

## Exploring the impact of green space exposure on college students' mental health and academic performance

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### Abstract

College students often face high stress and mental health challenges that impact their academic performance and well-being. Time spent in green space (TSIGS) may reduce depressive symptoms, alleviate anxiety, and enhance cognitive function. However, few studies investigate how nature directly impacts these factors among undergraduates. The purpose of this study was to evaluate the associations between TSIGS and anxiety, depression, and academic achievement among undergraduates at a Southeastern US university. This study surveyed undergraduate students (n=291), about anxiety, depression, academic performance, and TSIGS. Adjusted binary logistic regressions analyzed relationships between annual level of TSIGS (low, moderate, or high usage) or weekly TSIGS (low, moderate, or high usage) and three separate outcomes: levels of anxiety, levels of depression, and academic achievement level. Most participants held majors in public health (49.8%) or arts and sciences (15.8%), and were predominantly female (83.8%), sophomores (29.6%), and White (82.8%). Most respondents did not exhibit reported minimal/mild levels of anxiety (69.4%) or depression (63.2%), and most achieved high academic performance (71.5%). Regarding TSIGS, 26.8% of respondents reported low annual usage, while 54.6% reported high annual usage. Per week, 62.9%, 32.0%, and 5.2% of respondents had low, moderate, and high usage of green spaces, respectively. TSIGS was not significantly related to measurable levels of anxiety, depression, or academic achievement. This study found no significant relationships between students' TSIGS and their anxiety, depression, or academic achievement levels. Possible influences include seasonal factors and survey timing. Future research should explore longitudinal impacts of TSIGS on mental health and academic outcomes.

**Keywords:** green space; nature; mental health; academic outcomes; anxiety; depression

College students often experience poor mental health, with high stress levels and poor coping mechanisms and habits perpetuating worse outcomes (Karyotaki et al., 2020; American College Health Association, 2020; American College Health Association, 2023). These conditions can lead to heightened anxiety and depression, significantly impacting students' quality of life (Mahmoud et al., 2012). Students face increasingly stressful situations with changing social support, making it challenging to manage new experiences effectively (Bray et al., 2022; W. Liu et al., 2022; Trevino et al., 2022; Bratman et al., 2019). Consequently, mental health disorders pose a threat to individual well-being and require multifaceted solutions.

Green spaces, defined as any areas with natural elements such as trees, flowers, rivers, parks, and other vegetated environments, have been shown to reduce depressive symptoms, improve anxiety levels, and increase student quality of life (Berman et al., 2012; Hipp et al., 2016). Existing literature has explored various interventions and their effects on student mental health, including spending time in nature, indicating that nature also provides cognitive restoration, enhancing attention, memory, and reaction time (Kaplan, 1995). This improved cognition increases students' chances of academic success, as mental faculties are restored, allowing better outcomes in the classroom (Li & Sullivan, 2016; Felsten, 2009; Vleet et al., 2023; Bratman et al., 2012).

However, despite the unique characteristics of and challenges faced by college students, many studies involve participants beyond the college demographic, including high school and adult populations, and have often taken place outside the United States (Bruffaerts, 2018). These factors limit the generalizability of findings but also highlight a significant gap in understanding how college students – a population particularly vulnerable to high stress levels – might uniquely benefit from such research (Q. Liu et al., 2018; Meredith et al., 2020). Some research has also used academic performance as a moderator of mental health outcomes rather than a direct outcome variable; instead, this study will isolate multiple mental health outcomes, specifically depression and anxiety, from academic achievement outcomes, and focus directly on college undergraduates. Finally, our study examines the separate effects of both longer term (annual) and recent (past week) exposure to green space both on and off campus. By considering these diverse contexts and outcomes, this research will add to the literature by providing more precise insights into the relationship between nature exposure and well-being among this important population.

The purpose of this study was to better understand associations between spending time in green spaces and mental health outcomes and academic performance among college undergraduates. Specifically, we sought to examine the relationship between the amount of time students spend in green spaces and 1) their levels of anxiety, 2) their levels of depression, and 3) their level of academic achievement.

## Methods

### Study Setting

A survey was distributed to undergraduate students at the University of South Carolina, Columbia campus using diverse convenience sampling methods. In spring 2024, there were 26,727 undergraduate students enrolled (University of South Carolina, 2025). Professors and on-campus organization leaders were contacted to distribute the survey link and project description to their classes and networks; in total, approximately 20 campus organizations and 6 professors agreed to do so. Interested participants accessed and completed the survey through a Qualtrics link. Distribution occurred in January-February 2024, when most students were back from winter break and on campus, and participation was incentivized with a raffle for one of five \$100 gift cards. The study was approved by the Institutional Review Board at the University of South Carolina.

### Measures

*Demographics.* Age was self-reported and then categorized (18, 19, 20, 21, 22, 23+). Self-reported major was categorized by academic college. Student classification was indicated as Freshman, Sophomore, Junior, or Senior. Gender was reported as Male, Female, or Self-Describing. Race (American Indian or Alaska Native; Asian; Black/African American; White; Native Hawaiian or Pacific Islander; Mixed/Two or more races) and Ethnicity (Hispanic, Latino, or Spanish Origin), were addressed in separate questions.

*Anxiety.* Anxiety was assessed using the General Anxiety Disorder-7 (GAD-7), a seven-item questionnaire measuring general feelings of anxiety over the past two weeks (Spitzer et al., 2006). Respondents rated their anxiety frequency on a scale from “not at all” (0) to “nearly every day” (3). Total GAD-7 scores, ranging from 0-21, were categorized as: 0-4 (minimal anxiety), 5-9 (mild anxiety), 10-14 (moderate anxiety), and 15-21 (severe anxiety). For analysis, students were grouped into those with measurable levels of anxiety (moderate to severe) versus those who did not (minimal to mild).

*Depression.* Depression was assessed using the modified Patient Health Questionnaire-9 (PHQ-9), a nine-item survey measuring depression symptoms over the past two weeks (Kroenke et al., 2001). Due to sensitivity, three PHQ-9 questions were omitted. Respondents rated the frequency of being bothered by prompted problems on a scale from “not at all” (0) to “nearly every day” (3). Scores, ranging from 0-18, were categorized as: 0-3 (none to minimal depression), 4-6 (mild depression), 7-9 (moderate depression), 10-12 (moderately severe depression), and 13-18 (severe depression). For analysis, these categories were grouped into those with measurable levels of depression (moderate to severe) versus those who did not (none to mild).

*Academic Performance.* Academic performance was measured via students' grade point average (GPA) using 0.5 increments ranging from “below 2.00” to “3.50-4.00.” For

analysis, based on respondent characteristics, students were grouped into two categories: lower (GPA 3.49 and below; 28.5% of respondents) versus higher academic achievement (GPA 3.50-4.00; 71.5% of respondents).

*Time Spent in Green Spaces (TSIGS).* Respondents reported their average *annual* frequency of visits to green spaces on campus and off campus (separately) using the following intervals: “none,” “less often than once every 2-3 months,” “once every 2-3 months,” “once or twice a month,” “once a week,” “twice a week,” “more than twice a week, but not every day,” and “every day.” The combined annual frequency of on-campus and off-campus visits was then categorized into three groups: low (once every 2-3 months), moderate (up to once a week), and high (at least twice per week).

In addition to annual frequency, respondents also indicated the amount of time they spent in green spaces on and off campus (separately) during the *past week*. The combined weekly frequency of on- and off-campus visits was then categorized into three groups: low (less than 30 minutes per week), moderate (up to 2 hours per week), and high (more than 2 hours per week).

### Analysis

A total of 393 surveys were submitted, but 102 were excluded due to incomplete data, resulting in 291 responses for analysis. Descriptive statistics were used to understand students’ anxiety scores, depression scores, academic achievement, annual TSIGS frequency, and weekly TSIGS duration. Adjusted binary logistic regressions analyzed relationships between annual TSIGS (low, moderate, or high) and weekly TSIGS (low, moderate, or high) with anxiety level, depression level, and academic achievement. Covariates included age, grade classification, gender, race,

and ethnicity. Data analysis was performed using SPSS 29.0, with significance set at  $p < 0.05$ .

## Results

### Descriptive Statistics

As shown in Supplemental Table 1, the largest age groups in the sample were 19-year-olds (27.8%) and 20-year-olds (25.4%). Almost half of participants were enrolled in the Arnold School of Public Health (49.8%) and sophomores comprised 30.2% of respondents. The majority of the sample was female (83.8%), White (82.8%), and non-Hispanic (96.6%). Furthermore, 30.6% and 36.8% of respondents reported measurable levels of anxiety and depression, respectively, and 71.5% achieved high academic performance. Additionally, for annual TSIGS, 26.8% reported low usage (once every 2-3 months), 54.6% reported moderate usage (up to once per week), and 18.6% reported high usage (at least twice per week). For weekly TSIGS, 62.9%, 32.0%, and 5.2% reported low (less than 30 minutes per week), moderate (up to 2 hours per week), and high usage (more than 2 hours per week), respectively. The supplemental table also shows sample characteristics and attributes according to level of weekly TSIGS. (low/moderate/high).

There were no significant relationships between TSIGS and anxiety (Table 1). Moderate (OR=.877, 95% CI=0.381-2.019) and high (OR=1.766, 95% CI=0.862-3.615) annual usage levels showed no significant differences in anxiety compared to low usage. Similarly, moderate (OR=0.901, 95% CI=0.283-2.869) and high (OR=0.888, 95% CI=0.273-3.074) weekly usage displayed no significant differences in anxiety compared to low weekly usage.

Table 1. Association Between Time Spent in Green Space and Anxiety, Depression, and Academic Performance (n=291)

Table Notes:

Variable	Anxiety			Depression			Academic Performance		
	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p
Annual Usage									
Low	1.00		0.066			0.886	1.00		0.384
Moderate	0.877	0.381-2.019	0.758	0.845	0.399-1.787	0.659	1.717	0.775-3.803	0.183
High	1.766	0.862-3.615	0.120	0.962	0.494-1.872	0.909	1.477	0.738-2.954	0.270
Weekly Usage									
Low	1.00		0.984			0.774			0.191
Moderate	0.901	0.283-2.869	0.860	1.433	0.426-4.814	0.561	2.754	0.910-8.337	0.073
High	0.888	0.273-3.074	0.888	1.572	0.446-5.533	0.481	2.762	0.859-8.881	0.088

Covariates include age, gender, grade classification, race, and ethnicity.

Annual Usage of Green Space - Low: (once every 2-3 months), Moderate (up to once per week), High (at least twice per week)

Weekly Usage of Green Space - Low: (less than 30 minutes per week), Moderate (up to 2 hours per week), High (more than 2 hours per week)

No significant relationships were found between TSIGS and depression (Table 1). Moderate (OR=0.845, 95% CI=0.399-1.787) and high (OR=0.962, 95% CI=0.494-1.872) annual usage categories showed no significant differences in depression compared to low usage. Similarly, moderate (OR=1.433, 95% CI=0.426-4.814) and high (OR=1.572, 95% CI=0.446-5.533) weekly usage categories displayed similar depression levels compared to low weekly usage.

There were no significant relationships between TSIGS and academic performance (Table 1). Moderate (OR=1.717, 95% CI=0.775-3.803) and high (OR=1.477, 95% CI=0.738-2.954) annual usage categories showed no significant differences in achieving high academic performance compared to low usage. Similarly, moderate (OR=2.754, 95% CI=0.910-8.337) and high (OR=2.762, 95% CI=0.859-8.881) weekly usage categories showed no significant variations in academic achievement compared to low weekly usage.

### Discussion

In the current sample of college students collected during South Carolina's winter season, there were no statistically significant relationships found between the amount of time students spend in on- and off-campus green spaces on an annual or weekly basis and the outcome variables of anxiety, depression, and GPA. Contextual factors such as weather and climate during data collection, which may have limited students' access to outdoor spaces, could have influenced the results. Additionally, the timing of survey distribution at the beginning of the semester, when students were adjusting to new schedules and academic demands, might have impacted their mental well-being and academic performance differently.

Characteristics of our sample may have also skewed the present results. For example, Lui et al. found a significant relationship between males' major of study and their self-rated levels of health and interpretation of the restorative levels of green spaces. In contrast, our survey garnered a high number of female respondents, similar to Hipp et al.'s study about campus greenness and restorative qualities and the ACHA nationwide surveys from 2019 and 2022 with over 60% of surveys completed by females. The results regarding academic achievement could also be skewed due to an overrepresentation of high-achieving students in the sample. This may be influenced by the higher proportion of upperclassmen, who generally have more stable and higher GPAs compared to lower-grade students.

Contrary to some previous findings, this study's results indicate that at this time of year and within this student population, green space usage did not demonstrate a significant association with mental health outcomes or academic achievement. Prior studies have often highlighted positive impacts of green spaces on mental health. Felsten et al. proposed that students were likely to choose spaces that had green qualities to relax. Although our survey did not analyze what behaviors were performed during TSIGS, most respondents had high annual usage, implying that students chose to spend time in natural spaces.

Additionally, Vleet et al. reported that in their experimental conditions, the group who spent time outdoors did not have the most consistent outcome for well-being changes compared to other groups' time usage. This is consistent with our findings, as no evidence was found to predict better or worse outcomes in health or academics based on green space usage.

Most research, however, has reported a significant relationship between time in green spaces and mental health outcomes. Some studies found a higher level of cognitive restoration when spending time outdoors, while others reported that green space improved students' mood or measurable mental health (Ibes & Forestell, 2022). Liu et al. (2022) stated that green spaces had an essential effect on mental health, and Bray et al. argued that mental health benefits were based on the opportunity to participate in activities that facilitated better health outcomes, including pick-up sports or socializing with friends outdoors. Some studies also found that the time students spent outdoors improved their cognitive states, through mechanisms such as improved attentional focus, stress recovery, and mental restoration. Based on such literature, it is surprising that the current study's findings were not significant. Interestingly, although not statistically significant, higher levels of annual green space usage were associated with higher anxiety, contrasting with lower anxiety seen at moderate usage levels. This may reflect that students with higher anxiety tend to seek coping mechanisms, or that external stressors unique to this group (i.e., walking to class may require walking through a green space) influenced the observed trend (Whitehead & Bergeman, 2012; Roe et al., 2017). Further research is needed to explore these possibilities and assess the activities performed in green spaces.

One limitation was that our sample was not fully representative of the entire undergraduate population. The convenience sampling method, focusing on student organizations and lecture classes, likely favored specific departments due to academic connections and organizational affiliations. A more balanced and representative sample could have been achieved with a random selection of undergraduate emails, but this was constrained by campus restrictions on mass email communication. Another limitation was the categorization of variables and the temporal mismatch between the anxiety/depression ratings (past two weeks) and green space usage (weekly and yearly). We also considered high academic achievement as GPA 3.5 or greater given that these respondents comprised almost three-quarters of the sample.





Future research could benefit from using more precise measures that capture behaviors and outcomes within the same time frame or longitudinally, potentially revealing nuances in the relationship between green space usage and student health concerns and academic performance. Additionally, conducting studies during different seasons and varying weather conditions could further elucidate the impact of environmental factors on these relationships. Further, knowing why students visit green spaces and their behaviors and activities within such environments would add substantial context and understanding to any observed

relationships between green space usage and benefits to mental health or academic performance. Finally, capturing more nuanced exposures to green space would be valuable; for example, examining whether more frequent doses of local green space are more or less beneficial than longer and doses to larger but more distal green spaces would be interesting to explore.

In conclusion, this study examined the relationship between students' green space usage and their mental health and academic outcomes at a single, large, comprehensive university. The findings suggest that no significant association existed between time spent in green spaces and anxiety levels, depression levels, or academic achievement among undergraduate students. Further research is warranted to explore these relationships across diverse populations and settings.

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#### Acknowledgments

This work was supported in part by the South Carolina Honors College Senior Thesis Grant. This research project was approved by the Institutional Review Board (IRB) at the University of South Carolina.

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**Supplemental Material**

Supplemental Table 1. Sample Characteristics

Demographic Characteristic			Weekly Green Space Usage					
	Full Sample		Low		Moderate		High	
	N	%	N	%	N	%	N	%
Age								
18	40	13.7	20	50.0%	17	42.5%	3	7.5%
19	81	27.8	51	63.0%	26	32.1%	4	4.9%
20	74	25.4	50	67.6%	23	31.1%	1	1.4%
21	58	19.9	36	62.1%	18	31.0%	4	6.9%
22	27	9.3	17	63.0%	8	29.6%	2	7.4%
23 and older	11	3.9	9	81.8%	1	9.1%	1	9.1%
Total	291	100	183	62.9%	93	32.0%	15	5.2%
College								
School of Public Health	145	49.8	93	64.1%	45	31.0%	7	4.8%
College of Arts and Sciences	46	15.8	35	76.1%	8	17.4%	3	6.5%
College of Education	2	0.7	1	50.0%	1	50.0%	0	0.0%
College of Engineering and Computing	33	11.3	17	51.5%	13	39.4%	3	9.1%
College of Hospitality, Retail, and Sport Mgmt	6	2.1	3	50.0%	3	50.0%	0	0.0%
College of Information and Communications	6	2.1	3	50.0%	3	50.0%	0	0.0%
College of Nursing	22	7.6	10	45.5%	11	50.0%	1	4.5%
College of Pharmacy	2	0.7	1	50.0%	1	50.0%	0	0.0%
College of Social Work	4	1.4	4	100.0%	0	0.0%	0	0.0%
School of Business	10	2.4	6	80.0%	4	40.0%	0	0.0%
Double Majors	12	5.2	8	66.7%	3	25.0%	1	8.3%
Undeclared	2	0.7	1	50.0%	1	50.0%	0	0.0%
Missing	1	0.3	1	100.0%	0	0.0%	0	0.0%
Total	291	100	183	62.9%	93	32.0%	15	5.2%
Academic Year								
Freshman	59	20.3	32	54.2%	24	40.7%	3	5.1%

Sophomore	86	29.6	53	61.6%	28	32.6%	5	5.8%
Junior	71	24.4	49	69.0%	19	26.8%	3	4.2%
Senior	75	25.8	49	65.3%	22	29.3%	4	5.3%
Total	291	100	183	62.9%	93	32.0%	15	5.2%
Gender								
Female	244	83.8	152	62.3%	80	32.8%	12	4.9%
Male	44	15.1	30	68.2%	11	25.0%	3	6.8%
Prefer to self describe	3	1.0	1	33.3%	2	66.7%	0	0.0%
Total	291	100	183	62.9%	93	32.0%	15	5.2%
Race								
Asian	17	5.8	13	76.5%	3	17.6%	1	5.9%
Black/African American	27	9.3	20	74.1%	6	22.2%	1	3.7%
White	241	82.8	147	61.0%	81	33.6%	13	5.4%
Mixed/two or more races	5	1.7	2	40.0%	3	60.0%	0	0.0%
Missing	1	0.3						
Total	291	100	182	62.8%	93	32.1%	15	5.2%
Hispanic, Latino, or Spanish Origin								
Yes	10	3.4	7	70.0%	1	10.0%	2	20.0%
No	281	96.6	176	62.6%	92	32.7%	13	4.6%
Total	291	100	183	62.9%	93	32.0%	15	5.2%
Measurable Anxiety								
No	202	69.4	128	63.4%	64	31.7%	10	5.0%
Yes	89	30.6	55	61.8%	29	32.6%	5	5.6%
Total	291	100	183	62.9%	93	32.0%	15	5.2%
Measurable Depression								
No	184	63.2	116	63.0%	57	31.0%	11	6.0%
Yes	107	36.8	67	62.6%	36	33.6%	4	3.7%
Total	291	100	183	62.9%	93	32.0%	15	5.2%
Academic Achievement Level								
Low	83	28.5	51	61.4%	25	30.1%	7	8.4%

High	208	71.5	132	63.5%	68	32.7%	8	3.8%
Total	291	100	183	62.9%	93	32.0%	15	5.2%
Annual Green Space Usage								
Low Usage	79	26.8						
Moderate Usage	159	54.6						
High Usage	54	18.6						
Total	291	100						
Weekly Green Space Usage								
Low Usage	183	62.9						
Moderate Usage	93	32.0						
High Usage	15	5.2						
Total	291	100						

Table Notes:

Academic Achievement Level: High (GPA of 3.5 and above), Low (GPA below 3.5)

Measurable Anxiety: Yes (moderate to severe), No (minimal to mild)

Measurable Depression: Yes (moderate to severe), No (none to mild)