Effect of Hometown Seasonality on Undergraduate Students' Risk of Developing Seasonal Affective Disorder

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Abstract

Seasonal affective disorder (SAD) is a prevalent and potentially serious medical condition. Young adults are at particularly high risk. However, it is unknown if college students whose hometowns are in geographic areas with less seasonal variability, such as in the state of Hawai'i, are particularly vulnerable if they attend schools in areas with seasonal variability. An adapted version of the Seasonal Patterns Assessment Questionnaire (SPAQ) was administered to students at 3 universities to test this hypothesis. Surveys were administered twice: a baseline (T0) assessment in the fall and a follow-up (T1) assessment in the winter and were administered in the second month of each semester. A linear regression model was constructed to identify potential risk factors for developing seasonal fluctuations in mood (SPAQ scores T1-T0). Study subjects (n=115) from non-seasonal hometowns had a 1.6-point greater increase in SPAQ score than students from seasonal hometowns (-0.26 ± 3.88 vs 1.35 ± 3.03; P =.01). This difference is independent of demographic and lifestyle predictors (linear regression coefficient: β = 1.73; standard error = 0.68; P =.012). Interestingly, SPAQ score changes of students from seasonal hometowns did not differ significantly from 0 (t = -0.97; P =.33), indicating that they did not generally experience seasonal shifts in depressive symptoms. Students from less seasonal hometowns and counselors at seasonal institutions should be aware that these students could be more at risk of developing depressive symptoms and address these concerns before interfering with students' daily and academic lives.

Keywords

seasonal depression, risk factors, seasonality, hometown environment, adjustment

Abbreviations and Acronyms

SAD = Seasonal Affective Disorder
SPAQ = Seasonal Patters Assessment Questionnaire
AC = Amherst College
WU = University of Washington in St. Louis
UP = University of Portland
IRB = Institutional Review Board

Introduction

Major depressive disorder is the leading cause of disability in the United States for people aged 15 to 44 years, affecting an estimated 6.6% of the population each year with a lifetime prevalence of 16.2%.[1,2] Major depressive disorder has been associated with poor quality of life and increased mortality due to suicide.[3,4]

Seasonal affective disorder (SAD) is a type of depression related to change in seasons, and most commonly, peaks during the winter months and wanes during the summer. SAD accounts for 10% to 20% of all recurrent depression, ranging from 9.7% in New Hampshire to 1.4% in Florida.[5,6] Overall, 10% to 20% of patients diagnosed with SAD have mild cases, while 6% have severe symptoms that require hospitalization.[5,6]

SAD is correlated more strongly with climatic variables than latitudinal position.[7] Previous studies have found a strong, negative relationship between SAD prevalence, the number of wintertime daylight hours, and average daily temperature,[8] and a strong, positive relationship between SAD prevalence and cloudiness.[9] However, the leading predictor of the development of SAD is the reduction in sunlight exposure during winter due to shortened days or lifestyle changes. In fact, light therapy is being examined as a possible treatment for SAD.[10,11]

The impact of other environmental and patient-specific factors on the development of SAD is poorly understood. Young adults are a particularly high-risk group for both major depression and SAD.[12,13] A meta-analysis reported that 27.2% of medical students had depressive symptoms, with other studies found similarly elevated risk among college students.[14,15] Interestingly, the impact of students groups of similar social or cultural identity, or affinity groups (eg, the Hawai'i Club, Black Student Union, Asian Student Union, Gay-Straight Alliance), and the strength of social networks on the risk of developing SAD is unknown.

This student-initiated, student-led multicenter study investigated the relationship between SAD and a student's hometown seasonal variability. We hypothesized that students from hometowns with less seasonal variation are more susceptible to seasonal depressive shifts in mood.

Methods

Study Population

College undergraduates at the 3 participating sites, Amherst College (AC) in Massachusetts, Washington University at St. Louis (WU) in Missouri, and Portland University (UP) in Oregon, were eligible for participation. Students were recruited during the second month of the fall semester in 2017 to ensure a warm climate and mitigate any carry-over effects of summer travel or adjustment back to school. These sites were selected due to co-investigator professional connections and for their diverse student bodies as well as their representation of dif-

ferent regions of the country, with 1 school in New England (AC), 1 in the Midwest (WU), and 1 in the Pacific Northwest (UP). Students were recruited by a co-investigator at each site through flyers, social media posts, word of mouth, and face-to-face recruiting. Students were asked to complete a baseline survey at enrollment and a follow-up survey the following spring. Participants were not compensated for their participation. Institutional Review Board (IRB) approval was obtained from each study site (IRB reference numbers: 16-020 at AC, 201709214 at WU, and 2017-0124 at UP).

Survey

An adapted version of the well-validated Seasonal Pattern Assessment Questionnaire (SPAQ) was used for our survey. The SPAQ is the most commonly used instrument to assess the risk of SAD, with respondents scoring higher on the instrument being at greater risk of developing SAD. Although not sensitive enough to be considered a diagnostic instrument for SAD, it is widely considered to be an accurate screening instrument, with good specificity (94%), modest sensitivity (44%), and sufficient ability to classify subjects (81% correctly classified).[17,18]

The SPAQ was adapted to make it a 2-step longitudinal survey asking participants to rate their current emotional state at 2 points in time rather than reflect on how they feel throughout changing seasons. The survey was administered twice: a baseline (T0) assessment in the fall and a follow-up (T1) assessment in the winter. Surveys were administered in the second month of each semester to mitigate the influence of early semester stress and pre-semester traveling. Change in SPAQ score was calculated by subtracting the fall from the winter score (T1-T0), with positive scores representing an increase in depressive symptoms and negative scores indicating an improvement.

Participants provided additional information on their demographics, lifestyle, and hometown characteristics. Hometown was defined as a student's most recent place of residence before college. Lifestyle variables included self-reported measures on a 1 to 5 Likert Scale and included academic stress, the importance of affinity groups, and an estimate on the cultural similarity between a students' school and their hometown. Hometown climate characteristics were derived based on the first 3 digits of the student's hometown zip code. The Health Insurance Portability and Accountability Act of 1996 considers 3-digit zip codes to be non-identifiable information.[19]

Climate Variables

Hometown climate data were measured at ground-level weather stations and accessed through a free online repository.[20] The primary measure of seasonality was hours of sunlight during winter months (December–February). Hours of sunlight were measured by ground sensors at select weather stations across the country and gives a more accurate measurement than the time between sunrise and sunset, as climate conditions such as cloudiness, rain, and fog can influence estimates. Due to the inherently bimodal nature of this variable, it was dichotomized into seasonal or non-seasonal categories with a threshold value of fewer than 550 hours of winter sunlight representing a seasonal hometown (Figure 1). Temperature variables were taken as monthly averages, with low temperature representing the lowest average monthly temperature and change in temperature representing the difference between the highest average monthly temperature and the lowest. Latitude measurements were also collected. Hometown climate was measured using the closest available weather station.

Data Analysis

The final analytic sample (n=115) included students who completed both surveys (baseline and follow-up), which was necessary because the primary outcome was a change in SPAQ scores. Students who failed to provide 3-digit hometown zip codes or resided in their hometown for less than 4 years were excluded. Students who scored greater than 16 on the baseline SPAQ survey (T0) indicating that they had a number of depressive symptoms at baseline were also excluded, as they met the screening criteria for the potential to be "very depressed" and were advised to follow up with their health care providers (n=45). For the primary analysis, SPAQ score changes were compared between students from seasonal and non-seasonal hometowns via 2-sample, 2-tailed Welch's *t*-test. To identify independent factors associated with seasonal changes in SPAQ scores, we used multivariable linear regression with climate, demographic, and lifestyle variables as independent variables. Given the high number of correlated climate predictors and our emphasis on predicting which students would have winter variation in mood, we used least absolute shrinkage and selection operator (Lasso) variable selection to select the most relevant climate variables, minimize the consequences of overfitting, and address collinearity.[21] Qualtrics Software was used for data collection (Qualtrics, Provo, USA), while R statistical software, version 3.4.1 for Mac, was used for data analytics (Vienna, Austria). Averages are expressed as mean ± standard deviation (SD) unless otherwise noted.

Results

Population and Hometown Characteristics

Overall, 323 students completed the fall (T0) survey (92 at AC, 101 at UP, 136 at WU). Forty-five students (13.9%) had SPAQ scores >16 and were excluded from our analysis. Of the remaining 278 subjects, 115 (41.4%) completed the spring (T1) survey and comprised our final analytic cohort. Compared with the 115 students who completed the spring survey, the 165 who did not were similar in their fall SPAQ score and baseline characteristics ($P = .67$).

As expected, the average hours of sunlight months in seasonal and non-seasonal hometowns significantly differed (393 ± 16 vs 619 ± 16 hours; P <.001). Similarly, the latitude of seasonal and non-seasonal hometowns significantly differed (41.8 ± 1.3 vs 29.1 ± 2.3 degrees; P <.001), the average low temperature (-0.46 ± 43 vs 15.9 ± 2.4°C; P <.001) was significantly lower for seasonal than non-seasonal hometowns, and the seasonal change in temperature was higher (27.9 ± 0.9 vs 13.8 ± 2.4°C; P <.001; Table 1).

A total of 38 students at AC, 29 students at the UP, and 48 from the WU completed both surveys. There were no significant differences between student respondents at each site regarding gender, year in school, and minority status. Students from WU had an average baseline SPAQ score (9.71 ± 2.65) that was significantly lower than for students at AC (11.7 ± 3.07; P =.002) and UP (12.8 ± 1.94; P <.001). Baseline SPAQ scores did not differ between students from AC and UP (P =.09).

Although slightly more respondents (60%) were from seasonal rather than non-seasonal hometowns, the proportion of first-year students, men, and those who self-identified as a racial/ethnic minority was statistically similar between the 2 groups. In contrast, students from non-seasonal hometowns were significantly more likely to be involved in multiple affinity groups and strongly influenced by them and significantly less likely to report that their closest friends share a similar background (Table 2).

Seasonal Change in SPAQ

Baseline (fall) SPAQ scores were similar between the 2 groups (10.9 ± 3.1 vs 11.4 ± 2.7;P =.40; Table 2). Study subjects from non-seasonal hometowns had a 1.6-point greater increase in SPAQ score than students from seasonal hometowns (-0.26 ± 3.88 vs 1.35 ± 3.03; P = 0.01). SPAQ score changes of students from seasonal hometowns did not differ significantly from 0 (t = -0.97; P =.33), indicating that they did not generally experience seasonal shifts in depressive symptoms (Figure 2).

After linear regression adjustment for student demographics, lifestyle, and hometown characteristics, the difference in SPAQ score between students from non-seasonal and seasonal hometowns remained significant and similar in magnitude (β = 1.73; standard error = 0.68; P =.012). This finding indicates the difference in score is independent of other predictors (Table 3).

Climate, Demographic, and Lifestyle Variables

Because our primary definition of seasonal hometown was based solely on hours of sunlight per day, we sought to determine the influence of other climate variables on SPAQ scores. None of the average climate variables, such as temperature, latitude, or rainfall, were significantly related to our outcome and were not included in the final model.

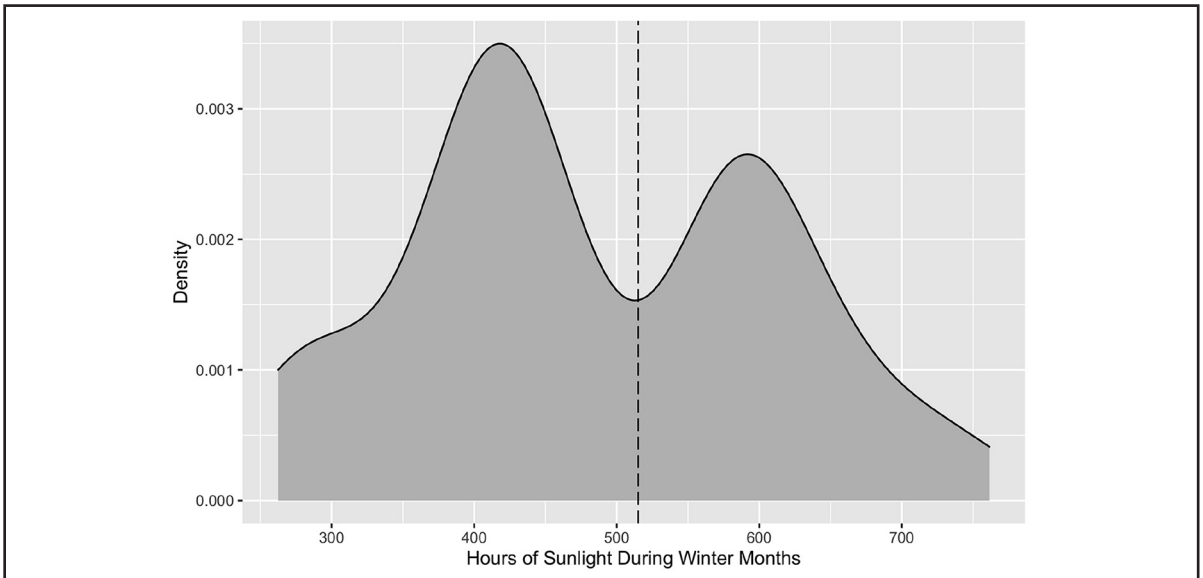

Figure 1. Distribution of Hometown Sunlight Hours During Winter Months.
Hours of sunlight during winter months has a distinctly bimodal distribution, with "seasonal" and "non-seasonal" hometowns corresponding to the lower (~420 hours) and higher (~580 hours), respectively. Therefore, we categorized hometowns as seasonal or non-seasonal based on whether or not they were above the threshold value of sunlight hours during the winter months (December to February). This threshold was the local minimum of the hours of sunlight distribution.

Table 1. Seasonal Variability Between Seasonal and Non-Seasonal Hometowns		
Variables[a]	**Seasonal Hometown Mean (95% CI)**	**Non-Seasonal Hometown Mean (95% CI)**
Average hours of sunlight during winter months, hours	393 (377, 409)	619 (603, 635)
Average latitude	41.8 (40.6, 43.1)	29.1 (26.8, 31.5)
Average low temperature during winter months, degrees Fahrenheit	-0.46 (-1.16, 0.65)	15.9 (13.4, 18.3)
Average temperature change during winter months, degrees Fahrenheit	27.9 (27.0, 28.8)	14.8 (12.3, 17.2)

Abbreviation: CI, confidence interval.
[a] All variables were significantly different at $P < .001$.

Table 2. Study Demographic Characteristics			
Characteristics	**Seasonal Hometown (n= 69) n (%)[b]**	**Non-Seasonal Hometown (n=46) n (%)**	***P* value[a]**
First-year students	17 (24.6)	8 (17.4)	.49
Men	18 (26.1)	14 (30.4)	.67
Self-identifying as minorities	14 (20.2)	11 (23.9)	.65
Reporting high stress	33 (47.8)	23 (50.0)	.85
Involved in multiple affinity groups	15 (21.7)	18 (39.1)	.06
Report strong influence of affinity groups	19 (27.5)	25 (54.3)	.01*
Consider their close friends to share a similar background	31 (44.9)	43 (93.5)	<.01*
Fall SPAQ score, mean (SD)	10.9 (3.06)	11.4 (2.69)	.67

Abbreviation: SD, standard deviation; SPAQ, Seasonal Pattern Assessment Questionnaire. [a] Asterisk represents values in the non-seasonal hometown column are significantly different from seasonal hometown at $P < .05$. [b] Presented as number and percentage unless otherwise noted.

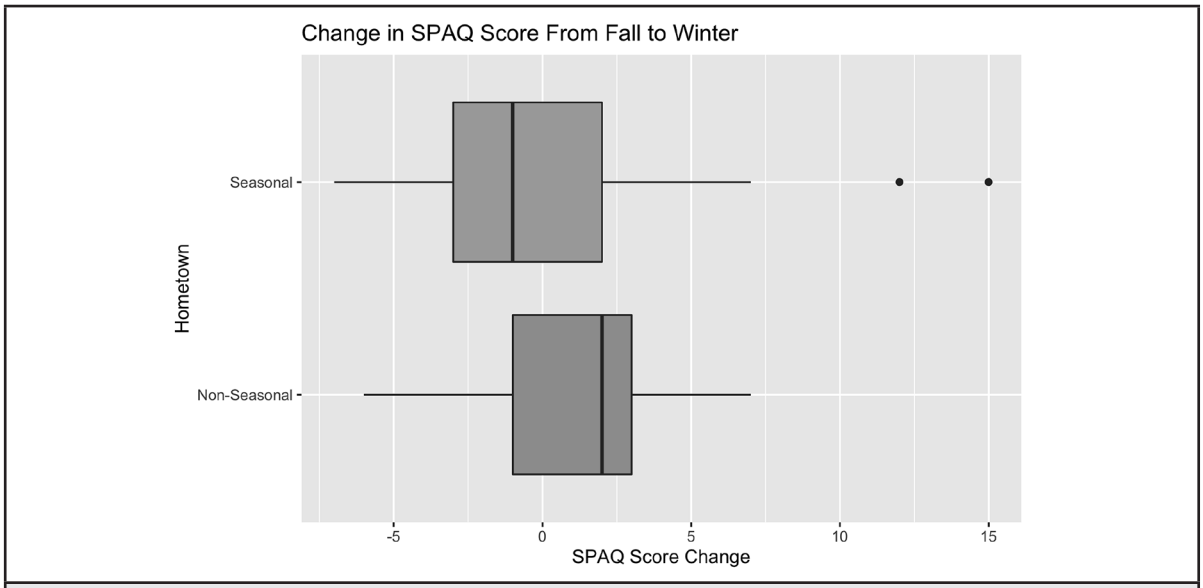

Figure 2. Change in SPAQ Score From Fall to Winter.
Students whose hometowns were non-seasonal (eg, Hawai'i), experienced greater increases in modified SPAQ score on average than their peers from seasonal hometowns (eg, Boston). This observed difference remained significant even after adjustment for climate, demographic and lifestyle covariates via multivariable linear regression (β = 1.73; standard error = 0.68; $P = .012$).

Table 3. Linear Regression Model Depicting Differences in SPAQ Score After Controlling for Lifestyle and Demographic Factors			
Variables[a]	**Model Coefficient (Change in SPAQ Score)**	**Standard Error**	***P* value**
Non-seasonal hometown	1.73	0.68	.012
First-year students	-2.42	0.83	.004
Stress (Scale -2, 2)	1.73	0.30	<.001
Involved in affinity groups	-1.04	0.87	.23
Report strong influence of affinity groups	2.00	0.83	.02
Consider their close friends to share a similar background	1.06	0.68	.12
Self-identify as a minority	0.14	0.79	.85
Men	1.19	0.70	.09
Model Performance			
Observations	115		
R^2	0.424		
Residual Standard Error	3.033 (df = 83)		

Abbreviation: df, degrees of freedom; Lasso, least absolute shrinkage and selection operator; SPAQ, Seasonal Pattern Assessment Questionnaire.
[a] Variables were selected via Lasso variable selection methods designed to identify the most powerful of the candidate predictors in a setting of suspected and known collinearity.

Aside from the school year, no demographic variables, including minority racial status and gender, were significantly related to changes in depression scores, and so they were not included in our final model. First-year students had average SPAQ change scores lower than upper-level students, indicating fewer depressive symptoms in the winter ($\beta = -2.42$; $P = .004$).

In contrast, lifestyle and cultural variables were generally very powerful predictors. Students reporting higher levels of stress in their follow-up survey scored higher than those who reported little to no stress ($\beta = 1.73$; $P < .001$). Thus, students who are stressed are more likely to report an increase in depressive symptoms in the winter when compared to their fall survey. Overall, students involved in affinity groups tended to have fewer depressive symptoms (mean difference, -1.04; $P = .23$); however, respondents who stated that these affinity groups had a "very significant" impact on their daily lives tended to have more depressive symptoms (mean difference, 2.00; $P = .02$). The variable "do your close friends share a similar culture to you" was included in the model as it added predictive power but was not significant (mean difference, 1.06; $P = .12$). More detail can be found in Table 3.

Discussion

Seasonal shifts in SPAQ depression scores are present and prevalent on college campuses. In this study of college undergraduates from 3 diverse schools representing the Northeast, Northwest, and Midwest, nearly half of all respondents had an increase in SPAQ score, indicating more depressive symptoms. This finding was true for each of the 3 institutions that participated in the study, suggesting that seasonal mood changes are a widespread phenomenon that may affect students across various environments.

Hometown seasonality, defined as seasonal or non-seasonal depending on the hours of sunlight during the winter months, has a statistically significant effect on SPAQ score changes. Students whose hometowns are less seasonal (eg, Hawai'i) tended to report an increase in depressive symptoms in the winter, whereas those from more seasonal climates did not. This conclusion aligns with our hypothesis that students from less seasonal hometowns are at higher risk of developing seasonal depression. It also suggests that susceptibility to SAD has an acquired component based on the climate of the previous residence.

The strength of this study is its examination of changes in SPAQ scores among college students across three geographically diverse campuses. Prior studies have shown that communities at higher latitudes are more resistant to SAD[21-23] and that certain groups have a more difficult transition to new environments, especially colleges.[11-16] While seasonal affective disorder is well-documented, particularly its prevalence in young adults, most studies use only participants' current residence.[5-10] Two prior studies have examined the relationship between prior resistance and SAD, 1 comparing Japanese residents in Northern Europe to South East Asia and 1 comparing African students attending university in Washington, DC to their African American peers. Both studies, however, consisted of populations that were older than the average American college student (the DC study had an average age of 29.5 years for their African American control group and 30.5 years for their African student group). Moreover, both studies were subject to a much greater level of confounding than our study, as their groups had vastly different cultural experiences. Finally, African students from the DC study were from hometowns of equivalent latitudes to their university, suggesting their fluctuations in wintertime sunlight may not vary significantly.[24,25] Given the geographical diversity but relative

cultural homogeneity between our seasonal and non-seasonal groups, this study is more specific to the influence of hometown climate and generalizable to those experiencing a less drastic cultural change.

There are several limitations to our study. First, we used an adapted SPAQ survey to estimate the change in depressive symptoms at 2 points in time. While our assessment had the advantage of not relying on participant's self-assessment of their mood over the prior year, there are no well-defined cutoff points to identify participants with SAD. Thus our tool cannot be used to diagnose this disease. SAD diagnosis can only be made through clinical evaluation and reoccurrence of symptoms over several years and therefore is impossible in this study's timeframe. Thus, our study focused on changes in SPAQ scores rather than assessing the prevalence of SAD. This finding is still a clinically meaningful observation, as pre- or sub-SAD fluctuations in mood can have profound lifestyle effects. Second, there may be other unmeasured factors driving the observed changes in SPAQ score. For instance, differences in seasonal mood changes could stem from the fact that those from non-seasonal hometowns are farther from home and less likely to have traveled home to visit family during the school year. However, even if these findings had some non-climate related origin, it is important to identify this population as distinct and potentially at higher risk.

In conclusion, students from non-seasonal hometowns appear to experience greater seasonal shifts in mood, even after controlling for demographic and lifestyle factors. We found that nearly 50% of students from non-seasonal hometowns reported an increased SPAQ score in the winter, compared to no change for those with non-seasonal hometowns. Moreover, adaptive factors appeared to affect seasonal mood changes. This conclusion suggests that increasing awareness in students from non-seasonal hometowns and their college community of the potential for seasonal mood swings may be important. Further study is needed to determine whether susceptibility to seasonal mood swings has an acquired component based on the climate of the previous residence.

Conflict of Interest

None of the authors identify any conflicts of interest.

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