Perceived Restorativeness of Healing Gardens in Office Environments: Evidence from the Restorative Perception and Stress Reduction Survey

Murni binti Zainal[1*], Nur Dalilah binti Dahlan[1], Firdaus binti Mukhtar[2], Mohd Nazri bin Saidon[3]

[1]Department of Architecture, Faculty of Design & Architecture, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.

[2]Department of Psychiatry, Faculty of Medicine & Health Sciences, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.

[3]Department of Landscape Architecture, Faculty of Design & Architecture, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.

***Corresponding author**

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ABSTRACT

This study examines nature-based features integrated with healing gardens and perceived soft fascination in tropical office environments in Peninsular Malaysia using the Restorative Perception and Stress Reduction (RPSR) survey. The study investigated four nature-based office environments with healing gardens and used eight real-colour photographs selected by experts using Visual Aesthetic Quality Assessment (VAQA) as visual stimuli embedded in the RPSR survey. The survey was administered to 119 respondents comprising three adult groups: nature-exposed office workers, comparison office workers, and adults with clinically diagnosed mild or moderate depression and/or anxiety. The analysis examined differences, relationships, and associations in perceived restorativeness and stress-reduction responses across the groups. The findings showed high perceived restorativeness and stress-reduction potential across all three groups. The analysis identified significant group differences for five items associated with three visual stimuli: “break”, open “staircase”, plant “arrangement”, “water”, and natural “ventilation and lighting”. Positive relationships between perceived restorativeness and perceived stress reduction were found within all groups, while adults with clinical depression and anxiety showed stronger responses to several restorative stimuli than the non-clinical groups. The findings suggest that varied nature-based visual stimuli within restorative office environments can support attentional and emotional restoration across diverse adult populations. Because the study was conducted in selected tropical office environments in Malaysia, applying it to other settings may require climatic and cultural adaptation. The reliable, content-validated and culturally adapted RPSR survey provides a practical tool for evaluating restorative office environments and informs evidence-based integration of nature-based features and healing gardens to support mental well-being.

Keywords: Healing gardens, Nature-based features, Office environments, Restorative Perception and Stress Reduction, Visual stimuli.

INTRODUCTION

Rapid urbanisation in Malaysia is projected to reach 80% by 2030 (Ministry of Housing and Local Government Malaysia, 2020), increasing separation from nature and the risk of mental health problems (Xingrui & Ibrahim, 2024). Urban growth has also been linked to higher perceived stress and environmental degradation, including reduced green spaces, deforestation, habitat loss, and biodiversity decline (Darus & Latif, 2019; Raaj et al., 2021; Seto et al., 2012). Consequently, limited access to natural environments

encourages indoor lifestyles, with people spending about 90% of their time indoors (Klepeis et al., 2001), reducing exposure to nature and adversely affecting health (Baggerly et al., 2015; Sandifer et al., 2015). Furthermore, the 2023 National Health and Morbidity Survey (Institute for Public Health, 2024) reported that depression affected 4.6% of Malaysian adults (approximately one million adults), doubling since 2019, while overall mental health problems increased from 7.9% to 16.5%. In addition, 53% of employees reported workplace stress associated with depression and anxiety (Teo, 2019; The Edge, 2019).

These issues highlight the need for design strategies that strengthen human-nature connections, support mental well-being, and promote restorative office environments. Attention Restoration Theory (ART) states that natural environments help mental recovery through four experiences: being away, fascination, coherence, and compatibility (Kaplan, 1995; Kaplan & Kaplan, 1989). Stress Reduction Theory (SRT) posits that nature supports physiological and psychological recovery through four areas of design considerations: a sense of control, social support, physical movement, and natural engagement (Ulrich, 1991). The Perceived Restorativeness Scale (PRS) measures these qualities as psychological responses (Hartig et al., 1997). Together, ART, SRT, and PRS provide a unified psychological framework for understanding how nature-based office environments promote restorative experiences and mental well-being.

Despite this theoretical foundation, several research gaps remain. First, although ART, SRT, and PRS are established frameworks, few studies have integrated them to examine restorative office environments across indoor, semi-outdoor, and outdoor spaces (Evans, 2003; Malekinezhad & Lamit, 2017; Konijnendijk et al., 2023). Second, researchers have studied healing gardens mainly in healthcare settings, with limited attention to their restorative potential in office environments (Jer & Ibrahim, 2014; Daniels et al., 2022; Cao & Huang, 2023; Lestari & Favurita, 2024; Verma & Singh, 2023). Third, rapid urbanisation limits opportunities for green spaces, while current green building criteria place little emphasis on restorative user experiences (Maryanti et al., 2016; Zaid & Kiani, 2016). Fourth, previous studies have relied largely on homogeneous samples, particularly university students, providing limited evidence from diverse adult populations and integrated exposure to nature across indoor, semi-outdoor, and outdoor office environments (Ahmad et al., 2019; Dreyer et al., 2018; Hartig et al., 1997; Hartig et al., 2001; Markevych et al., 2017; Ulrich, 1991). Finally, many studies have used context-free measures that inadequately represent real-world exposure to nature (Bringslimark et al., 2007; Colley et al., 2017; Sadick & Kamardeen, 2020).

To address these gaps, this study investigated healing gardens in Malaysian office environments using an integrated psychological framework comprising ART, SRT, and PRS. A methodological triangulation approach combined Visual Aesthetic Quality Assessment (VAQA) with photo sampling (Clay & Daniel, 2000; Clay and Smidt, 2004; Daniel, 2001) and the newly developed Restorative Perception and Stress Reduction (RPSR) survey to evaluate restorative perceptions and stress reduction in nature-based office environments (Frumkin, 2001; Ulrich, 1991; Kaplan, 1984; Surcinelli et al., 2023; Yanru et al., 2020). Using real-colour photographs of outdoor, semi-outdoor, and indoor spaces, the study provides ecologically relevant evidence of restorative perception and stress reduction among diverse adult populations.

This study examines nature-based features of healing gardens in office environments and human perceptions of soft fascination. It analyses how garden design affects mental well-being and uses soft fascination as a stress-relief intervention, focusing on microclimatic conditions in Malaysian offices. The specific objectives are:

- To investigate the nature-based features of healing gardens in selected tropical office buildings in urban areas of Peninsular Malaysia, focusing on mental well-being.
- To assess perceptions of soft fascination in tropical office buildings that include healing gardens.

METHODS

Study Design

This study uses a mixed-methods approach grounded in a unified psychological framework to assess

restorative and stress-related responses. It combines theory with real-life case studies and participants to produce holistic insights (Paparini et al., 2020). This integration led to the development of the Restorative Perception and Stress Reduction (RPSR) survey, which assesses perceived restorativeness and stress reduction across diverse groups. The instrument development used a sequential triangulation approach, as shown in Figure 1, combining quantitative and qualitative methods, such as observations and surveys, to enhance reliability and validity (Amirzadeh et al., 2024; Thurmond, 2001).

The study focused on context-based measures using real-colour photographs of nature-based features integrated with healing gardens in office environments. The study carefully selected office environments to illustrate integration across outdoor, semi-outdoor, and indoor spaces. Visual Aesthetic Quality Assessment (VAQA) was used to evaluate these environments, extending research beyond single settings (Bringslimark et al., 2007; Cleland & MacLeod, 2021; Colley et al., 2017; Glaw et al., 2017; Sadick & Kamardeen, 2020). Including diverse respondent groups captures contrasting perspectives and broadens the contextual relevance of the findings (Nyimbili & Nyimbili, 2024).

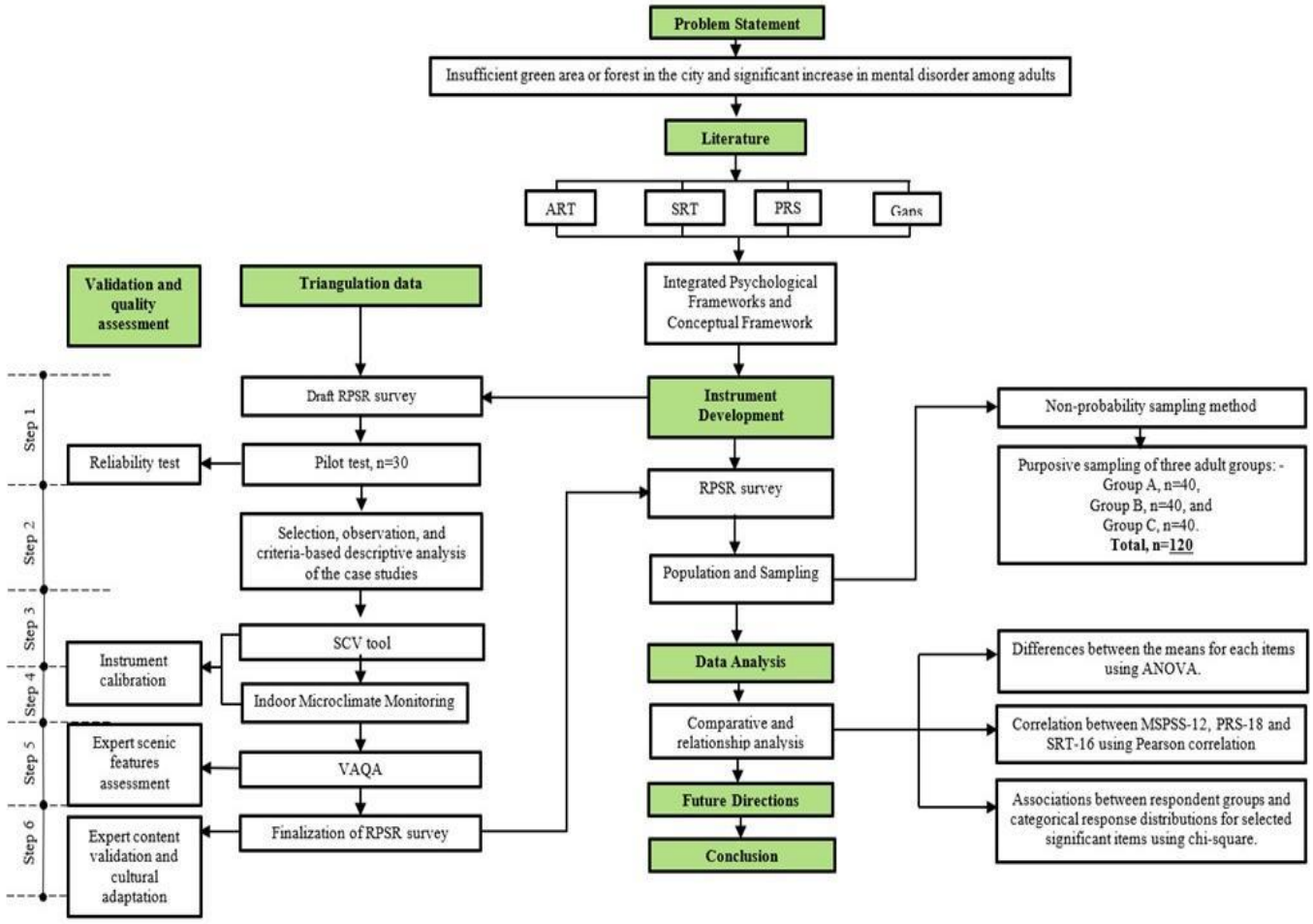

Figure 1. Research process

Case Studies

Four office environments in Central and Northern Peninsular Malaysia were selected using four predefined criteria: (i) urban location, (ii) recognition through architectural or sustainability awards, (iii) integration of nature-based features with healing gardens, and (iv) potential to support restorative experiences. Table 1 summarises the selected office environments, their nature-based features, and their functions in the study. To maintain confidentiality, the identities and exact locations of the participating organisations remain undisclosed (Yin, 2018).

Table 1. Office environments, their nature-based features and functions.

Office environments	Nature-based features	Functions
Office setting 1 (OS1)	Includes a large central courtyard, pocket gardens between the office blocks, and proximity to a forest reserve	Photographic inventory for outdoor and semi-outdoor spaces.
Office setting 2 (OS2)	Includes courtyards, roof gardens, and garden terraces	Photographic inventory for outdoor, semi-outdoor, and indoor spaces. Soft-fascination Criteria Validation (SCV) tool and indoor microclimate measurement.
Office setting 3 (OS3)	Includes courtyards, sky gardens, and garden terraces, surrounded by hilly forest	Self-administered RPSR survey for office workers exposed to nature-based features integrated with healing gardens (Group A)
Office setting 4 (OS4)	Includes roof gardens, pocket gardens between office blocks, and buildings adjacent to and connected to the lake garden	

Site observations verified compliance with the selection criteria, and the office environments were evaluated against the characteristics of healing gardens and the soft fascination criteria; all four met the required characteristics. Office Settings 1 (OS1) and 2 (OS2) were photographed for the Visual Aesthetic Quality Assessment (VAQA). Before VAQA, researchers assessed Office Setting 2 (OS2) using the Soft-fascination Criteria Validation (SCV) tool, a mixed-methods survey that validated the three soft-fascination criteria (visibility, accessibility, and proximity) and measured indoor air temperature, relative humidity, and light intensity. Office Settings 3 (OS3) and 4 (OS4) were subsequently used for the full-scale Restorative Perception and Stress Reduction (RPSR) survey involving Group A office workers.

Visual stimuli using Visual Aesthetic Quality Assessment (VAQA) with photo sampling

Visual stimuli were developed using Visual Aesthetic Quality Assessment (VAQA) with photo sampling to systematically document nature-based features integrated with healing gardens across outdoor, semi-outdoor, and indoor office environments (Zainal et al., 2026). Standardised photographic procedures and expert evaluation ensured consistency and minimised subjectivity (Clay & Daniel, 2000; Clay & Smidt, 2004; Daniel, 2001; Zainal et al., 2026).

Office Setting 2 (OS2) underwent additional evaluation using the SCV tool and indoor microclimate measurements before photographic documentation. These complementary assessments provided further environmental evidence regarding the selected office setting, consistent with the case study approach and the principle of literal replication (Yin, 2018).

As Zainal et al. (2026) detail, the VAQA procedure used 39 photographic positions across outdoor, semi-outdoor, and indoor spaces, producing 89 photographs. After initial screening, the researchers organised 60 test scenes according to eight visual descriptors derived from the integrated psychological framework. Two experts in visual landscape assessment evaluated these scenes using a binary rating scale (Agree/Disagree), guided by four or five sub-descriptors for each visual descriptor. The experts conducted a joint assessment and reached complete consensus on the final eight photographs. As the evaluation involved joint ratings rather than independent assessments, a separate inter-rater reliability coefficient was not calculated.

The eight selected photographs were matched to the corresponding PRS and SRT constructs based on their visual descriptors and sub-descriptors. Four photographs represented the PRS constructs of being away, fascination, coherence, and compatibility (Figure 2), while four represented the SRT components of sense of control, social support, physical movement and exercise, and natural engagement (Figure 3). These

photographs served as standardised visual stimuli in the Restorative Perception and Stress Reduction (RPSR) survey.



Figure 2. Four photographs selected through the Visual Aesthetic Quality Assessment (VAQA) with photo sampling to represent the Perceived Restorativeness Scale (PRS) constructs: being away, fascination, coherence and compatibility.



Figure 3. Four photographs selected through the Visual Aesthetic Quality Assessment (VAQA) with photo

sampling to represent the Stress Reduction Theory (SRT) constructs: sense of control, social support, physical movement and exercise, and natural engagement.

Measures and Instrument Development

Restorative Perception and Stress Reduction (RPSR) survey

The RPSR survey integrates three validated instruments: Multidimensional Perceived Social Support (MSPSS-12) (Zimet et al., 1988; Wongpakaran et al., 2011), Perceived Restorativeness Scale (PRS-18) (Hartig et al., 1997) and Stress Reduction Theory (SRT-16) (Ulrich, 1991). The survey included eight real-colour photographs (Figures 2 and 3) representing the PRS-18 and SRT-16 visual stimuli, each accompanied by four or five questionnaire items.

The MSPSS-12 measures perceived social support from family, friends, and significant others. Higher scores relate to lower depression and anxiety (Zimet et al., 1988; Wongpakaran et al., 2011). It assesses the role of social support in mental well-being and stress reduction as a buffer against psychological distress, on a 7-point scale (1 = Very strongly disagree; 7 = Very strongly agree).

PRS-18, adapted from PRS-16 by Hartig et al. (1997). The questionnaire items in each PRS-16 subgroup are not balanced (i.e., 2 items in being away, 5 items in fascination, 4 items in coherence, and 5 items in compatibility). Two additional items were incorporated into the being away visual stimuli: (i) “being here helps me to relax” and (ii) “coming here helps me to get relief from unwanted demands on my attention”, to strengthen the conceptual representation of the being away construct, better reflect restorative experiences in healing garden office environments, and balance subgroup representation (Hartig et al., 1997; Pasini et al., 2014), resulting in a total of 18 items in PRS-18. However, two of the coherence items include negative words: “It is a confusing space” and “It is chaotic here”, both reflecting confusion and disorganisation, which are contrary to restorativeness. These items capture a lack of coherence, with being away, fascination, and compatibility representing general factors, and coherence as an independent restorative aspect.

SRT-16, developed based on Stress Reduction Theory (SRT) (Ulrich, 1991), evaluates stress reduction through areas of consideration that can guide the design of restorative environments: sense of control, social support, physical movement and exercise, and natural engagement. Each SRT visual stimulus is accompanied by four questionnaire items derived from the characteristics of healing gardens and the soft fascination criteria, for a total of 16 items.

PRS and SRT are complementary frameworks in environmental psychology for evaluating restorative environments and psychological well-being (Zainal et al., 2025). Previous studies have applied PRS to assess perceived restorativeness across forest and indoor office environments (Liu et al., 2021; Xuan & Zhang, 2024). Building on these applications, this study integrates PRS-18 and SRT-16 within a unified psychological framework to evaluate perceived restorativeness and stress-reduction experiences associated with nature-based features integrated with healing gardens in office environments. Both PRS-18 and SRT-16 were assessed utilising a seven-point scale (Hartig et al., 1997) (0 = Strongly disagree; 6 = Strongly agree) (Ahmad et al., 2019) to suit the research context.

Reliability and Validity of the Survey Instrument

Before finalising the RPSR survey instrument, the draft underwent a pilot test to identify and address ambiguities. The instrument was then finalised through content and cultural validation before use in the full survey. This process is crucial for ensuring the instrument's reliability. The pilot test involved n=30 control subjects to assess the reliability of the MSPSS-12, PRS-18 and SRT-16 constructs. The pilot survey was prepared in both English and Malay and included eight nature-based features integrated with healing garden photos in office environments, using dummy photos from Google depicting four PRS and four SRT visual stimuli. Dummy photos were used because the photographic inventory for the case studies has not yet started. In this study, validity was established following reliability testing through the pilot, as reliability is a prerequisite for validity (Vetter & Cubbin, 2019). The overall reliability analysis showed very good internal

consistency (Cronbach's α = 0.881) across 46 items (12 items of MSPSS, 18 items of PRS, and 16 items of SRT), confirming the instrument's robustness. Cronbach's alpha for MSPSS-12 was 0.876, indicating very good internal consistency; PRS-18 was 0.912, indicating excellent internal consistency; and SRT-16 was 0.855, also indicating very good internal consistency (Hair et al., 2021; Arshad et al., 2023).

Once the eight real-colour photographs (Figures 2 and 3) were integrated into the survey, it underwent two quality assessments: content validity and cultural adaptation. Three experts aligned with the integrated psychological framework evaluated content validity: a clinical psychologist, a landscape and wellbeing specialist, and an architect familiar with the Malaysian biophilic approach. They independently assessed 46 items on a binary scale, with acceptable agreement (Mat Said et al., 2022; Polit et al., 2007). Items with low content validity (i-CVI = 0.67) were revised for clarity and relevance. For physical movement and exercise, one expert suggested that the healing garden should be quiet, peaceful, and relaxing, leading to revisions from "the healing garden, completed with the outdoor fitness equipment" to "may have included the outdoor fitness equipment." All items of the MSPSS-12, PRS-18, and SRT-16 were translated into Malay by the Institut Terjemahan dan Buku Malaysia (ITBM) prior to the full-scale survey, and the survey was available in both languages to suit the Malaysian context.

Respondents

RPSR survey was administered to three groups of respondents (aged 18 or above in 2025), which consisted of:

- The nature-exposed subjects had over 6 months of experience and were exposed to nature-based features in office environments Group A.
- The comparison subjects, office workers with no experience working in offices with nature-based features, are currently in standard offices Group B.
- The mental disorder subjects, referred to as adults with clinical depression and anxiety, are Group C.

Groups A and B are categorised as non-clinical depression subjects. Group C was categorised as clinical depression subjects with mild and moderate depression and anxiety. Table 2 shows the inclusion and exclusion criteria for the respondents.

Table 2. Inclusion and exclusion criteria for the respondents

Criteria	Inclusion	Exclusion
Population	Adults aged 18 and above in 2025	Kids and teenagers (aged below 18 in 2025)
Respondents	Non-clinical (Groups A and B); clinical (Group C: mild-to-moderate depression and anxiety)	Severe mental disorder
Nature Exposure	Passive nature exposure includes simply sitting in a garden, looking at trees through a window	Active nature exposure involves engaging in physical activities within natural environments, such as hiking, gardening, or playing sports.
Health condition	Able to participate and respond to the survey	Neurological disorders, severe physical disabilities, and visual impairments

Sampling strategies

The study used purposive sampling to select 120 adult respondents from three groups with varying levels of exposure to nature-based office environments, ensuring rich, context-specific data. This approach captured diverse experiences and variation in perceived restorativeness and stress reduction, strengthening the analysis (Sella et al., 2023; Nyimbili and Nyimbili, 2024).

Sample size was determined using a power analysis in G*Power, with 0.80 power, a medium effect size of

0.30, and $p < 0.05$, requiring 111 participants across three groups (Pérez et al., 2024; Sella et al., 2023). An 8% dropout rate was used (Kato & Miura, 2021; Kullgard et al., 2022) The final sample suggested 120 respondents, 40 per group. The survey with photo-based Likert-scale items was designed to reduce cognitive load and keep participants engaged (Cernat et al., 2024; Yan & Williams, 2022). This approach ensured adequate statistical power while capturing contrasting perspectives across the three respondent groups.

Procedure for the Full Survey

Group A comprised office workers from nature-based office environments, drawn from Office Settings 3 (OS3) and 4 (OS4), recruited via representatives through online surveys, followed by printed questionnaires with incentives to achieve the target sample size (n=40). Group B included adults working in conventional office environments without exposure to nature-based features, recruited similarly via online distribution and supplemented with printed surveys. Group C consisted of adults diagnosed with clinical depression and anxiety, recruited through a psychiatry clinic at Hospital Sultan Abdul Aziz Shah, UPM, using face-to-face administration of printed surveys. Incentives were provided across groups to enhance participation and ensure an adequate sample size.

Analysis

Data were analysed using IBM SPSS Statistics (v30). Descriptive statistics, including means, total scores, and standard deviations, summarised responses from MSPSS-12, PRS-18, and SRT-16 across three groups. Higher MSPSS scores indicate greater perceived social support and better psychological outcomes (Zimet et al., 1988), while higher PRS and SRT scores reflect greater restorative quality and stress reduction (Hartig et al., 2001).

Inferential analyses examined mean differences and relationships across groups. One-way ANOVA identified differences, with Tukey's post hoc used for pairwise comparisons (Zhu et al., 2024). Effect sizes (f) and eta-squared (η^2) were interpreted using Cohen's (1988) benchmarks, while coefficient determination (R^2) values were interpreted as the proportion of variance explained, with reference to Cohen's (1992) benchmarks. Pearson correlation (r) was used to assess the relationship between perceived restorativeness and stress reduction, with the strength of the relationship interpreted using Cohen's (1988) benchmarks. Chi-square tests examined categorical associations among items significant in ANOVA, with cross-tabulations across groups interpreted using Alkharusi (2022).

RESULTS

Respondents Background

Initial recruitment for Groups A and B was conducted online, and the RPSR survey links were distributed via email and WhatsApp; however, response rates were insufficient. To reach the target sample size (n = 40 per group), we subsequently administered colour-printed surveys in person through their representatives, yielding 80 valid responses. Group C was recruited through a psychiatry clinic with a psychiatrist's guidance. Data were collected through face-to-face administration of printed surveys over multiple weeks, yielding 39 valid responses. This survey received 119 valid responses (40 from Group A, 40 from Group B, and 39 from Group C). Table 3 shows the socio-demographic background. Not applicable; numbers 4, 5, and 6 refer to individuals from Group C.

Table 3. Background of the respondents (n=119)

No.	Variables	n	%
1	Gender:		
	Male	54	45
	Female	65	55
2	Age:		
	18 - 29 years old	28	24

	30 - 39 years old	41	34
	40 – 49 years old	36	30
	50 – 59 years old	11	9
	60 years old and above	3	3
3	Ethnicity:		
	Malay	107	89
	Chinese	9	8
	Indian	-	-
	Others	3	3
4	Working in the office:		
	6 months – 4 years	26	22
	5 – 10 years	21	18
	More than 10 years	57	48
	Not applicable (housewives, undergraduate students, and unemployed)	15	12
5	Educational background:		
	STPM/A-Levels	16	14
	Undergraduate	48	40
	Postgraduate	51	43
	Not applicable (SPM and lower)	4	3
6	Position in the office:		
	Junior level	17	14
	Executive level	28	24
	Professional	28	24
	Manager	11	9
	Others	21	18
	Not applicable (housewives, undergraduate students, and unemployed)	14	11

Descriptive analysis

The mean total scores for MSPSS-12, as shown in Table 4, indicated that Groups A and B experienced high perceived social support, which was linked to low levels of depression and anxiety symptoms (Zimet et al., 1988). Lakey and Cohen (2015) confirmed that social support reduces the impact of stressful life events on health, acting as a significant buffer against psychological distress. In contrast, Group C had moderate perceived social support, which was associated with a lack of protection against psychological distress, leading to negative outcomes such as relapse into depression, poor health, and psychological effects due to stressful life experiences (Wongpakaran et al., 2011).

Table 4. The mean total scores for MSPSS-12 across groups

Groups of respondents	Mean total scores	Indicator
Group A	5.97 (±1.0)	High perceived social support
Group B	5.40 (±1.3)	High perceived social support
Group C	5.07 (±1.8)	Moderate perceived social support

Note: 1.00 – 2.90 = Low perceived social support, 3.00–5.09 = Moderate perceived social support, and 5.10–7.00 = High perceived social support, as indicated by the MSPSS-12 (Source: Zimet et al., 1988).

The mean total scores for PRS-18, shown in Table 5, indicated that all groups fell within the high perceived restorativeness range, with mean total scores >4.00 on a seven-point scale (0 to 6). This pattern aligns with Ahmad et al. (2019), who also observed mean values >4.00 across all PRS sub-constructs, reflecting positive perceived restorativeness. Hartig et al. (2001) noted that higher mean values indicate greater restorative quality, whereas midrange mean values < 3.00 correspond to low evaluations of restorativeness in the natural environment. The findings suggest that respondents consistently evaluated each photo as having high restorative potential.

Table 5. The mean total scores for PRS-18 across groups

Groups of respondents	Mean total scores	Indicator
Group A	4.24 (±1.2)	High perceived restorativeness
Group B	4.41 (±1.3)	High perceived restorativeness
Group C	4.32 (±1.3)	High perceived restorativeness

Note: 0.00 – 2.00 = Low perceived restorativeness, >2.00 – 4.00 = Moderate perceived restorativeness, and >4.00 – 6.00 = High perceived restorativeness, an indicator of PRS-18. Adapted from Alkharusi (2022) for the three-point scale of class intervals using the average method.

SRT explains how nature, like a healing garden, aids affective restoration as part of stress recovery involving positive psychological and physiological changes (Ulrich, 1991). The mean total scores on the SRT-16, as shown in Table 6, indicated that all groups were in the high-perceived-stress-reduction range. This pattern is consistent with Liu et al. (2021), who found mean PRS values > 4.00 across three forest sites, indicating greater stress reduction than at the shopping square.

Ulrich (1979) supports the view that visual exposure to nature, rather than urban scenes, on slides affects psychological well-being, especially in mildly stressed individuals. His experiment shows that exposure to nature scenes reduces anxiety, while urban scenes increase sadness and decrease attention. Collectively, these findings suggest that the four SRT visual stimuli were consistently perceived as having high stress-reduction potential across all respondent groups, with particularly strong responses among adults with clinical depression and anxiety.

Table 6. The mean total scores for SRT-16 across groups

Groups of respondents	Mean total scores	Indicator
Group A	4.52 (±1.2)	High perceived stress reduction
Group B	4.81 (±1.1)	High perceived stress reduction
Group C	4.83 (±1.2)	High perceived stress reduction

Note: 0.00–2.00 = Low perceived stress reduction, >2.00–4.00 = Moderate perceived stress reduction, and >4.00–6.00 = High perceived stress reduction, an indicator of SRT-16. Adapted from Alkharusi (2022) for the three-point scale of class intervals using the average method.

Comparative analysis

The comparative analysis examined item-level differences across three respondent groups using MSPSS-12, PRS-18, and SRT-16.

MSPSS-12

MSPSS-12 had three sources of social support: family, friends, and significant others, each with four items shown in Figure 4. All family items differed significantly across groups, with Group A reporting the highest family support, followed by Group B, then Group C, which scored in the moderate range on the items “support” and “decision.”

For friends, only items “help" and "count on" differed significantly, with Group A scoring higher than B and C, implying that those in nature-based office environments might experience stronger collegial support, aligning with theories that supportive environments foster social interaction and well-being (Kellert & Calabrese, 2015). Less supportive built environments might limit interaction (Evans, 2003). For significant others, all items were generally high across groups.

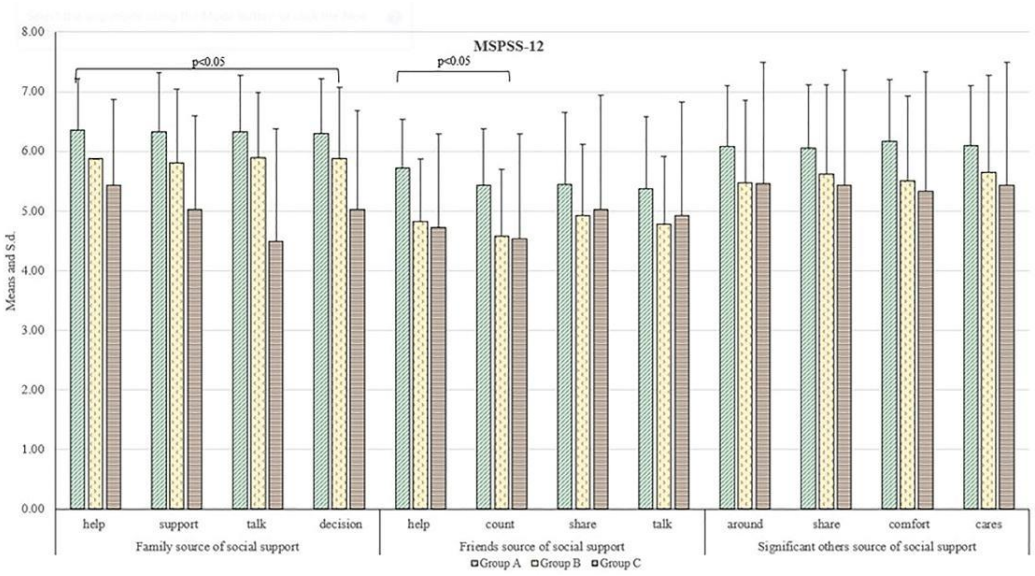

Figure 4. Comparison of 12 items in MSPSS-12 (scale 1 to 7) across three groups

PRS-18

PRS-18 had four subgroups: being away, fascination, coherence, and compatibility, as shown in Figure 5. In being away, only the item "break" differed significantly, with Group C reporting the highest perceived score, followed by Group B, while Group A reported the lowest score. This unexpected pattern contrasts with the expectation that groups' direct exposure to nature-based features integrated with healing gardens would yield stronger restorative perceptions. This finding is consistent with Lottrup et al. (2013), who reported that many office workers rarely use outdoor spaces during the workday despite having access to nature because they feel too busy and workplace culture does not encourage outdoor use. Similarly, Thomson and Bruk-Lee (2019) found that the restorative benefits of workplace nature depend on individual nature preferences. Together, these findings suggest that access to healing gardens alone may not guarantee stronger perceptions of being away, as workplace culture and nature preferences influence restorative experiences. No significant differences emerged across the remaining PRS-18 subgroups, indicating consistent perceptions across respondent groups. Although the coherence items had comparatively lower mean scores because they included negatively worded statements, the overall response pattern remained similar across groups. These findings suggest that the visual stimuli effectively represented the restorative qualities of the PRS-18 constructs, consistent with Hartig et al. (1997), Kaplan and Kaplan (1989), Korpela (2013), and Sella et al. (2023).

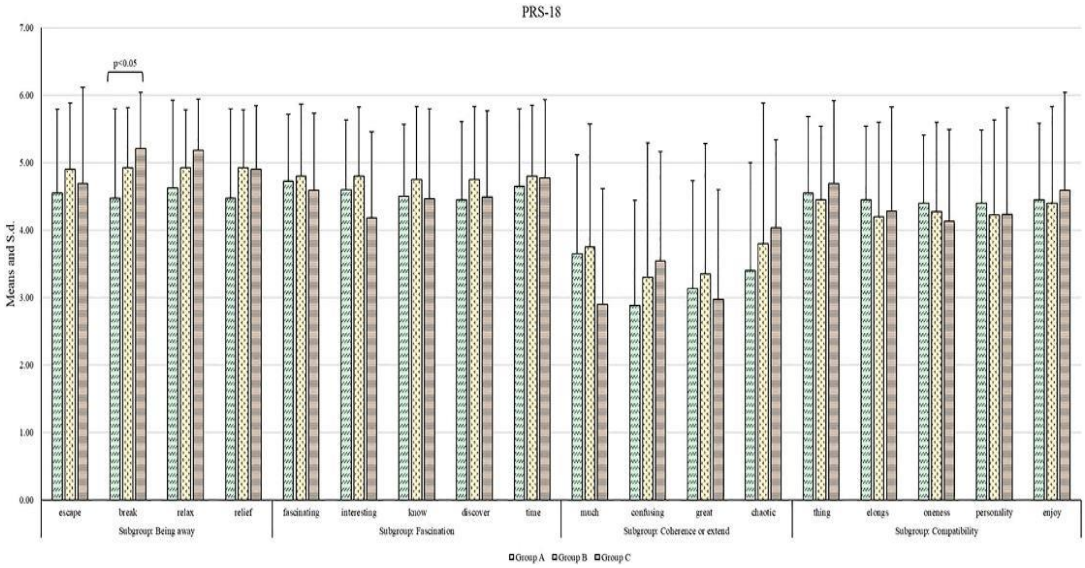

Figure 5. Comparison of 18 items in PRS-18 (scale 0 to 6) across three groups

SRT-16

SRT-16 comprised four areas: sense of control, social support, physical movement, and natural engagement, each assessed using four questionnaire items (Figure 6). No significant differences were observed in the areas of sense of control and social support. Significant differences were found for the open "staircase" item in physical movement and the "arrangement", "water", and "ventilation and lighting" items in natural engagement.

Group A consistently reported the lowest scores for these items. These findings indicate that Group C showed stronger responses to several of the selected nature-based features, particularly the open "staircase", plant "arrangement", and "natural ventilation and lighting", whereas Group B showed the strongest response to the "water" element. This finding is consistent with Bettmann et al. (2025), who reported that nature-based interventions produced broader psychological benefits among adults with mental illness than among non-clinical populations. The lower scores reported by Group A may also reflect habituation following prolonged exposure to the same nature-based features in office environments, consistent with Hasebe and Harada (2025)

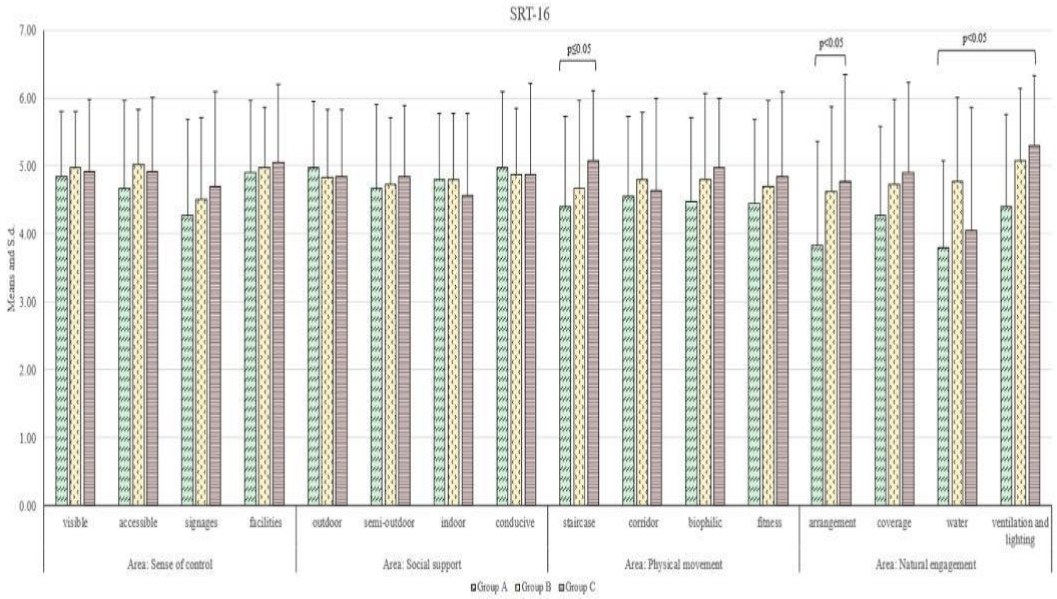

Figure 6. Comparison of 16 items in SRT-16 (scale 0 to 6) across three groups

Correlation Analysis

Correlation between MSPSS-12, PRS-18, and SRT-16 across groups

Correlation patterns among MSPSS-12, PRS-18, and SRT-16 are in Table 7. MSPSS-12 wasn't significantly associated with PRS-18 and SRT-16, indicating no statistically significant relationship within this sample. The findings aligned with Acoba (2024), which found that social support may influence mental health indirectly via perceived stress (coping ability), rather than through environmental features such as healing gardens. Perceived restorativeness and stress reduction are linked concepts in environmental psychology (Kaplan, 1995; Ulrich, 1991; Hartig et al., 1997), with stress reduction mitigating and cognition enhancing.

Table 7. The Pearson correlation between MSPSS-12, PRS-18, and SRT-16 across groups

Pearson Correlation Sig. (2-tailed)	Group A, n=40	Group B, n=40	Group C, n=39
MSPSS-12 and PRS-18	0.25	0.12	0.21
	p >0.05	p >0.05	p >0.05
MSPSS-12 and SRT-16	0.13	0.30	0.13
	p >0.05	p >0.05	p >0.05

PRS-18 and SRT-16	0.81	0.39	0.63
	p <0.05	p <0.05	p <0.05

Note: 0.10 – 0.20 = Very small, 0.21– 0.40 = Small. 0.41 – 0.60 = Medium, 0.61 – 0.80 = Large, and 0.81 – 1.00 = Very large, an indicator of Pearson correlation. Adapted from Cohen (1988) and Lakens (2013).

Correlation between PRS-18 and SRT-16 patterns across groups

This analysis showed positive relationships between perceived restorativeness and perceived stress reduction across all three groups, although the strength of the relationships varied.

Table 8. The Pearson correlation between PRS-18 and SRT-16 across groups

Group of respondents	PRS–SRT Correlation	Strength	Significance
A	r = 0.81	Very large positive	p < 0.05
B	r = 0.39	Small positive	p < 0.05
C	r = 0.63	Large positive	p < 0.05

Note: 0.10 – 0.20 = Very small, 0.21– 0.40 = Small. 0.41 – 0.60 = Medium, 0.61 – 0.80 = Large, and 0.81 – 1.00 = Very large, an indicator of Pearson correlation. Adapted from Cohen (1988) and Lakens (2013).

Figure 7 presents the visual correlation between PRS-18 and SRT-16 across groups, as shown in the scatter plot analysis. Cohen's benchmarks for R^2 indicate that values of 0.02, 0.13, and 0.26 represent small, medium, and large effect sizes, respectively (Cohen, 1992). All groups showed a general upward trend, but the magnitude varied, as follows:

- Group A recorded the highest coefficient of determination ($R^2 = 0.651$), indicating a large proportion of shared variance between PRS-18 and SRT-16 (Cohen, 1992). This represents the strongest association between perceived restorativeness and stress reduction among the three respondent groups.
- Group B showed a slight upward trend with a coefficient of determination ($R^2 = 0.155$), indicating a moderate proportion of shared variance between PRS-18 and SRT-16 (Cohen, 1992). This reflects the weakest association among the three respondent groups, suggesting a less consistent relationship between perceived restorativeness and stress reduction in typical office environments.
- Group C showed a central concentration trend with a coefficient of determination ($R^2 = 0.395$), indicating a large proportion of shared variance between PRS-18 and SRT-16 (Cohen, 1992). This represents a strong association between perceived restorativeness and stress reduction, consistent with Bettmann et al. (2025), who reported broader psychological benefits of exposure to nature among adults with mental health conditions.

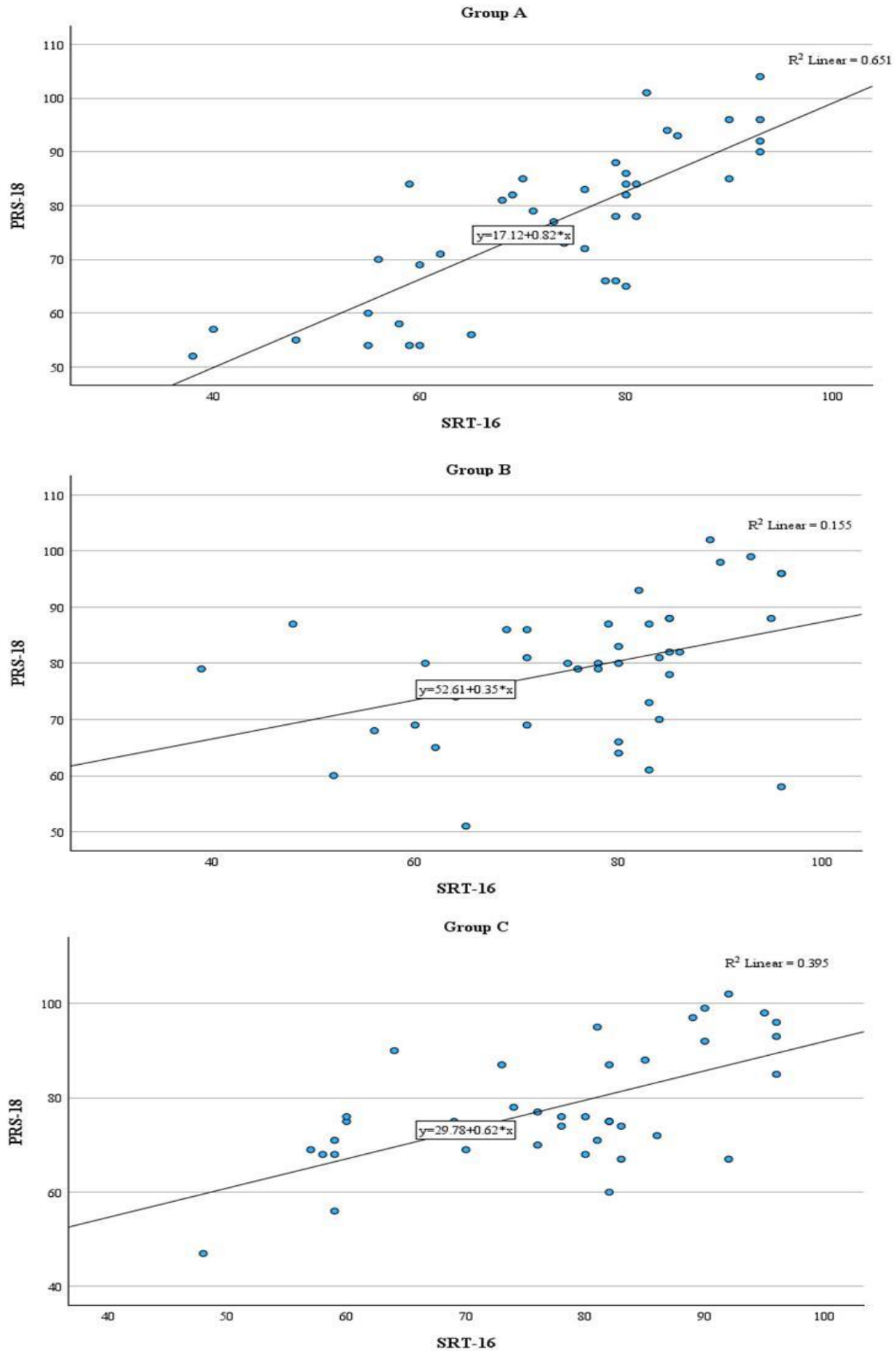

Figure 7. Scatter plots show the visual correlation strength of PRS-18 and SRT-16 across three groups

Associations of Significant Items

Significant associations were identified for items: "break" and "arrangement". For "break", a significant relationship was observed ($\chi^2 = 12.43$, $p < 0.05$), indicating that Group C had a larger share of responses in the high category, while Group A showed more moderate responses. This suggests variation across groups in perceptions of whether being away provides a good "break". Similarly, the plant "arrangement" demonstrated a significant association ($\chi^2 = 10.48$, $p < 0.05$), with Groups B and C showing higher proportions of responses in the high category than Group A, reflecting differences in perceived natural engagement by having plant "arrangements" immerse the natural environment in supporting stress reduction**.**

In contrast, no significant associations were found for the open "staircase" ($\chi^2 = 2.22$, $p > 0.05$), "water" ($\chi^2 = 8.71$, $p > 0.05$), and "ventilation and lighting" ($\chi^2 = 9.02$, $p > 0.05$), despite these items showing significant differences in ANOVA. This indicates that although the groups differed in mean ratings, response distributions across categorical levels were similar.

DISCUSSION

These findings align with integrated psychological frameworks, ART (Kaplan, 1995; Kaplan & Kaplan, 1989), SRT (Ulrich, 1991), and PRS (Hartig et al., 1997), suggesting a complementary relationship between perceived attentional and emotional restoration. The discussion focuses on six main areas:

- The role of perceived social support in psychological well-being.
- The importance of nature-based features with varied biophilic stimuli.
- The use of real-colour photographs to understand human–environment interactions and restorative needs across groups.
- The restorative potential of varied nature-based stimuli.
- Practical implications for office design.
- Theoretical implications.

The role of perceived social support in psychological well-being

Perceived social support may buffer psychological distress and support mental well-being (Lakey & Cohen, 2000; Acoba, 2024). Although Groups A and B reported higher perceived social support than Group C, their differing PRS-18 and SRT-16 relationships suggest that social support and perceived restoration may represent complementary aspects of psychological well-being. Nature-based environments may also provide opportunities for social interaction alongside attentional and emotional restoration (Evans, 2003; Kellert & Calabrese, 2015). However, the absence of significant correlations between MSPSS-12 and the restorative measures suggests that social support should be considered a contextual factor rather than a demonstrated predictor of restorative responses in this study. This interpretation is consistent with broader perspectives on the attentional, emotional, social, and physical dimensions of nature experiences (Bratman et al., 2019; Hartig et al., 1997; Kaplan, 1995; Ulrich, 1991).

The importance of nature-based features with varied biophilic stimuli.

Nature-based environments have been associated with improved mood, perceived restoration, and sustained attention, although the effects on attentional recovery vary (McMahan & Estes, 2015; Ohly et al., 2016; Pasanen et al., 2018). In office environments, connecting indoor spaces with outdoor gardens may provide accessible opportunities for everyday nature engagement (Hartig et al., 2008). Perrins et al. (2021) similarly highlighted the relationship between nature connectedness and reduced anxiety, emphasising the value of accessible green spaces. Furthermore, Hasebe and Harada (2025) suggested that varied biophilic stimuli, including daylight, window views, plant diversity, and plant prominence, may help maintain restorative experiences and reduce habituation. Together, these studies support the importance of spatial continuity and diverse nature-based features in office design.

Real-Colour Photographs To Understand Human-Environment Interaction and Needs Across Groups

Real-colour photographs provided a consistent way to examine restorative perceptions across contrasting respondent groups. This approach aligns with Ulrich (1979, 1981), who demonstrated the potential influence of natural scenes presented through photographic slides on emotional responses and stress recovery. Photographic methods also offer insights into human–environment interactions and environmental preferences (Cleland & MacLeod, 2021; Glaw et al., 2017).

The contrasting responses across groups suggest that restorative perceptions may vary according to nature exposure and individual needs. Group C's stronger responses to certain stimuli may reflect a greater perceived need for restoration rather than greater restorative benefits. This interpretation is consistent with Bettmann et al. (2025), who reported varying responses to nature exposure among adults with and without symptoms of mental illness. Bettmann et al. (2024) also highlighted the relevance of nature-exposure duration for adults experiencing mental-health symptoms. Conversely, Group A's prolonged nature exposure may have contributed to habituation and less pronounced responses (Hasebe & Harada, 2025). However, these explanations remain tentative because the present study assessed perceived restoration rather than actual psychological changes.

Variety of Restorative Stimuli

The findings highlight the potential relevance of varied nature-based stimuli to perceived attentional and emotional restoration, consistent with previous research on gardens, greenery, water, and sensory experiences (Ulrich, 1993; Berman et al., 2012).

Opportunities for “breaks” may support being away by allowing temporary psychological distancing from routine demands (Kaplan, 1995). Open “staircases” may encourage physical movement and social interaction, contributing to restorative experiences (Nicoll & Zimring, 2009; Zimring et al., 2005). Meanwhile, plant “arrangements”, “water” elements, and natural “ventilation and lighting” may encourage engagement with nature. Previous studies have associated these environmental features with fascination, positive emotions, relaxation, and perceived well-being (Ahmad et al., 2019; Evensen et al., 2017; Jeong & Park, 2021; McCormick et al., 2025; Ríos-Rodriguez et al., 2023). These complementary attributes suggest that restorative office environments may benefit from offering different opportunities for being away, physical movement, and natural engagement.

Practical Implications for Office Design

These findings offer practical considerations for architects, interior designers, landscape architects, and planners seeking to integrate restorative nature-based features into office environments. Healing gardens may provide accessible spaces for “breaks” and opportunities for being away (Kaplan, 1995). Open “staircases” with daylight and garden views may encourage movement and visual engagement with nature (Zainal et al., 2026). Layered plant “arrangements” near workstations and “water” features in communal spaces may enhance visual engagement (Browning et al., 2014; Zainal et al., 2026). Also consider natural “ventilation and lighting” alongside appropriate indoor environmental conditions (Browning et al., 2014). Integrating these features across indoor, semi-outdoor, and outdoor spaces may support perceived attentional and emotional restoration. In offices with limited window access, indoor planting and accessible shared spaces with garden views may offer alternative opportunities for visual engagement with nature, while daylight and ventilation strategies should be adapted to the building's environmental requirements. However, these recommendations are based on responses to photographic stimuli rather than direct experimental evidence.

Theoretical Implications

The findings align with integrating ART (Kaplan, 1995) and SRT (Ulrich, 1991), with PRS (Hartig et al., 1997) measuring perceived restorativeness. Positive correlations between PRS-18 and SRT-16 across all groups suggest a complementary relationship between perceived attentional and emotional restoration. The

stronger relationship in Group A may reflect prolonged nature exposure, while Group B's weaker relationship may relate to limited exposure. Group C's strong relationship may indicate greater perceived restorative needs (Bettmann et al., 2025). These variations suggest that environmental exposure and respondent characteristics may influence restorative perceptions, although they do not establish distinct psychological mechanisms or causal effects.

LIMITATIONS AND FUTURE RESEARCH

This study has four main limitations. First, access constraints limited the photographic inventory of indoor office environments. OS1 restricted access to indoor spaces for confidentiality, while OS2 allowed only limited documentation. As a result, the photo-based assessment represented indoor environments less diversely.

Second, the RPSR survey used real-colour photographs of tropical nature-based features rather than direct environmental exposure. Therefore, the findings reflect perceived restorative qualities rather than actual restorative benefits. Furthermore, the study recruited respondents from Peninsular Malaysia, limiting generalisability across different geographical, climatic, and cultural contexts. Future studies should examine actual environmental exposure and validate the RPSR survey instrument across diverse settings.

Third, the cross-sectional, non-experimental design limits causal interpretation of the relationship between nature-based features and restorative outcomes. Self-reported responses may also be influenced by social desirability and recall bias (Althubaiti, 2016). Future research could employ longitudinal or experimental approaches to examine restorative changes over time.

Fourth, face-to-face survey administration in the clinical setting may have influenced Group C's responses through interviewer-related bias (Bowling, 2005). As Group C comprised adults with mild to moderate depression and anxiety, the findings may not apply to other clinical populations. Future studies should consider pre- and post-exposure assessments, anonymous surveys, and participants with different diagnoses and symptom severity.

CONCLUSION

This study used a rigorous mixed-methods approach and provides empirical evidence that integrating nature-based features with healing gardens across spatial categories can support restorative experiences. Its significance lies in three key contributions. First, a unified psychological framework integrating ART, SRT, and PRS explains attentional and emotional restoration in office environments by linking perceived restorativeness with perceived stress reduction. Second, empirical evidence on the restorative potential of healing gardens in tropical office environments identifies five significant restorative items: “break”, open “staircase”, plant “arrangement”, “water”, and natural “ventilation and lighting”, associated with three visual stimuli that support attentional and emotional restoration across diverse adult groups, including adults with clinical depression and anxiety. Third, the RPSR survey instrument was developed through a six-step sequential mixed-methods approach with data triangulation to comprehensively assess perceived social support, perceived restorativeness, and stress-reduction responses in office environments.

The findings indicate that restorative office environments have the potential to support perceived restorativeness and stress reduction among both non-clinical adults and adults with clinical depression and anxiety. Varied nature-based visual stimuli and the integration of healing gardens across connected indoor, semi-outdoor, and outdoor spaces can support attentional and emotional restoration and contribute to mental well-being. By extending restorative-environment research within the Malaysian context and bridging the fields of design, construction, health and psychology, this study reinforces the potential of healing gardens as a nature-based strategy for healthier and more sustainable office environments, supporting Sustainable Development Goals 3 (Good Health and Well-being) and 11 (Sustainable Cities and Communities).

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Ethics Statement

The University Ethics Committee for Research Involving Human Participants (JKEUPM), Universiti Putra Malaysia (UPM), approved the study protocol (reference number: JKEUPM-2024-911). Informed consent was obtained from all participants. In return for their participation, Groups A and B received gifts, and Group C received MYR 10.00 in cash.

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