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Optimal Duration of Campus Green Space Exposure for Stress Recovery and Vitality Enhancement among University Students in Malang

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Abstract. *This study aimed to determine the optimal duration of campus Green Open Space (GOS) exposure for reducing stress and enhancing students' subjective vitality. A quasi-experimental within-subjects repeated measures design was applied, involving 129 university students in Malang who participated in a 60-minute "sit and view" activity. The Perceived Stress Scale (PSS-10) was measured before and after the intervention, while the Restorative Outcome Scale (ROS) and Subjective Vitality Scale (SVS) were assessed at 0, 20, 40, and 60 minutes. Results showed a significant decrease in stress levels ($p < 0.001$) and progressive improvements in emotional-cognitive restoration and vitality ($p < 0.001$). The most substantial restorative and vitality gains occurred between 20–40 minutes of exposure. These findings support Attention Restoration Theory (ART) and Stress Recovery Theory (SRT), highlighting that passive engagement with natural environments can effectively promote psychological recovery and mental well-being among university students.*

Keywords: *academic stress; green open space; psychological restoration; subjective vitality; university students*

I. INTRODUCTION

Academic stress is one of the most common psychological problems experienced by university students worldwide. Data from the American College Health Association (2023) indicate that more than 80% of students in the United States report moderate to high levels of stress during their studies. Similar findings were reported by the World Health Organization (2022), which revealed that the prevalence of stress-related disorders among university students in Southeast Asia ranges from 27% to 42%. The main contributing factors include academic workload, social pressure, and adaptation to competitive learning environments (Beiter et al., 2015; Misra & McKean, 2000). Unmanaged stress has been shown to lead to sleep disturbances, reduced motivation, and decreased academic performance (Dyrbye et al., 2006).

A growing body of research has demonstrated that exposure to natural environments has measurable restorative effects on both physiological and psychological stress. According to the Attention Restoration Theory (ART) (Kaplan & Kaplan, 1989) and the Stress Recovery Theory (SRT) (Ulrich, 1983), contact with nature can restore attentional capacity and reduce emotional strain through cognitive and affective recovery processes. Berman et al. (2008) found that walking for 50 minutes in a natural environment improved cognitive performance by 20% compared to walking in urban areas. Jiang et al. (2014) reported that as little as 10 minutes of green space exposure significantly reduced heart rate and blood pressure. Similarly, Hunter et al. (2019) found that 20–30 minutes spent in outdoor green areas was sufficient to reduce cortisol levels—a physiological indicator of stress—to an optimal degree. Furthermore, White et al. (2019), in an analysis of over 19,000 respondents in the United Kingdom, found that spending 120 minutes per week in natural environments was associated with higher levels of mental and physical well-being.

In the context of higher education, Green Open Spaces (GOS) within university campuses

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hold substantial potential as restorative environments for students. A preliminary study conducted at University X involving 129 students from three cohorts (2022, 2023, and 2024) reported mean Perceived Stress Scale (PSS-10) scores of 24.52, 22.02, and 18.04, respectively (Putrianto et al., 2025). These findings indicate a tendency toward increasing stress levels as students progress in their studies. Although most respondents acknowledged the restorative benefits of natural environments, 81% of them were unaware of the optimal duration of exposure required to obtain these benefits effectively.

The absence of empirical data on the optimal duration of exposure to campus GOS presents an important research gap that warrants further investigation. Therefore, this study aims to determine the optimal duration of student interaction with campus GOS in reducing cognitive and emotional stress and enhancing vitality. The findings are expected to provide an empirical foundation for developing evidence-based guidelines and interventions that leverage the restorative function of campus green spaces to promote students' mental health and well-being.

II. Research Methods

Research Design

This study adopted a quasi-experimental within-subjects repeated measures design to examine changes in stress, restorative outcomes, and subjective vitality during exposure to campus Green Open Space (GOS). The intervention consisted of a "sit and view" activity, where participants sat quietly and observed the natural surroundings for 60 minutes. Measurements were taken at 0, 20, 40, and 60 minutes using the Restorative Outcome Scale (ROS) and Subjective Vitality Scale (SVS), and before–after the session using the Perceived Stress Scale (PSS-10).

Participants

Participants were undergraduate students from the 2022–2024 cohorts at University X, selected through purposive sampling. Inclusion criteria were: (1) active enrollment, (2) willingness to participate for 60 minutes, (3) absence of diagnosed psychiatric disorders, (4) no current use of sedatives or stimulants, and (5) avoidance of caffeine or vigorous activity two hours prior. All participants provided informed consent, and data confidentiality was ensured.

Research Site and Procedure

The study took place at a passive GOS area on campus, designed for rest and contemplation without physical activity. Each participant sat individually in a designated spot and engaged in the "sit and view" activity for one hour. They were instructed not to talk, move, or use electronic devices to prevent distractions. Measurements were conducted as follows:

1. Minute 0: ROS and SVS (baseline)
2. Minutes 20, 40, and 60: repeated ROS and SVS
3. Before and after the session: PSS-10 (stress levels)

All sessions were held in the morning under clear weather to maintain environmental consistency.

Instruments

Three standardized self-report scales were used:

1. Perceived Stress Scale (PSS-10): measures perceived stress during the past two weeks (Cohen et al., 1983). Ten items, 5-point scale (0 = never, 4 = very often).
2. Restorative Outcome Scale (ROS): measures emotional and cognitive restoration (Korpela et al., 2008). Six items, 7-point scale (1 = strongly disagree, 7 = strongly agree).
3. Subjective Vitality Scale (SVS): measures energy and enthusiasm (Ryan & Frederick, 1997). Four items, 7-point scale (1 = strongly disagree, 7 = strongly agree).

Validity and Reliability Testing

Instrument validity was assessed using Corrected Item–Total Correlation in IBM SPSS Statistics 28. Items with correlation coefficients $r \geq 0.30$ were considered valid (Nunnally & Bernstein, 1994; DeVellis, 2017).

The analysis used combined data (pre–post) to ensure stable correlation estimates. Internal consistency reliability was evaluated using

Cronbach's Alpha, where α ≥ 0.70 indicated acceptable reliability (Gliem & Gliem, 2003).

Data Analysis

Data were analyzed in SPSS using nonparametric tests due to ordinal scale levels and non-normal distribution. Friedman test assessed differences in ROS and SVS scores across four time points. Wilcoxon Signed-Rank test served as a post-hoc test for pairwise comparisons (0–20, 20–40, 40–60, and 0–60 minutes). PSS-10 pre–post comparison used the Wilcoxon test to evaluate overall stress reduction.

Trend analysis examined mean changes and score gradients (Δ) across intervals to identify the optimal duration of GOS exposure. The interval showing the largest and significant score increase in ROS and SVS was interpreted as the most effective exposure duration.

All analyses used a two-tailed significance level (α = 0.05). Trend visualizations were created in Microsoft Excel.

III. Results and Dicussion

Instrument Validity and Reliability

The Perceived Stress Scale (PSS-10) on table 1 demonstrated excellent internal consistency with a Cronbach's Alpha of 0.978. The Corrected Item-Total Correlation values ranged from 0.877 to 0.916, indicating that all items were strongly correlated with the overall scale score. Therefore, all items were considered valid and reliable for assessing students' perceived stress before and after the green space intervention.

Table 1. Reliability Statistics of the Perceived Stress Scale (PSS-10)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.978	.978	10

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q1	12.90	80.927	.893	.814	.975
Q2	12.93	80.786	.895	.811	.975
Q3	13.00	79.969	.916	.846	.974
Q4	12.91	80.876	.893	.808	.975
Q5	13.00	82.046	.885	.807	.975
Q6	12.98	81.448	.884	.799	.975
Q7	12.98	81.204	.894	.809	.975
Q8	12.95	81.928	.878	.781	.975
Q9	12.99	81.741	.877	.781	.975
Q10	12.90	80.534	.890	.800	.975

Table 2. Reliability Statistics of the Restorative Outcome Scale (ROS)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.937	.938	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q1	20.78	54.409	.838	.738	.923
Q2	20.73	52.882	.862	.764	.920
Q3	20.93	55.477	.792	.653	.929
Q4	21.01	52.954	.866	.792	.919
Q5	20.96	54.087	.803	.675	.927
Q6	21.11	55.059	.726	.537	.937

Changes in Stress Levels Before and After the Intervention

The Wilcoxon Signed-Rank Test on Table 3 revealed a significant difference between stress levels before and after the green space intervention, with an Asymptotic Sig. (2-tailed) value of 0.001 ($p < 0.001$).

This result indicated a significant decrease in perceived stress following the 60-minute "sit and view" activity in the Green Open Space (GOS). Thus, the null hypothesis was rejected, supporting the effectiveness of the intervention in reducing stress levels.

Changes in Emotional and Cognitive Restoration During the Intervention

The Friedman Test on Table 4 showed a significant difference in emotional and cognitive restoration across the four time intervals, with $\chi^2 = 1882.771$, df = 3, p = 0.001. This finding suggested that the participants' restoration levels changed significantly over time during the intervention.

Post-hoc Wilcoxon tests indicated that Table 5. ROS 0 vs 20 Minutes: p = 0.381 (not significant). Table 6. ROS 20 vs 40 Minutes: p = 0.001 (significant). Table 7. ROS 40 vs 60 Minutes: p = 0.001 (significant). These results suggested that no substantial restorative effect occurred

Table 3. Wilcoxon Signed-Rank Test of PSS-10 (Pre vs Post Intervention)

Related-Samples Wilcoxon Signed Rank Test Summary	
Total N	1300
Test Statistic	.000
Standard Error	9129.010
Standardized Test Statistic	-33.166
Asymptotic Sig.(2-sided test)	.001

Table 4. Friedman Test of ROS Scores at Four Time Intervals (0, 20, 40, and 60 Minutes)

Related-Samples Friedman's Two-Way Analysis of Variance by Ranks Summary	
Total N	780
Test Statistic	1882.771
Degree Of Freedom	3
Asymptotic Sig.(2-sided test)	.001

Table 5. ROS 0 vs 20 minutes

Related-Samples Wilcoxon Signed Rank Test Summary	
Total N	780
Test Statistic	60029.000
Standard Error	2910.174
Standardized Test Statistic	.876
Asymptotic Sig.(2-sided test)	.381

Table 6. ROS 20 vs 40 minutes

Related-Samples Wilcoxon Signed Rank Test Summary	
Total N	780
Test Statistic	194561.000
Standard Error	4491.913
Standardized Test Statistic	21.189
Asymptotic Sig.(2-sided test)	.001

within the first 20 minutes, but significant improvements emerged after 40 minutes and continued up to 60 minutes of exposure in the green space.

Changes in Subjective Vitality During the Intervention

The Friedman Test on table 8 indicated significant changes in subjective vitality across time, with χ^2 = 1321.922, df = 3, p = 0.001. This showed that participants' vitality levels varied significantly during the 60-minute intervention.

Tables 9–11 show Wilcoxon Signed-Rank

Table 7. ROS 40 vs 60 minutes

Related-Samples Wilcoxon Signed Rank Test Summary

Total N	780
Test Statistic	44551.000
Standard Error	1290.385
Standardized Test Statistic	17.263
Asymptotic Sig.(2-sided test)	.001

Table 8. Friedman Test of SVS Scores at Four Time Intervals (0, 20, 40, and 60 Minutes)

Related-Samples Friedman's Two-Way Analysis of Variance by Ranks Summary

Total N	520
Test Statistic	1321.922
Degree Of Freedom	3
Asymptotic Sig.(2-sided test)	.001

Table 9. SVS 0 vs 20 minutes

Related-Samples Wilcoxon Signed Rank Test Summary

Total N	520
Test Statistic	38503.000
Standard Error	1156.711
Standardized Test Statistic	16.643
Asymptotic Sig.(2-sided test)	.001

Table 10. SVS 20 vs 40 minutes

Related-Samples Wilcoxon Signed Rank Test Summary

Total N	520
Test Statistic	67896.000
Standard Error	1962.286
Standardized Test Statistic	17.300
Asymptotic Sig.(2-sided test)	.001

Table 11. SVS 40 vs 60 minutes

Related-Samples Wilcoxon Signed Rank Test Summary

Total N	520
Test Statistic	17020.000
Standard Error	627.366
Standardized Test Statistic	13.565
Asymptotic Sig.(2-sided test)	.001

Tests between Time Intervals. Pairwise Wilcoxon comparisons revealed significant improvements at every time interval:

Table 9. SVS 0 vs 20 Minutes: $p = 0.001$

Table 10. SVS 20 vs 40 Minutes: $p = 0.001$

Table 11. SVS 40 vs 60 Minutes: $p = 0.001$

These findings indicated that subjective vitality increased progressively with the duration of exposure to the green environment.

Pattern and Optimum Duration of Restorative Recovery

Figure 1 illustrates the changes in the Restorative Outcome Scale (ROS) scores across four measurement points: 0, 20, 40, and 60 minutes of exposure to the green space. The mean ROS score increased steadily over time, from 3.25 at the baseline (0 minute) to 3.94 at 20 minutes, 4.63 at 40 minutes, and 5.12 at 60 minutes.

The gradient of change (Δ Mean) was highest between 0–20 minutes (Δ = +0.69), indicating the most substantial improvement in restorative outcomes during the initial exposure period. Between 20–40 minutes, the rate of increase remained positive but relatively stable (Δ = +0.69), while a slower improvement occurred from 40–60 minutes (Δ = +0.49). These results suggest that the restorative process occurs rapidly during the first 20 minutes and continues to increase gradually until reaching a plateau around 40–60 minutes.

The red bars represent the mean ROS score at each time point, and the yellow line represents the gradient (Δ Mean) of change between intervals. The sharpest increase occurred within the first 20 minutes, followed by a steady rise until 40 minutes, and a slower improvement toward 60 minutes.

Pattern and Optimum Duration of Vitality Subjectives

Figure 2 shows the evolution of Subjective Vitality Scale (SVS) scores at 0, 20, 40, and 60 minutes. Mean SVS rose from 3.36 at baseline to 3.89 at 20 minutes, 4.85 at 40 minutes, and 5.21 at 60 minutes. The gradients of change (Δ Mean) indicate a moderate early increase from 0–20 minutes (Δ = +0.53), a sharp acceleration from 20–40 minutes (Δ = +0.96, the largest gain), and a slower rise from 40–60 minutes (Δ = +0.35). Descriptively, vitality gains accumulate throughout the exposure, with the steepest improvement occurring between 20 and 40 minutes.

The largest increase in vitality occurred between 20–40 minutes, followed by a smaller incremental gain from 40–60 minutes.

This study examined the psychological benefits of passive exposure to a campus Green Open Space (GOS) through a 60-minute "sit and view" activity. The findings revealed that engagement with natural environments effectively reduced perceived stress, enhanced emotional and cognitive restoration, and increased subjective vitality among university students. Collectively, these results reinforce the central tenets of both Attention Restoration Theory (ART) (Kaplan & Kaplan, 1989) and Stress Recovery Theory (SRT) (Ulrich, 1983), which

Figure 1. Changes in mean ROS scores and gradient of change across time intervals.

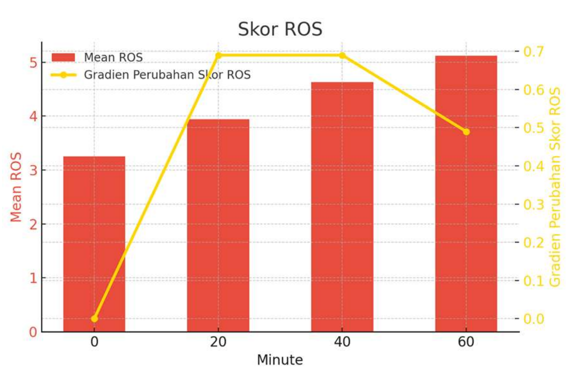
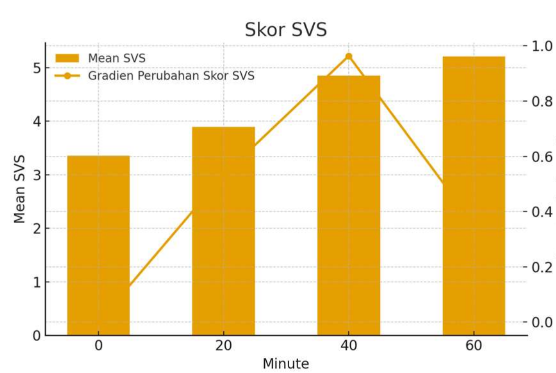


Figure 2. Mean SVS (bars) and gradient of change (line) across time.



emphasize nature's capacity to restore depleted attentional and emotional resources.

The significant reduction in perceived stress aligns with extensive evidence that natural environments foster psychophysiological recovery. According to SRT, exposure to natural stimuli elicits positive affective responses and physiological calmness, promoting parasympathetic activation and stress alleviation (Ulrich et al., 1991). Similarly, previous studies have shown that immersion in nature, even without active participation, can lower cortisol levels and reduce self-reported stress (Park et al., 2010; Bratman et al., 2019). Within the academic context, where students often face intense cognitive demands, such stress relief is particularly valuable. The observed decline in perceived stress thus suggests that structured, nature-based interventions may serve as an effective and accessible coping mechanism. Furthermore, because the activity required no physical exertion, the benefits appear primarily psychological rather than physiological—consistent with prior observations by Hartig et al. (2003) and Tyrväinen et al. (2014).

Beyond stress recovery, the findings revealed a clear temporal pattern in emotional and cognitive restoration. Improvements became evident only after approximately 20 minutes of exposure and continued to increase up to 60 minutes. This pattern supports ART's assertion that attentional recovery unfolds progressively as directed attention is released and involuntary attention is gently engaged (Kaplan, 1995). The existence of an initial adaptation phase (0–20 minutes) followed by a more pronounced recovery phase (20–60 minutes) mirrors the temporal models proposed by Beute and de Kort (2014) and Nordh et al. (2011), who observed that extended exposure to natural settings deepens restorative outcomes, though benefits eventually plateau. Consistent with this view, the slower rate of improvement after 40 minutes in the current study suggests that the optimal restorative window lies between 20 and 40 minutes—sufficient for substantial psychological gains without diminishing returns.

Parallel to the restorative outcomes, subjective vitality increased consistently across all time points. This progressive rise suggests that nature exposure not only alleviates mental fatigue but also actively promotes feelings of energy and intrinsic motivation. According to Self-Determination Theory (SDT), natural environments fulfill basic psychological needs for autonomy, competence, and relatedness, thereby enhancing vitality (Ryan & Deci, 2001). Supporting this interpretation, previous research has shown that contact with nature contributes to both physiological renewal and psychological well-being (Ryan et al., 2010; Nisbet et al., 2011). The present findings extend this evidence to passive forms of engagement, reinforcing the concept of micro-restorative experiences (Joye & van den Berg, 2011), whereby even brief, non-physical interactions with nature can meaningfully elevate energy and mood.

Taken together, the concurrent improvements in stress, restoration, and vitality suggest an integrated recovery mechanism: reductions in stress facilitate emotional and cognitive restoration, which subsequently enhance subjective vitality. This interplay reflects the complementary operation of ART and SRT within a single environmental exposure (Ohly et al., 2016). In essence, natural environments serve both as a psychological refuge and an energizing context, providing a dual pathway toward well-being and optimal functioning. This integrated interpretation underscores the holistic nature of human–environment interactions, where affective and cognitive recovery are not isolated processes but mutually reinforcing dimensions of restoration.

From a practical perspective, these findings offer important implications for campus design and student well-being initiatives. Incorporating designated "green recovery zones" or structured "sit and view" sessions into daily routines could provide students with accessible opportunities for psychological restoration. Evidence from this study indicates that at least 20–40 minutes of exposure is optimal for achieving significant benefits. Given that such interventions require minimal resources and effort, universities can feasibly integrate them into wellness programs to enhance emotional resilience, focus, and vitality among students.

Despite these promising outcomes, several limitations should be acknowledged. The reliance on self-reported measures may introduce subjective bias; future research should integrate physiological indicators—such as heart rate variability, blood pressure, or salivary cortisol—to validate these findings objectively. Moreover, the focus on passive exposure limits generalizability; comparative studies involving active engagement (e.g., walking or mindfulness-based activities) could clarify whether different modes of nature interaction yield distinct restorative pathways. Finally, longitudinal and repeated-exposure designs would be valuable to determine whether these benefits are sustained, cumulative, or subject to habituation over time.

IV. Conclusions

This study reinforces the restorative and energizing potential of green open spaces in academic contexts. Passive exposure to nature significantly reduced stress, enhanced emotional and cognitive restoration, and elevated subjective vitality, with the most notable gains occurring between 20 and 40 minutes of exposure. These findings highlight the importance of integrating green space utilization into campus well-being strategies and contribute valuable evidence to the growing discourse on nature-based psychological recovery.

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