic medication (Ulrich, 1984; Stone and Irvine, 1994; Choi et al., 2012; Tural and Tural, 2024). Similarly, office workers' preferences for window views are closely associated with job satisfaction, mood, and cognitive performance (Mangone et al., 2017; Jamrozik et al., 2019; Yeom et al., 2020; Rios-Rodríguez et al., 2023). Furthermore, the economic value of window views is often reflected in the “view premium,” where properties or office spaces with higher-quality views tend to be more attractive in the market (Baranzini and Schaerer, 2011; Turan et al., 2021).

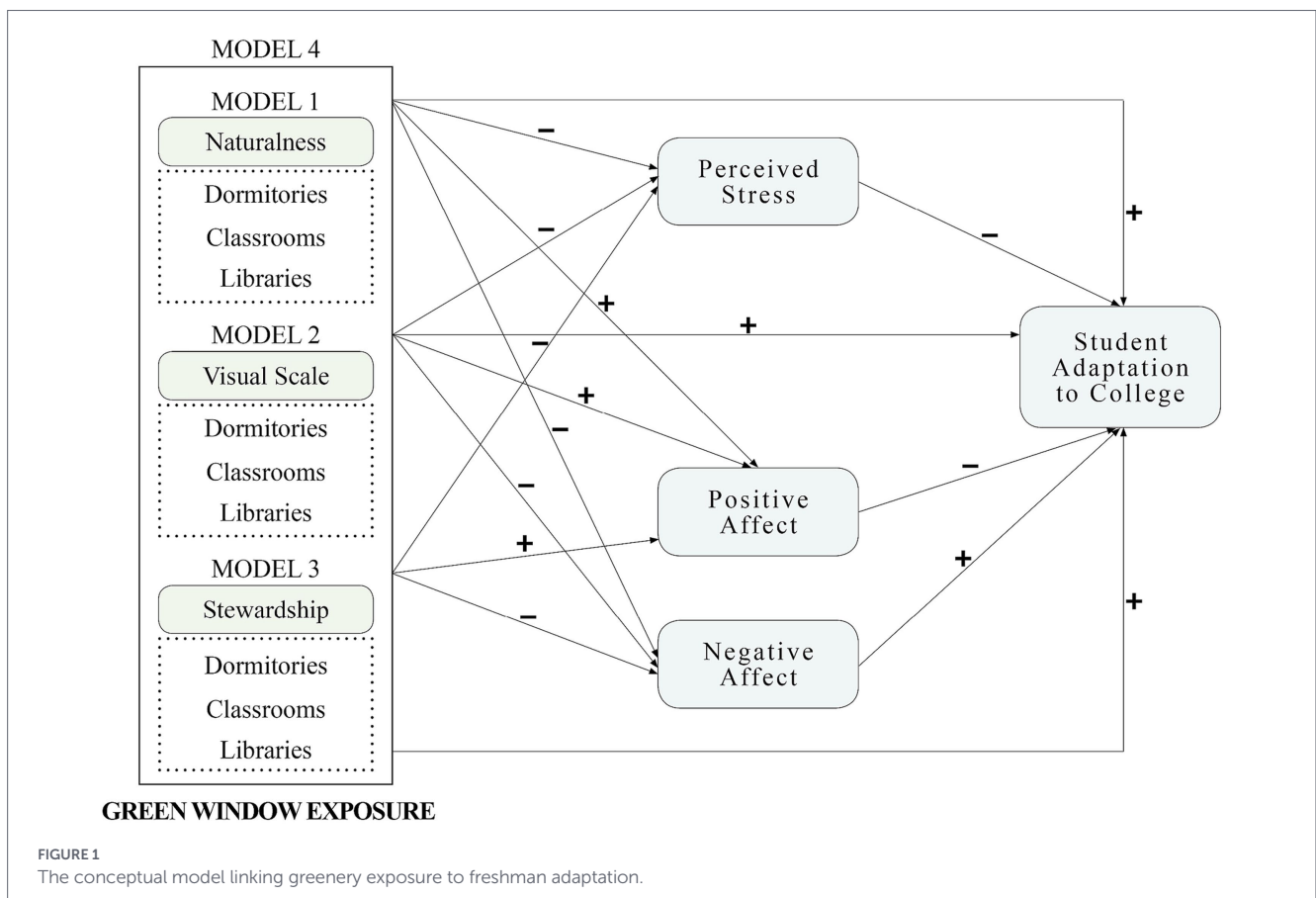
The quality of window views and their associations with occupants have become an increasingly important research direction in the fields of built environment, environmental psychology, and health design. Studies have shown that high-quality window views—particularly those containing natural elements—are closely associated with psychological restoration, stress reduction, improved mood, enhanced attention, and overall wellbeing among users (Ko et al., 2022; Matusiak et al., 2024). Research indicates that window view quality can be evaluated across three dimensions: content (e.g., natural elements, dynamic scenes), accessibility (scope of view and degree of obstruction), and clarity (legibility of visual information) (Konstantzos et al., 2015; Ko et al., 2022). High-quality views—especially those incorporating natural elements such as trees and water, as well as dynamic scenes like moving clouds or falling leaves—have been found to significantly improve individuals' psychological comfort, attentional recovery, and emotional state (Kaplan, 1995; Rodriguez et al., 2021). A substantial body of research suggests that visual stimuli, particularly scenic views and those with natural elements, contribute to stress recovery (Ulrich, 1981, 1986) and attention restoration (Kaplan, 1995), both of which are linked to improved cognitive performance (Tennessen and Cimprich, 1995; Berman et al., 2008).

Existing research has predominantly focused on healthcare, office, and residential buildings, while studies examining how perception of window views in educational buildings—particularly in spaces such as dormitories, classrooms, and libraries on university campuses—are associated with students' psychological adaptation, especially among first-year students, remain relatively scarce. As a group that spends prolonged periods indoors for learning and daily living, university freshmen are frequently and passively exposed to nature through window views in a low-cost manner, which may serve as an important pathway for alleviating adaptation stress and enhancing emotional

and cognitive resources. However, there is still a lack of systematic research examining the relationship between students' exposure to green window views in different functional buildings on campus and changes in their psychological adaptation, and the mediating pathways in the adaptation process of specific groups (such as university freshmen) need to be deeply explored. First, it remains unclear how the multidimensional perceptual characteristics of window views encountered daily by freshmen (such as in dormitories, classrooms, and libraries)—including naturalness, visual scale, and stewardship—are associated with their adaptation. The classic visual landscape analysis framework (Tveit et al., 2006) selects three core indicators—Naturalness, Visual Scale, and Stewardship—because they best reflect the structural characteristics of green quantity in window views. These dimensions exhibit high perceptibility and psychological relevance in the context of window views. Other indicators, such as coherence, historicity, and symbolism, are more significant in large-scale landscape evaluation but demonstrate weaker explanatory power in micro-scale window-view environments. Second, most studies focus on the psychological and behavioral effects of green window views from specific or similar campus buildings (e.g., dormitories, classrooms, libraries), with few investigations combining different building types to examine their combined associations with freshman adaptation. Third, it is particularly noteworthy that perceived window greenery could not directly associate with adaptability but instead show indirect relationships through a series of internal psychological processes. Stress and affect, as core psychological responses to environmental stimuli, represent potential key mediating variables. However, previous studies have predominantly examined individual pathways in isolation, failing to integrate perceived stress, positive affect, and

negative affect into a unified model to compare and clarify their respective mediating roles.

This study aims to explore how perceived green window view exposure enhances the natural and social sustainability benefits of campuses—as key carriers of urban forests. Unlike most studies that focus on general student groups or primary and secondary school students (Li and Sullivan, 2016; Lindemann-Matthies et al., 2021), we focus particularly on university freshmen as a critical transitional group, quantifying the relationship between perceived greenery characteristics (naturalness, visual scale, stewardship) in dormitories, classrooms, and libraries and their psychological adaptation. We construct and validate a multiple mediation model to reveal the underlying mediations through which the relationships of perceived green window view exposure with freshman adaptation could be examined via three pathways: perceived stress, positive affect, and negative affect. To achieve this objective, we selected the new campus of a university in Nanjing, China, as our research site. The study period, January 2025, corresponded to approximately one semester after the September 2024 enrollment of first-year students. We hypothesize that three indicators of perceived window view greenery exposure—Naturalness, Visual Scale, and Stewardship—from three major campus building types could reduce perceived stress, decrease negative affect, increase positive affect, and ultimately show positive relationships with freshman adaptation. The conceptual framework (see Figure 1) for the proposed hypotheses is presented. Models 1–3 could be used to examine relationships of perceived window view greenery exposure (Naturalness, Visual Scale, and Stewardship) from three types of campus buildings with freshman adaptation. Model 4 integrated Models 1–3 to investigate the associations of these three perceived



window-view characteristics across campus building types with freshmen's adaptation.

2 Materials and methods

2.1 Study area

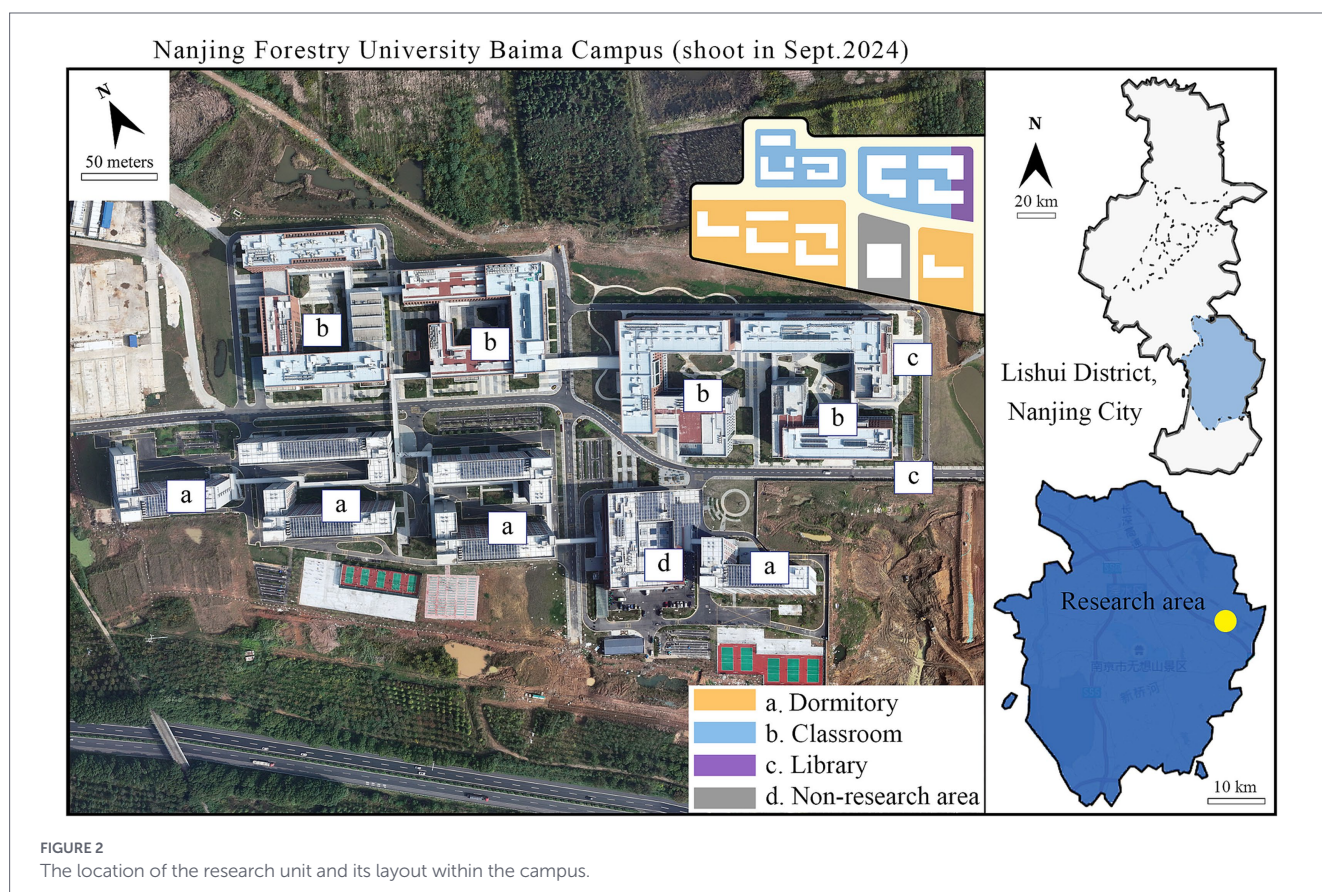
Our research was conducted at the Baima Campus of Nanjing Forestry University (31°61'N, 119°18'E) in Nanjing's Lishui District, a major Yangtze River Delta city characterized by a subtropical monsoon climate. The predominant vegetation type in Nanjing consists of mixed deciduous and broadleaf evergreen forests (Zhu et al., 2022).

This study was conducted at the Baima Campus of Nanjing Forestry University, a newly developed campus under phased construction where adjacent areas were still undergoing development. The operational infrastructure at the time of the study consisted of 6 dormitories (point a in Figure 2) for 4,500 freshmen, 6 teaching buildings (point b) with 85 multimedia classrooms and a library (point c), 51 specialized laboratories and art studios, and one restaurant (point d). Students mainly live in 4 dormitory buildings (point a) on the west side of point d. The south-facing windows of the two dormitory buildings on the south side and the north-facing windows of the two dormitory buildings on the north side are mainly grass and green plants. The north-facing windows of the two dormitory buildings on the south side and the south-facing windows of the two dormitory buildings on the north side are dominated by the central garden, grass and greenery between the two buildings. The green window scenery visible

from the windows of the teaching building is dominated by the central garden, grass and green plants in the enclosed area of the teaching building. The library is located on the ground floor between the two teaching buildings on the eastern side. The green window view seen through the south-facing window on the first floor of the library is dominated by grass and green plants, and the green window view visible from the west-facing window is dominated by the central garden, grass and green plants in the enclosed area of the teaching building. In order to prevent the construction process from disrupting normal academic activities during the semester, the later-phase construction zones on campus were separated with enclosures. The dormitory buildings near the construction zones—specifically the dormitory (point a) to the west of the dining hall (point d) in Figure 2—were not assigned for student occupancy and were instead temporarily used for administrative purposes. Furthermore, all subsequent construction was conducted only during vacation periods when students were away from campus. Therefore, factors such as the later-phase construction did not alter the campus landscape during the study period and can be considered negligible with regard to students' perceptual evaluations of window views in this research. The locations of research units and the layout within the campus are shown as Figure 2.

2.2 Study samples

This study utilized data from a cross-sectional online survey administered between January 3 and 6, 2025, to first-year students who had completed approximately one semester (over 4 months) at the new campus. We specifically designed the questionnaire collection platform to ensure validity by verifying that respondents were currently



registered at the new campus (confirmed via student ID numbers). Each participant could only complete the survey once; respondents with the same Internet Protocol (IP) address were prevented from submitting a second time. Incentive compensation (RMB 10) was provided to participants who completed the survey. The online questionnaire comprised four sections: demographic variables (gender, only child status, place of origin), perceived greenery exposure through window views of major campus buildings, emotional state, perceived stress, and freshman adaptation. The system collected 520 questionnaires. We excluded non-freshmen from the new campus and respondents with incomplete information, ultimately retaining 500 valid responses.

This study, reviewed and approved by the Academic Committee of College of Landscape Architecture in Nanjing Forestry University, ensures a scientifically sound, fair, and impartial design, with voluntary informed consent from participants, protection of their rights and privacy, and no conflicts of interest or ethical violations.

2.3 Measures

2.3.1 Green window view metrics

Grounded in Tveit's theoretical framework (Tveit et al., 2006), this study operationalizes window view quality through three key perceived indicators: naturalness, reflecting the landscape's ecological attributes and proximity to a predefined natural state; visual scale, capturing spatial attributes of visibility and openness; and stewardship, based on the specific context of this new campus, defined as a comprehensive concept encompassing human management and human-made elements, reflecting the interaction between humans and the landscape, and representing a concentrated manifestation of the "human factors" in the visual landscape.

We designed a nine-item questionnaire to evaluate participants' subjective perceptions of green window view exposure in various campus buildings (dormitories, classrooms, libraries). Specifically, the questionnaire measured three key indicators: Naturalness, Visual Scale, and Stewardship.

Perceived green exposure was assessed on a 5-point Likert scale (1 = "Not at all" to 5 = "Very much") across dormitories, classrooms, and libraries. The measure operationalized dimensions: Naturalness (from entirely artificial to fully natural), Visual Scale (from extremely limited to expansive). According to the classic framework for visual landscape analysis (Tveit et al., 2006), Stewardship is manifested in the physical landscape through the following six Landscape Attributes: signs of use/non-use (e.g., whether farmland is cultivated, whether grassland is mown), stage of vegetation succession (e.g., presence of weeds, abandoned land), status of buildings (e.g., state of disrepair, maintenance conditions), linear features (e.g., integrity and neatness of fences, paths, walls), management details (e.g., drainage systems, irrigation facilities), and presence of waste (e.g., litter, debris). In our questionnaire design, corresponding to the above description of the Landscape Attributes of Stewardship, we employed a 5-point Likert scale for scoring, where 1 represents "Not at all" and 5 represents "Very much." These three indicators per building type yielded nine independent observed variables.

2.3.2 Response evaluation scale data

In this study, the quantitative relationship between perceived green window view exposure and freshmen's perceptual responses was

operationalized through four variables: perceived stress (PS), positive affect (PAff), negative affect (NAff), and student adaptation to college (SAC).

Perceived stress (PS) was assessed using the Chinese 14-item perceived stress scale (Yang and Huang, 2003), which was adapted from the original scale (Cohen et al., 1983). The instrument comprises two dimensions: tension (8 items) and loss of control (6 items). Participants responded on a 5-point Likert scale (1 = "never" to 5 = "always"). These 14 items were consolidated into one latent variable, and the internal consistency in our study was high (Cronbach's $\alpha = 0.951$).

Positive and Negative Affect (PAff and NAff) were assessed using the Positive Affect and Negative Affect Schedule (Watson et al., 1988). The 20-item scale comprises two 10-item subscales measuring PAff and NAff, respectively. Participants responded on a 5-point Likert scale (1 = "never" to 5 = "always"), and subscale scores were calculated by summing the respective items, with higher scores indicating stronger affect. In this study, both subscales demonstrated good internal consistency (Cronbach's $\alpha = 0.861$ for PAff, 0.945 for NAff).

The student adaptation to college questionnaire (Baker and Siryk, 1984; Baker, 1989; Dahmus et al., 1992) was used to measure adaptation. While the original instrument contains 67 items, this study employed a 36-item version adapted for Chinese college students (Ouyang, 2012), particularly freshmen. Responses were collected on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), where higher scores reflect greater adaptability. This adapted version showed high internal consistency (Cronbach's $\alpha = 0.824$).

2.4 Statistical analyses

2.4.1 Main analyses

To assess the potential influence of common method variance, we performed Harman's single-factor test. All measurement items—including the nine-item Green Window Exposure Perception Scale (assessing campus buildings such as dormitories, classrooms, and libraries), Perceived Stress (PS), Positive Affect (PAff), Negative Affect (NAff), and the Student Adjustment Scale (SAC)—were subjected to an unrotated principal component analysis. The results indicated that the first factor accounted for 26.5% of the total variance, which is below the commonly accepted threshold of 50%. These findings suggest that common method bias did not substantially affect the study's conclusions.

To examine the monotonic relationships between perceived greenery exposure, mediators, and freshman adaptation outcomes, we conducted Spearman's rank correlation analyses using the R package "corrplot." The raw data were ranked, and correlation coefficients (ρ) with 95% confidence intervals and p -values were computed to assess the significance and strength of the bivariate associations. Spearman correlation coefficients could show weak (i.e., $0 \leq |\rho| < 0.3$), moderate (i.e., $0.3 \leq |\rho| < 0.7$), or strong associations (i.e., $|\rho| \geq 0.7$) (Akoglu, 2018).

Descriptive statistics were computed using the R package "psych." Demographic variables were summarized with frequencies and percentages. As ordinal variables, the indicators of green window view exposure were described using medians and ranges, alongside means and standard deviations to indicate central tendency and dispersion. For the four latent variables, composite scores were derived by averaging their respective observed variables, and the mean, standard deviation, and range of these scores were reported. This comprehensive

profiling facilitated a thorough understanding of the data prior to further inferential analysis.

2.4.2 Mediation analyses

We employed structural equation modeling (SEM) to investigate the direct and indirect associations of three perceived green window view indicators (Naturalness, Visual Scale, and Stewardship) across three campus building types (dormitories, classrooms, libraries) with student adaptation to college (SAC), as conceptualized in Figure 1 (Models 1–4). Path coefficients were estimated using maximum likelihood estimation, and bootstrap analysis with 5,000 resamples was conducted to generate bias-corrected confidence intervals, percentile confidence intervals (CIs) and standard errors (SE) for all paths, based on methods proposed in prior research (Preacher and Hayes, 2008; Hayes, 2022). The Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR) were also tested. CFI (≥ 0.90), TLI (≥ 0.90), RMSEA (≤ 0.08), and SRMR (≤ 0.05) are generally considered to be a good model fit (Hu and Bentler, 1999). The final model was retained after confirming adequate model fit. All analyses were performed using Mplus software version 7.4.

In our study, some exploratory analyses involve discussing trends or marginal significance ($p < 0.1$) and in line with practices in environmental psychology research (Li and Sullivan, 2016; Olszewska-Guizzo et al., 2018). Therefore, we want to report both conventional and marginal significance levels. Statistical significance is denoted as: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$ (marginally significant trend). The symbol $p < 0.1$ should be considered exploratory trends and interpreted with caution due to the risk of Type I error. We did not adjust for multiple comparisons because the study is exploratory; this limitation is now acknowledged.

3 Results

3.1 Sample characteristics

Table 1 presents descriptive statistics: the majority of participants (61.8%) were female. Among participants, the majority (63.4%) were not only children, and slightly more students originated from urban areas (52.4%) than rural areas. Participants' subjective evaluations of the three buildings and their respective window view greenery exposure characteristics all clustered around the median of 3, indicating an overall neutral environmental perception. The visual conditions were rated slightly higher than the stewardship, while naturalness was rated slightly lower. Participants showed significant differences in their visual quality ratings across building types, while their assessments of naturalness and stewardship were relatively consistent. Among the four latent variables, participants' mean perceived stress (PS) and negative affect (NAff) were slightly below the median of 3, while positive affect (PAff) and student adaptation to college (SAC) were slightly above the median.

3.2 Correlation among the variables

Spearman's correlation analysis was conducted to examine the relationships between nine indicators of perceived green window view

exposure (Dorm_N, Dorm_VS, Dorm_D, Cl_N, Cl_VS, Cl_D, Lib_N, Lib_VS, Lib_D) and four latent variables: perceived stress (PS), positive affect (PAff), negative affect (NAff), and student adaptation to college (SAC). The correlation matrix is presented in Figure 3.

The results reveal three key patterns (Figure 3). First, the nine window view greenery indicators exhibited weak to moderate inter-correlations. Most factor pairs were positively correlated, with notable exceptions: Dorm_D correlated negatively with Dorm_N and Dorm_VS; Cl_D with Cl_N and Cl_VS; and Cl_N with Dorm_D. Second, correlations with outcome variables varied. Perceived stress (PS) and Cl_D showed a significant positive correlation. For positive affect (PAff), Cl_D showed a significant negative correlation, while the five indicators (Dorm_N, Dorm_VS, Cl_N, Cl_VS, Lib_VS) showed significant positive correlations. For negative affect (NAff), only Dorm_VS showed a significant negative correlation. Third, the outcome variables themselves showed expected interrelationships: PS correlated negatively with PAff and SAC, and positively with NAff; PAff correlated negatively with NAff and positively with SAC; and NAff correlated negatively with SAC. Most of these associations were statistically significant and of moderate strength.

3.3 Results of multiple mediator models

The SEM examined the mediating roles of perceived stress (PS), positive affect (PAff), and negative affect (NAff) in the relationship between the perceived Naturalness of the buildings on the campus and student adaptation to college (SAC). The model (Model 1 in Figure 1) demonstrated acceptable fit ($\chi^2/df = 1.632$, RMSEA = 0.036, SRMR = 0.078, CFI = 0.943, TLI = 0.927) and explained 72.0% of the variance in SAC. As shown in Table 2 and Figure 4, library naturalness (Lib_N) exerted a significant direct association with SAC (Lib_N \rightarrow SAC: $\beta = 0.058$, $p = 0.025$). Although no indirect associations reached statistical significance, two mediation pathways involving dormitory naturalness (Dorm_N) approached marginal significance: through reduced negative affect (Dorm_N \rightarrow NAff \rightarrow SAC: $\beta = 0.018$, $p = 0.114$) and through reduced perceived stress (Dorm_N \rightarrow PS \rightarrow SAC: $\beta = 0.014$, $p = 0.105$), with confidence intervals remaining positive.

The SEM examining visual scale effects on freshman adaptation (Model 2 in Figure 1) demonstrated acceptable fit ($\chi^2/df = 1.614$, RMSEA = 0.035, SRMR = 0.079, CFI = 0.945, TLI = 0.929) and explained 64.6% of the variance in SAC. As shown in Table 3 and Figure 5, dormitory visual scale (Dorm_VS) exhibited a significant direct positive association with adaptation (Dorm_VS \rightarrow SAC: $\beta = 0.031$, $p = 0.024$). Regarding mediation pathways, the perceived classroom visual scale influenced adaptation through enhanced positive affect (Cl_VS \rightarrow PAff \rightarrow SAC: $\beta = 0.035$, $p = 0.027$), while dormitory visual scale operated through reduced negative affect (Dorm_VS \rightarrow NAff \rightarrow SAC: $\beta = 0.018$, $p = 0.013$). Additionally, dormitory visual scale showed a marginally significant indirect association via stress reduction (Dorm_VS \rightarrow PS \rightarrow SAC: $\beta = 0.007$, $p = 0.086$). No other direct or indirect associations reached statistical significance.

The SEM examining stewardship effects on freshman adaptation (Model 3 in Figure 1) demonstrated acceptable fit ($\chi^2/df = 1.805$, RMSEA = 0.040, SRMR = 0.079, CFI = 0.925, TLI = 0.907) and explained 67.8% of the variance in SAC. As detailed in Table 4 and Figure 6, the perceived classroom stewardship (Cl_D) showed a marginally significant indirect association with adaptation through

TABLE 1 Descriptive statistics results (participants number = 500).

Variables	Count (Percentage)	Category	Mean (SD)	Median (IQR)	Range
Gender	309 (61.8%)	Female			
Only_child	183 (36.6%)	Yes			
Rural/urban origin	262 (52.4%)	Urban			
Dorm_N		Naturalness of greenery exposure in dormitories	2.70 (0.83)	3 [2, 3]	[1–5]
Dorm_VS		Visual Scale of greenery exposure in dormitories	3.18 (1.09)	3 [2, 4]	[1–5]
Dorm_D		Stewardship of greenery exposure in dormitories	2.99 (0.83)	3 [2, 3]	[1–5]
Cl_N		Naturalness of greenery exposure in classrooms	2.79 (0.73)	3 [2, 3]	[1–5]
Cl_VS		Visual scale of greenery exposure in classrooms	3.06 (0.88)	3 [3, 4]	[1–5]
Cl_D		Stewardship of greenery exposure in classrooms	3.00 (0.75)	3 [3, 3]	[1–5]
Lib_N		Naturalness of greenery exposure in libraries	2.90 (0.69)	3 [3, 3]	[1–5]
Lib_VS		Visual scale of greenery exposure in libraries	3.09 (0.84)	3 [3, 4]	[1–5]
Lib_D		Stewardship of greenery exposure in libraries	2.93 (0.72)	3 [3, 3]	[1–5]
PS		The mean of observed variables as the composite score of the latent variable	2.58 (0.71)		[1–5]
PAff		The mean of observed variables as the composite score of the latent variable	3.39 (0.63)		[1–5]
NAff		The mean of observed variables as the composite score of the latent variable	2.35 (0.82)		[1–5]
SAC		The mean of observed variables as the composite score of the latent variable	3.58 (0.53)		[2.11–5]

PS, Perceived Stress; PAff, Positive Affect; NAff, Negative Affect; SAC, Student Adaptation to College.

perceived stress (Cl_D → PS → SAC: $\beta = -0.029$, $p = 0.097$). No other indirect pathways through positive or negative affect reached significance, and all direct associations from pathways of the perceived dormitory and library stewardship were non-significant.

The comprehensive SEM (Model 4 in Figure 1) examining all perceived greenery characteristics demonstrated acceptable fit ($\chi^2/df = 1.529$, RMSEA = 0.033, SRMR = 0.078, CFI = 0.944, TLI = 0.929) and explained 67.4% of the variance in SAC. As shown in Table 5 and Figure 7, none of the direct relationships of most of perceived greenery characteristics with freshman adaptation demonstrated statistical significance, except that dormitory visual scale (Dorm_VS) showed a marginally significant association (Dorm_VS → SAC: $\beta = 0.032$, $p = 0.065$). However, four significant indirect pathways emerged: library visual scale enhanced adaptation through increased positive affect (Lib_VS → PAff → SAC: $\beta = 0.044$, $p = 0.045$); dormitory visual scale improved adaptation through reduced negative affect (Dorm_VS → NAff → SAC: $\beta = 0.022$, $p = 0.019$); and classroom stewardship impaired adaptation through both increased stress (Cl_D → PS → SAC: $\beta = -0.023$, $p = 0.031$) and heightened negative affect (Cl_D → NAff → SAC: $\beta = -0.035$, $p = 0.015$). Two additional marginal indirect relationships were observed through positive affect pathways.

4 Discussion

This study developed a framework to examine the psychological pathways linking perceived campus window greenery to freshman adaptation. Data on perceived window view characteristics

(Naturalness, Visual Scale, and Stewardship) were obtained via questionnaires for dormitories, classrooms, and libraries. We constructed separate models for each characteristic (Models 1–3) before combining them into an integrated model (Model 4). The mediation analyses of perceived stress, positive affect, and negative affect identified two key results. First, perceived campus window greenery, as a nature-based solution (NbS) (Hickey et al., 2008), could show positive relationships with freshman adaptation, reinforcing the role of campuses as micro-scale urban forests in supporting student wellbeing and green resilience. Second, the internal mediation of window view perception affecting freshmen's adaptation is mainly indirectly identified by pathways of psychological processes such as emotions and stress, rather than directly. Visual openness was the strongest positive predictor in dormitories and libraries, while visible stewardship near classrooms significantly reduced adaptation.

4.1 Correlation patterns between green window view and freshman psychological indicators

This study examined bivariate correlations between three perceived window view greenery factors across campus buildings and psychological outcomes. Among our key findings, classroom stewardship (Cl_D) was positively correlated with perceived stress (PS), consistent with previous research indicating that improved stewardship may be associated with elevated stress perception (Fang et al., 2023).

We found that Naturalness and Visual Scale in dormitory and classroom window views were significantly associated with increased positive affect. This corroborates prior work linking natural views to

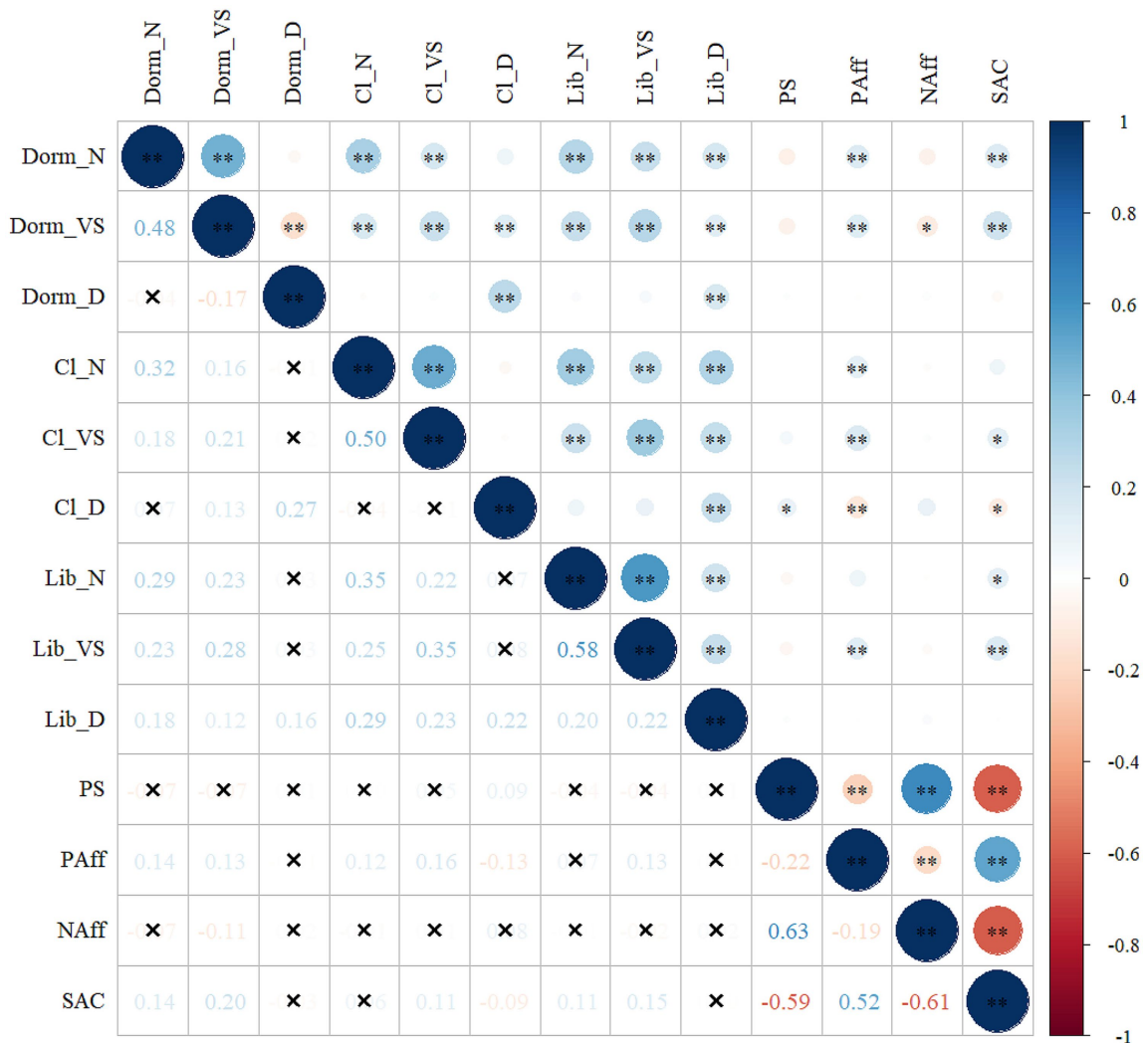


FIGURE 3 Bivariate correlations between variables. The crossed numbers indicate no statistical significance. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p > p < 0.05$, $p < 0.1$.

TABLE 2 Direct/indirect effect between greenery exposure of naturalness (Model 1) and freshman adaptation.

Path relationship	Estimates	Boot SE	C.R.	p	Bias-corrected 95%CI	Percentile 95%CI
Dorm_N → SAC	0.014	0.022	0.611	0.541	-0.029, 0.059	-0.031, 0.057
Cl_N → SAC	-0.021	0.024	-0.861	0.389	-0.070, 0.024	-0.068, 0.026
Lib_N → SAC	0.058	0.026	2.245	0.025	0.011, 0.115	0.008, 0.110
Dorm_N → PS → SAC	0.014	0.009	1.621	0.105	0.000, 0.034	-0.002, 0.032
Cl_N → PS → SAC	-0.009	0.011	-0.893	0.372	-0.033, 0.009	-0.031, 0.010
Lib_N → PS → SAC	0.009	0.011	0.824	0.410	-0.009, 0.034	-0.011, 0.032
Dorm_N → PAff → SAC	0.012	0.018	0.659	0.510	-0.018, 0.051	-0.018, 0.051
Cl_N → PAff → SAC	0.015	0.019	0.780	0.435	-0.017, 0.060	-0.017, 0.057
Lib_N → PAff → SAC	0.008	0.017	0.445	0.656	-0.024, 0.043	-0.025, 0.042
Dorm_N → NAff → SAC	0.018	0.012	1.581	0.114	-0.002, 0.045	-0.004, 0.042
Cl_N → NAff → SAC	0.000	0.014	0.016	0.987	-0.026, 0.029	-0.026, 0.028
Lib_N → NAff → SAC	-0.002	0.014	-0.136	0.892	-0.030, 0.027	-0.031, 0.026

Dorm_N, Naturalness of greenery exposure in Dormitories; Cl_N, Naturalness of greenery exposure in Classrooms; Lib_N, Naturalness of greenery exposure in Libraries; PS, Perceived Stress; PAff, Positive Affect; NAff, Negative Affect; SAC, Student Adaptation to College; 5,000 bootstrap samples. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$. Estimates with significant p -values are shown in bold.

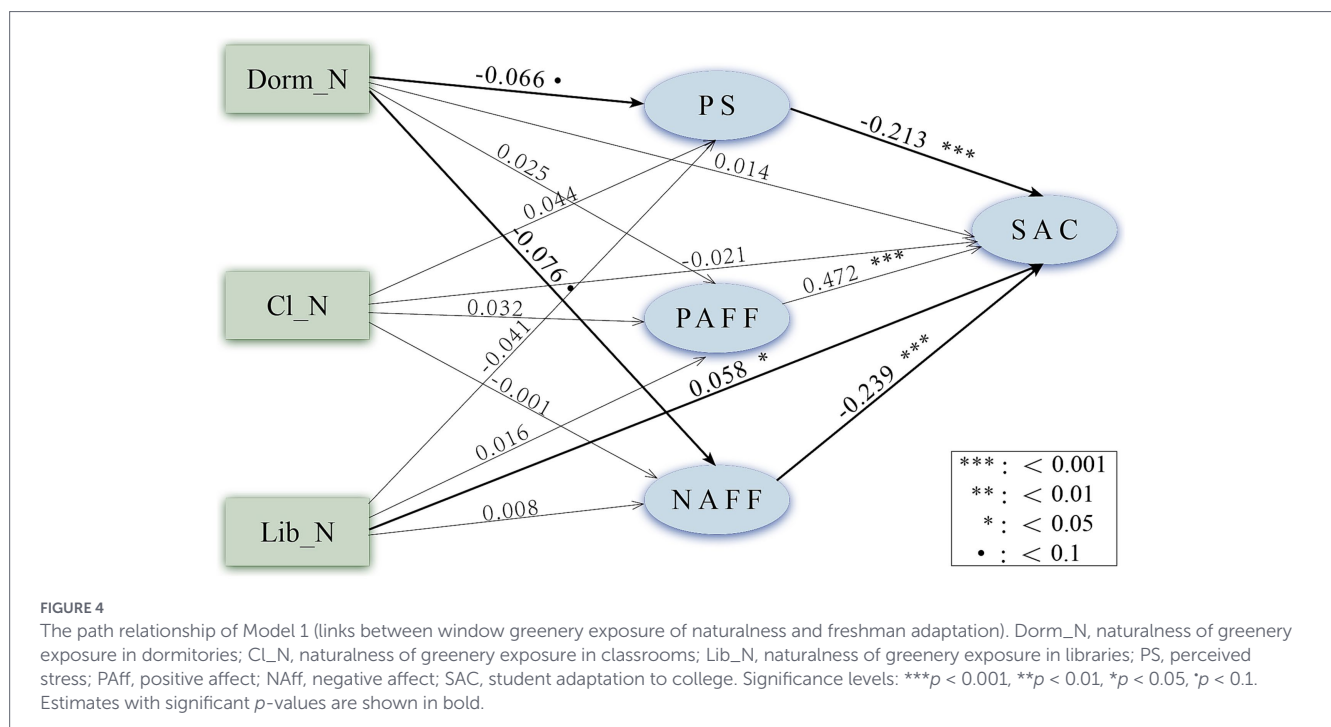


TABLE 3 Direct/indirect effect between greenery exposure of visual scale (Model 2) and freshman adaptation.

Path relationship	Estimates	Boot SE	C.R.	<i>p</i>	Bias-corrected 95%CI		Percentile 95%CI	
Dorm_VS → SAC	0.031	0.014	2.255	0.024	0.007	0.061	0.004	0.058
CL_VS → SAC	0.015	0.016	0.921	0.357	-0.016	0.047	-0.019	0.044
Lib_VS → SAC	0.020	0.019	1.026	0.305	-0.017	0.059	-0.017	0.059
Dorm_VS → PS → SAC	0.007	0.004	1.715	0.086	0.001	0.020	0.000	0.017
CL_VS → PS → SAC	-0.002	0.005	-0.286	0.775	-0.014	0.008	-0.013	0.009
Lib_VS → PS → SAC	0.006	0.006	1.040	0.298	-0.003	0.021	-0.005	0.018
Dorm_VS → PAff → SAC	0.015	0.011	1.355	0.175	-0.004	0.039	-0.005	0.038
CL_VS → PAff → SAC	0.035	0.016	2.212	0.027	0.007	0.070	0.004	0.067
Lib_VS → PAff → SAC	0.025	0.017	1.473	0.141	-0.006	0.060	-0.008	0.057
Dorm_VS → NAff → SAC	0.018	0.007	2.478	0.013	0.006	0.035	0.005	0.033
CL_VS → NAff → SAC	-0.001	0.009	-0.065	0.948	-0.019	0.019	-0.019	0.019
Lib_VS → NAff → SAC	0.005	0.010	0.505	0.613	-0.014	0.028	-0.015	0.026

Dorm_VS, Visual Scale of greenery exposure in Dormitories; CL_VS, Visual Scale of greenery exposure in Classrooms; Lib_VS, Visual Scale of greenery exposure in Libraries; PS, Perceived Stress; PAff, Positive Affect; NAff, Negative Affect; SAC, Student Adaptation to College; 5,000 bootstrap samples. Significance levels: ****p* < 0.001, ***p* < 0.01, **p* < 0.05, *p* < 0.1. Estimates with significant *p*-values are shown in bold.

improved attention and emotion (Lindemann-Matthies et al., 2021), and is further explained by research showing the benefits of high natural element proportions and open views (Yao et al., 2024) and the positive neurocognitive relationships with natural landscapes (Zhang et al., 2024).

We also found that favorable dormitory visual scale (Dorm_VS) was significantly associated with lower negative affect (NAff). This aligns with previous research findings that favorable dormitory views—particularly those incorporating natural elements and ample natural light—can significantly reduce negative affect among college students (Samaan et al., 2024).

Additionally, our study adds to growing evidence that green window views on campus are significantly associated with improved

psychological wellbeing and adaptation among freshmen. The observed pattern—where natural view exposure correlates with reduced stress, decreased negative affect, increased positive affect, and better adaptation—resonates with previous findings that positive engagement with green spaces predicts better mood and lower stress (Holt et al., 2019).

4.2 Mediations of window greenery exposure on freshman adaptation

This study elucidated the psychological mediating relationships linking perceived window greenery exposure to freshman adaptation by testing a series of pathways. While Models 1–3 individually

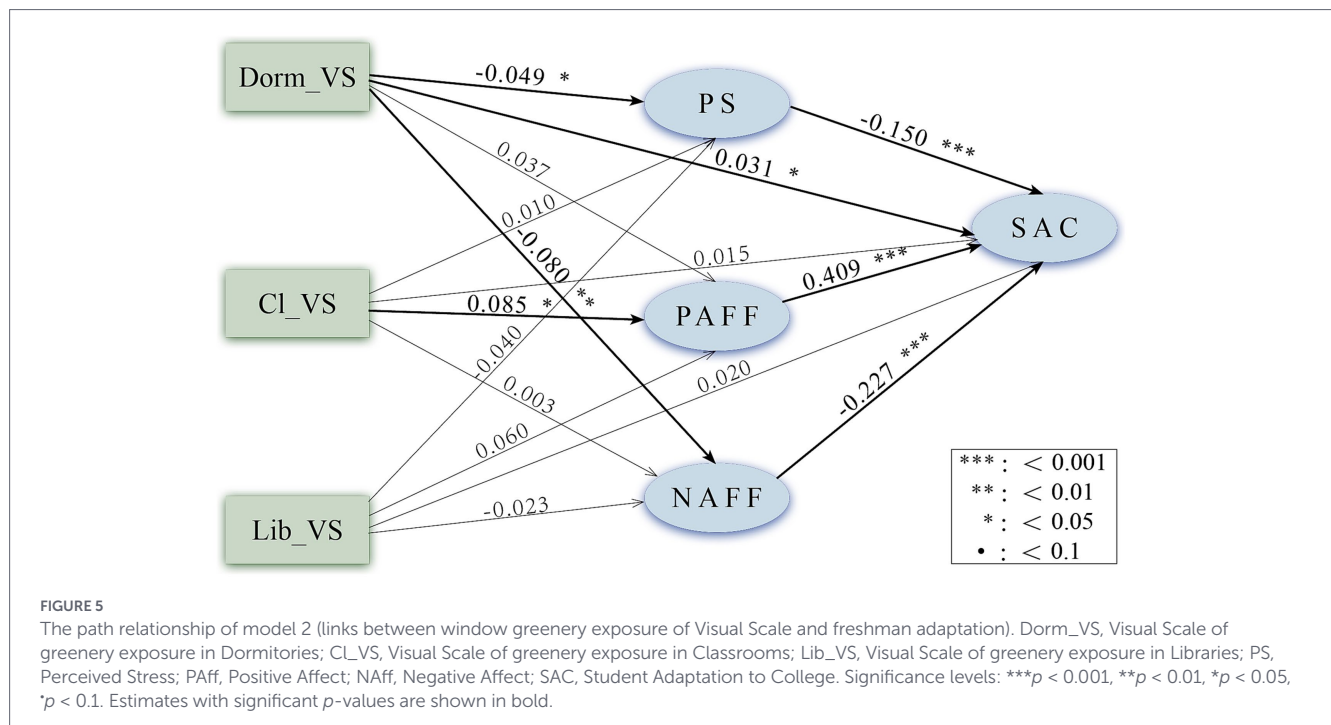


TABLE 4 Direct/indirect effect between greenery exposure of stewardship (Model 3) and freshman adaptation.

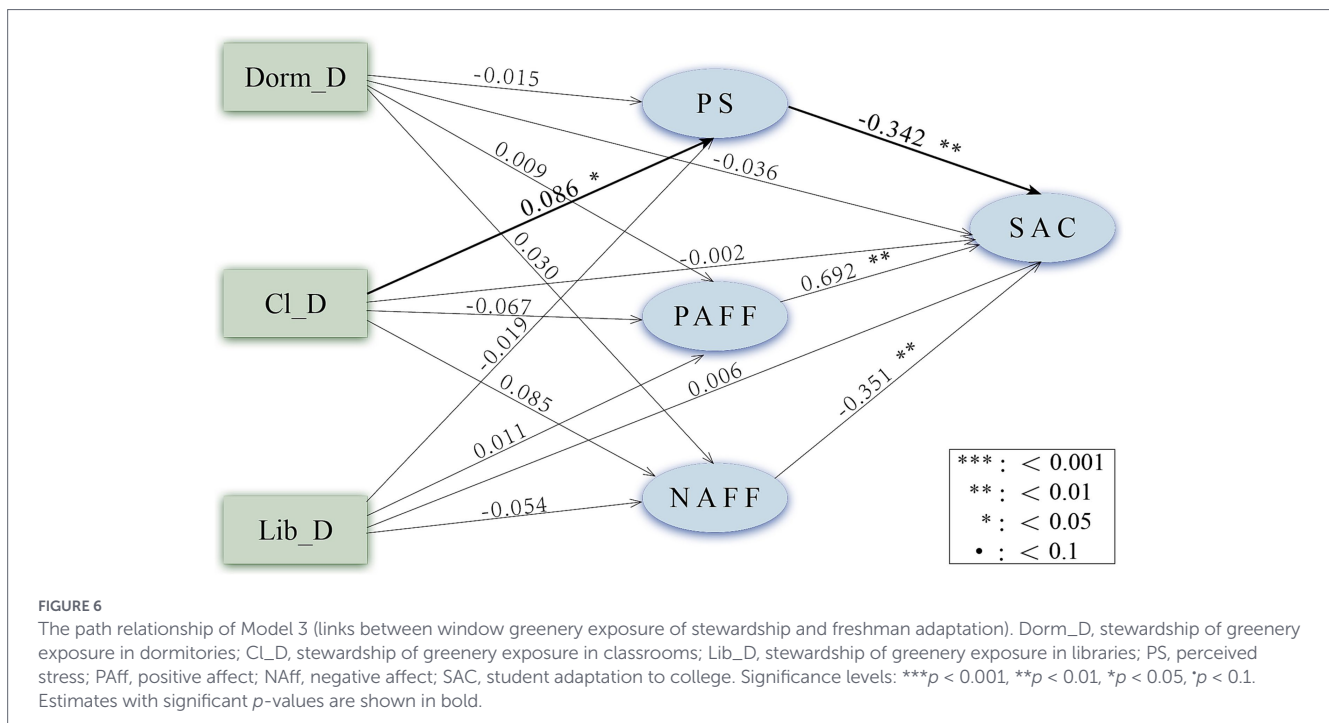
Path relationship	Estimates	Boot SE	C.R.	p	Bias-corrected 95%CI		Percentile 95%CI	
Dorm_D → SAC	-0.036	0.031	-1.176	0.240	-0.122	0.009	-0.098	0.024
Cl_D → SAC	-0.002	0.034	-0.058	0.954	-0.067	0.070	-0.065	0.072
Lib_D → SAC	0.006	0.033	0.184	0.854	-0.054	0.084	-0.061	0.073
Dorm_D → PS → SAC	0.005	0.012	0.424	0.671	-0.015	0.034	-0.017	0.031
Cl_D → PS → SAC	-0.029	0.018	-1.660	0.097	-0.086	-0.005	-0.067	0.000
Lib_D → PS → SAC	0.006	0.015	0.419	0.675	-0.019	0.043	-0.024	0.037
Dorm_D → PAff → SAC	0.006	0.023	0.251	0.802	-0.038	0.057	-0.038	0.058
Cl_D → PAff → SAC	-0.046	0.033	-1.415	0.157	-0.131	0.001	-0.114	0.009
Lib_D → PAff → SAC	0.008	0.030	0.258	0.796	-0.043	0.080	-0.049	0.071
Dorm_D → NAff → SAC	-0.010	0.016	-0.662	0.508	-0.049	0.016	-0.043	0.021
Cl_D → NAff → SAC	-0.030	0.021	-1.449	0.147	-0.085	0.000	-0.072	0.008
Lib_D → NAff → SAC	0.019	0.020	0.931	0.352	-0.012	0.073	-0.022	0.059

Dorm_D, Stewardship of greenery exposure in Dormitories; Cl_D, Stewardship of greenery exposure in Classrooms; Lib_D, Stewardship of greenery exposure in Libraries; PS, Perceived Stress; PAff, Positive Affect; NAff, Negative Affect; SAC, Student Adaptation to College; 5,000 bootstrap samples. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $p < 0.1$. Estimates with significant p -values are shown in bold.

examined the relationships of perceived greenery characteristics with freshmen's adaptation, the integrated Model 4 demonstrated that the overall association is primarily mediated by psychological pathways, identifying several significant indirect pathways through stress and affect. Overall, students' perceptions of window views from different campus buildings (depending on their location) are identified by distinct pathways. Specifically, the relationships of perceived campus building window views with university freshmen's adaptation varies according to building function and is mediated through different psychological pathways.

From the perspective of separately studying the relationships of window view naturalness perception with freshman adaptation (Model 1), the results of Model 1 reveal the differentiated mediations

underlying the perception of window views across different campus buildings (i.e., students' varying locations): dormitory is the main living space, and students spend most of their non-study time in the dormitory, and their window view naturalness perception (Dorm_N) indirectly promotes students' adaptation by reducing negative emotions and stress perception (mediating variables and mediating pathways), which is consistent with the stress recovery theory Stress Reduction Theory (SRT) (Ulrich et al., 1991). In addition, as a learning space, the perception of window view naturalness (Lib_N) has a direct positive association with adaptation to SAC, which may stem from the direct supporting of natural elements on cognitive function, which is consistent with the Attention Restoration Theory (ART) (Kaplan, 1995; Felsten, 2009). On the contrary, unlike the research that has



proven that natural window scenery in university classrooms can improve learning efficiency (Zhang et al., 2024), we found that the mediation of classroom window view perception (Cl_N) is not significant, and may be due to other factors in the classroom environment or the association of classroom window views is dominated by stronger factors such as teaching quality and teacher-student relationship. These findings underscore the importance of considering building functions and usage scenarios in environmental psychology research and warrant further investigation. In addition, most of the existing studies discuss “classroom” or “window view” in general terms, and do not distinguish between different mediations of dormitories, classrooms, and libraries (Lindemann-Matthies et al., 2021; Koprivec et al., 2022; Zhang et al., 2024).

By separately examining the relationships of visual scale feature perception with freshmen’s adaptation to SAC (Model 2), we find that dormitory window view visual feature perception (Dorm_VS) promotes freshmen’s adaptation through two pathways: first, the direct positive association, which may stem from the psychological recovery provided by the visual field; The second is the indirect association of improving emotional state and reducing stress. In contrast, the relationships of classroom window view (Cl_VS) with freshman adaptation are entirely emotionally mediated, which could reflect the perceived characteristics of the classroom as a learning space with window view that functions primarily indirectly through emotional regulation. In addition, the SEM analysis results for Model 2 did not reveal a significant direct or indirect association of library visual scale perception (Lib_VS) with freshman adaptation, which may mean that the mediating relationship of library visual scale (Lib_VS) with new adaptation is not within the scope of the three mediating variables in this study, and other mediating relationships (such as cognitive function, learning engagement, etc.) or perceived library visual scale (Lib_VS) is indeed weak and unstable, a finding that challenges the common assumption that “horizons are always beneficial”, suggesting that there may be overlooked contextual limiting factors. In summary, this “inconsistency” in the perception of window view features of the

main buildings on campus reveals the differentiated mediation, that is, the different mediating relationships of different architectural environments with freshman adaptation. Broadening is often thought to provide psychological recovery (Jang et al., 2024), which is consistent with the direct pathway which we found. Our study based on the structural equation model SEM identifies emotion-mediated (classroom) and dual-pathway (dormitory) mediating relationships, beyond most studies that only report total associations.

From the perspective of separately studying the association of window view stewardship perception with freshman adaptation (Model 3), the total effect is significant, but the direct association is not significant, and the indirect one found is much smaller than the total one. Specifically, classroom window view stewardship perception (Cl_D) has a significant negative total association with freshmen’s adaptation SAC, but the results of SEM show that this association is mainly mediated by stress perception PS, and the direct one is not significant. This could reflect the specificity of the classroom as a formal learning space: stewardship is perceived by students as an environmental stressor that affects their adaptability. In contrast, window view stewardship perception (Dorm_D and Lib_D) in dormitories and libraries could have less association with adaptability because students have more personal control and selectivity in their use. This seemingly “inconsistent” result reveals the complex psychological mediation by which environmental perception affects students’ adaptation. Similar studies have linked well-maintained green spaces to stress reduction and increased wellbeing (Li and Sullivan, 2016; Koprivec et al., 2022), and studies have shown that students do not like cluttered, poorly maintained landscapes (Koprivec et al., 2022). We found that “classroom stewardship perception” becomes a stressor, and this unique finding could reveal that in formal learning spaces with low sense of control and high evaluation pressure, the perception of “stewardship” is alienated into an order pressure, which has been rarely found in previous studies.

On the basis of separately studying the association of a certain type of window view feature perception with freshman adaptation

TABLE 5 Direct/indirect effect between greenery exposure (Model 4) and freshman adaptation.

Path relationship	Estimates	Boot SE	C.R.	p-value	Bias-corrected 95%CI	Percentile 95%CI		
Dorm_N → SAC	-0.020	0.022	-0.905	0.366	-0.066	0.022	-0.063	0.025
Cl_N → SAC	-0.021	0.028	-0.746	0.455	-0.076	0.032	-0.076	0.032
Lib_N → SAC	0.021	0.028	0.749	0.454	-0.033	0.076	-0.033	0.076
Dorm_N → PS → SAC	0.008	0.008	1.026	0.305	-0.005	0.028	-0.007	0.025
Cl_N → PS → SAC	-0.005	0.010	-0.455	0.649	-0.026	0.014	-0.026	0.014
Lib_N → PS → SAC	0.006	0.010	0.602	0.547	-0.011	0.029	-0.012	0.028
Dorm_N → PAff → SAC	0.030	0.021	1.439	0.150	-0.011	0.072	-0.009	0.073
Cl_N → PAff → SAC	0.012	0.022	0.544	0.586	-0.031	0.057	-0.030	0.057
Lib_N → PAff → SAC	-0.026	0.024	-1.086	0.277	-0.074	0.019	-0.073	0.021
Dorm_N → NAff → SAC	0.011	0.011	0.985	0.325	-0.008	0.037	-0.011	0.033
Cl_N → NAff → SAC	0.005	0.015	0.350	0.726	-0.022	0.036	-0.022	0.036
Lib_N → NAff → SAC	-0.001	0.015	-0.063	0.950	-0.030	0.029	-0.031	0.028
Dorm_VS → SAC	0.032	0.017	1.843	0.065	0.000	0.067	-0.005	0.063
Cl_VS → SAC	0.024	0.022	1.069	0.285	-0.017	0.070	-0.021	0.067
Lib_VS → SAC	0.022	0.025	0.878	0.380	-0.025	0.073	-0.027	0.070
Dorm_VS → PS → SAC	0.010	0.006	1.494	0.135	0.000	0.027	-0.002	0.023
Cl_VS → PS → SAC	-0.002	0.008	-0.302	0.762	-0.019	0.011	-0.017	0.014
Lib_VS → PS → SAC	0.007	0.009	0.798	0.425	-0.008	0.029	-0.011	0.025
Dorm_VS → PAff → SAC	0.011	0.016	0.663	0.507	-0.018	0.048	-0.022	0.042
Cl_VS → PAff → SAC	0.028	0.017	1.658	0.097	-0.003	0.063	-0.004	0.062
Lib_VS → PAff → SAC	0.044	0.022	2.006	0.045	0.004	0.093	-0.001	0.087
Dorm_VS → NAff → SAC	0.022	0.009	2.344	0.019	0.007	0.046	0.004	0.040
Cl_VS → NAff → SAC	-0.003	0.011	-0.271	0.786	-0.026	0.018	-0.025	0.019
Lib_VS → NAff → SAC	0.010	0.014	0.737	0.461	-0.015	0.040	-0.017	0.037
Dorm_D → SAC	-0.017	0.020	-0.856	0.392	-0.059	0.019	-0.056	0.022
Cl_D → SAC	-0.015	0.024	-0.620	0.535	-0.063	0.035	-0.063	0.035
Lib_D → SAC	-0.005	0.024	-0.220	0.825	-0.050	0.043	-0.052	0.041
Dorm_D → PS → SAC	0.012	0.008	1.560	0.119	0.001	0.033	-0.002	0.028
Cl_D → PS → SAC	-0.023	0.010	-2.161	0.031	-0.053	-0.008	-0.046	-0.004
Lib_D → PS → SAC	-0.008	0.009	-0.883	0.377	-0.030	0.008	-0.028	0.009
Dorm_D → PAff → SAC	0.007	0.016	0.434	0.664	-0.025	0.041	-0.025	0.040
Cl_D → PAff → SAC	-0.037	0.021	-1.782	0.075	-0.081	0.000	-0.076	0.005
Lib_D → PAff → SAC	-0.020	0.021	-0.917	0.359	-0.062	0.022	-0.065	0.019
Dorm_D → NAff → SAC	0.007	0.010	0.721	0.471	-0.010	0.032	-0.014	0.026
Cl_D → NAff → SAC	-0.035	0.014	-2.439	0.015	-0.074	-0.013	-0.064	-0.007
Lib_D → NAff → SAC	-0.004	0.013	-0.322	0.748	-0.030	0.021	-0.031	0.020

Dorm_N, Naturalness of greenery exposure in Dormitories; Cl_N, Naturalness of greenery exposure in Classrooms; Lib_N, Naturalness of greenery exposure in Libraries; Dorm_VS, Visual Scale of greenery exposure in Dormitories; Cl_VS, Visual Scale of greenery exposure in Classrooms; Lib_VS, Visual Scale of greenery exposure in Libraries; Dorm_D, Stewardship of greenery exposure in Dormitories; Cl_D, Stewardship of greenery exposure in Classrooms; Lib_D, Stewardship of greenery exposure in Libraries; PS, Perceived Stress; PAff, Positive Affect; NAff, Negative Affect; SAC, Student Adaptation to College; 5,000 bootstrap samples. Significance levels: ****p* < 0.001, ***p* < 0.01, **p* < 0.05, *p* < 0.1. Estimates with significant *p*-values are shown in bold.

(model 1–3), we comprehensively study the association of the perception of window scenery features of three types of main buildings on campus with freshman adaptation (model 4). We found that perceived visual scale is a key positive factor on adaptability, but the scenarios are different, where: dormitory visual field mainly reduces negative

emotions (such as anxiety, depression) and promotes adaptation; The main function of the library's vision is to enhance positive emotions and promote adaptation; Classroom vision may have a slight potential to increase positive emotions (close to significant). In addition, stewardship is a major negative factor on adaptability (especially in the

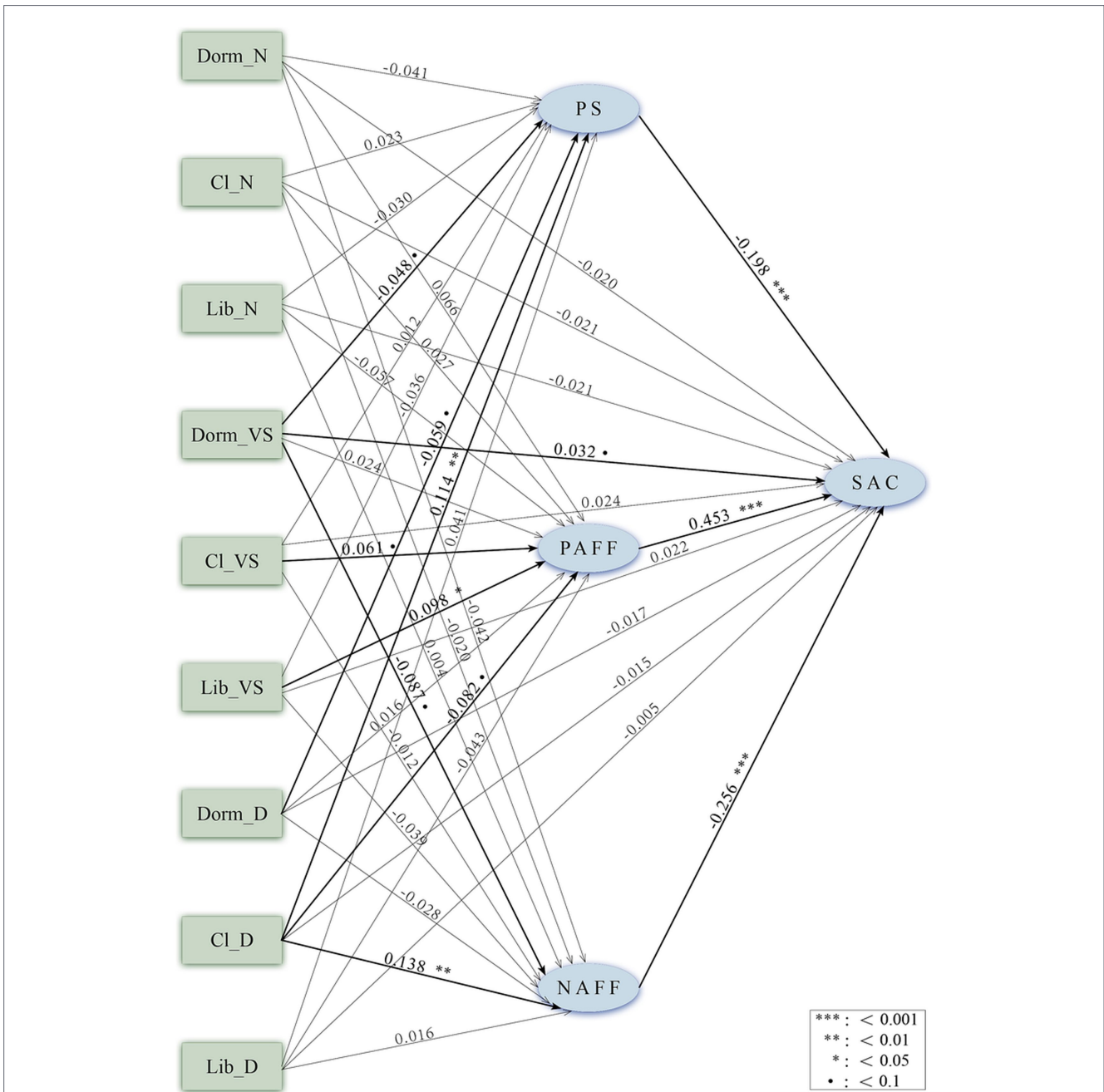


FIGURE 7
 The path relationship of Model 4 (links window greenery exposure and freshman adaptation). Dorm_N, naturalness of greenery exposure in dormitories; CI_N, naturalness of greenery exposure in classrooms; Lib_N, naturalness of greenery exposure in libraries; Dorm_VS, visual scale of greenery exposure in dormitories; CI_VS, visual scale of greenery exposure in classrooms; Lib_VS, visual scale of greenery exposure in libraries; Dorm_D, stewardship of greenery exposure in dormitories; CI_D, stewardship of greenery exposure in classrooms; Lib_D, stewardship of greenery exposure in libraries; PS, perceived stress; PAff, positive affect; NAff, negative affect; SAC, student adaptation to college. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, • $p < 0.1$. Estimates with significant p -values are shown in bold.

classroom): stewardship in the classroom significantly increases stress and negative emotions, impairing freshman adaptation, and it may also reduce positive emotions (near significantly). Similar to our study, existing research generally agrees that window views affect users through a combination of perceived features (naturalness, visual field, etc.) (Koprivec et al., 2022; Zhang et al., 2024). Our model further reveals that the same perceived features (such as vision) show association with adaptability in different architectural functional spaces (dormitories vs. libraries) through distinct psychological mediations (direct recovery vs. full emotional mediation), which profoundly

reveals the complexity of the “environment-person” relationship. Unlike most studies that generally examine “campus window view” (Lindemann-Matthies et al., 2021; Koprivec et al., 2022; Liu et al., 2022; Zhang et al., 2024), we juxtapose and distinguish the perceived window view features of dormitories, classrooms, and libraries, and use SEM to test multiple pathways, which transcends the limitation of most studies that only report the total association or a single mediating pathway (Li and Sullivan, 2016), and more detail depicts the mediation map of “window view perceptions → psychological process → freshman adaptation”.

In summary, the most important advancement of our research on the basis of verifying the basic value of perceived window views is to reveal the core principle that “the impact of perceived window views varies according to the function of the building and is realized through different psychological mediation paths”. Although several paths reach statistical significance, the standardized coefficients are modest (e.g., $\beta \approx 0.02\text{--}0.04$), which we argue represent meaningful increments in adaptation when considered in the context of daily, cumulative exposure to green window views.

4.3 Implications for campus landscape planning and management

This study proposes a comprehensive psychological framework linking perceived exposure to green window views on campus with the adaptability of university freshmen, offering significant implications for campus landscape planning and policy development.

First, we recommend integrating supporting student adaptation as a core objective in campus green planning. This approach is supported by established models including “the Green Prescription Program” (Hamlin et al., 2016) and contemporary “nature-based social prescribing programs” (Bell et al., 2024), which specifically prioritize mental wellness resource access. Accordingly, campus landscape and architectural design should explicitly prioritize students’ psychological adaptation and wellbeing as fundamental goals.

Second, targeted green interventions should be implemented through campus planning. This includes preserving natural landscapes and maintaining visual permeability to maximize exposure to natural and expansive window views, particularly from dormitories and libraries. Furthermore, connectivity between residential and academic zones should be enhanced through the design of convenient, safe, and visually engaging pedestrian routes. This integrated approach fosters repeated nature engagement as students transition between functional areas, supporting psychological restoration (Holt et al., 2019).

Third, these findings offer actionable principles for freshman-oriented campus planning. Campus design should pay attention to the direct and indirect relationships of window view perception of major buildings with students’ adaptation. Among them, the dormitory design should pay attention to the wide view of the window view, which not only directly promotes recovery, but also indirectly improves mood; Library design should also focus on broadening the horizon, mainly by promoting positive emotions to support learning. In addition, for the planning and design of the new campus, it is necessary to focus on the landscape design outside the classroom window, which should reflect the balance of the “human factor” in the visual landscape and reduce students’ stress and negative emotions. Beyond merely introducing natural elements, designs should strategically optimize green window views by balancing visual naturalness with appropriate stewardship—a combination shown to maximize restorative benefits (Stangierska-Mazurkiewicz et al., 2025). On campuses with limited established greenery, interior interventions such as potted plants in dormitories and corridors can enhance foreground layering and proximate nature exposure. This approach aligns with consistent evidence that users preferentially occupy window-adjacent spaces, where simultaneous access to daylight and exterior views contributes to improved mood and sustained cognitive performance (Keskin et al., 2015; Gou et al., 2018; Izmir Tunahan, 2022).

4.4 Limitations and directions for future research

Despite providing insights into how perceived green window views could be associated with freshman adaptation, this study has several inherent limitations.

First, the cross-sectional design of this study precludes the establishment of causal relationships between green window views and freshman adaptation. Although Harman’s one-factor test indicated that common method bias was not severe, and we implemented procedural controls such as anonymous responses and reverse scoring, cross-sectional designs relying on self-report may still be susceptible to methodological bias. Future research may employ longitudinal designs or marker variable approaches to further mitigate this methodological issue. In addition, the cross-sectional design precludes causal inference and that reverse causality cannot be ruled out and recommends longitudinal studies. Moreover, the findings are contextualized within a specific campus environment, climate, and cultural setting; consequently, their generalizability to institutions with divergent layouts, user demographics, or environmental conditions may be limited. Subsequent studies should adopt longitudinal approaches to track how seasonal variations in vegetation and view openness dynamically influence adaptation processes. Expanding the scope to include upperclassmen, diverse educational institutions (e.g., secondary schools, vocational colleges), and varied climatic-cultural contexts would also enhance the external validity of the findings.

Second, this study was observational rather than experimental. The indicators of perceived green window view exposure were assessed through self-reported questionnaires, making it difficult to avoid potential subjective bias. Although respondents answered questions about their perceptions of window greenery or scenery and items on the adaptation scale within a specific timeframe, demonstrating consistency in subjective data, these evaluations remain subjective perceptions. They cannot objectively and accurately reflect the perceived characteristics of window greenery exposure or the physiological and psychological indicators at that time. Future research should incorporate objective measures (e.g., NDVI, view indices) to explore their impact on freshmen’s adaptability. Where feasible, a semester-long randomized intervention would provide more substantive causal evidence. It should also be noted that during the early phase after the completion and occupancy of the new campus buildings, the surrounding vegetation was still in the initial post-transplantation growth stage. Differences in plant morphological characteristics—such as canopy size, trunk diameter, and plant height—were minimal, resulting in a high degree of overall homogeneity in campus greening. The immediate emotions or stress elicited by window-view exposure while the freshmen complete questionnaires indoors closely resemble their overall perception or general impression of the surrounding greenery outside the building. In future, we will select research areas based on the actual campus environments visible from inside different buildings, classify these environments according to defined criteria, and conduct comparative analyses of the findings. This will represent a significant comparative study.

Third, research on the psychological mediating relationships linking perceived window greenery exposure to freshman adaptation remains underdeveloped. This study selected naturalness, visual scale, and stewardship as representative perceived view characteristics to establish initial associations and mediating pathways. However, as students experience these features dynamically across different

campus buildings, the relationships are likely moderated by contextual factors such as duration of exposure and activity types. Future research should therefore investigate how perceived window views operate across diverse campus settings. Furthermore, while this study identified perceived stress and affect as key mediators, their structural relationships—whether parallel or sequential—and the potential involvement of other psychological mediations require further elucidation.

In summary, these limitations do not undermine the central finding, the establishment of a psychological mediation framework linking perceived campus window view exposure to freshman adaptation. Instead, they point to clear priorities for future research: emphasizing longitudinal designs, objective exposure assessment, and dynamic context-effects analysis. Advancing along these lines will refine evidence-based guidance to establish a comprehensive framework that better elucidates the psychological mediating relationships linking perceived campus window view greenery exposure to freshman adaptation.

5 Conclusion

This study reveals the core principle that “the impact of window scenery varies according to the architectural function and is realized through different psychological mediating paths” by constructing a comprehensive model of multiple buildings (dormitories, classrooms, libraries) and multiple perceived indicators (Naturalness, Visual Scale, Stewardship). It is called for future research and campus design not only to pay attention to “whether there is a natural landscape”, but also to combine the specific use of campus architectural space (dormitories, classrooms, libraries, etc.) and the psychological state of users to carry out differentiated design. Focusing on the critical transitional population of university freshmen, this study addresses a significant gap in understanding how campus environments show associations with psychological adaptation. This study established a data-driven framework with questionnaire data to analyze university freshmen adaptation. It pinpoints perceived campus green window views—a “micro-nature exposure” distinct from immersive experiences—as a significant factor enhancing adaptation. Our findings demonstrate that adaptation outcomes are not determined by singular environmental attributes but emerge from complex interactions between three core perceived view characteristics (naturalness, visual scale, and stewardship) operating through distinct psychological pathways.

We analyzed how window view perception showed the mediating relationship with freshman adaptation. Structural equation modeling (SEM) confirmed three mediating pathways via perceived stress, positive affect, and negative affect. Key findings show that perceived visual scale in dormitories and libraries strongly promotes adaptation, whereas poor classroom stewardship reduces it. The perceived dormitory naturalness also emerged as a significant positive factor, with all effects mediated through the aforementioned psychological pathways.

Although this study is based on a specific research population (university freshmen) and a single setting (university campuses), its methodology and core findings can serve as a reference for replication across diverse cultures, climates, and environments. The limitations of

this work—such as its cross-sectional design and lack of objective window view characteristic evaluation data—also point to directions for future research. Such studies should conduct longitudinal investigations, incorporate objective metrics for assessing exposure to green window views, and focus on dynamic exposure patterns and their mediating relationships.

Ultimately, this study adopts a multiple mediation framework to systematically investigate how perceived window view greenery exposure show the mediating relationship with freshman adaptation, specifically elucidating the mediating roles of perceived stress, positive affect, and negative affect. These findings not only advance theoretical knowledge of environment-mental health interactions but also offer actionable insights for campus planning and architectural design—such as optimizing dormitory layouts and classroom configurations—to support student wellbeing.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Academic Committee of College of Landscape Architecture in Nanjing Forestry University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

YF: Methodology, Investigation, Conceptualization, Writing – review & editing, Data curation, Validation, Visualization, Writing – original draft, Formal analysis. WW: Funding acquisition, Supervision, Project administration, Writing – review & editing, Resources. YY: Conceptualization, Methodology, Writing – review & editing. XL: Investigation, Data curation, Writing – review & editing, Software.

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Conflict of interest

XL was employed by Nanjing Jianpu Software Co., Ltd.

The remaining author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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