Empirical Article

Clinical Psychological Science
1–10

DOI: 10.1177/2167702615615867
cpx.sagepub.com

Major Depression With Seasonal Variation: Is It a Valid Construct?

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Abstract

Seasonal affective disorder (SAD) is based on the theory that some depressions occur seasonally in response to reduced sunlight. SAD has attracted cultural and research attention for more than 30 years and influenced the *DSM* through inclusion of the seasonal variation modifier for the major depression diagnosis. This study was designed to determine if a seasonally related pattern of occurrence of major depression could be demonstrated in a population-based study. A cross-sectional U.S. survey of adults completed the Patient Health Questionnaire–8 Depression Scale. Regression models were used to determine if depression was related to measures of sunlight exposure. Depression was unrelated to latitude, season, or sunlight. Results do not support the validity of a seasonal modifier in major depression. The idea of seasonal depression may be strongly rooted in folk psychology, but it is not supported by objective data. Consideration should be given to discontinuing seasonal variation as a diagnostic modifier of major depression.

Keywords

affective disorders, depression, psychiatric epidemiology, seasonal variations

Received 4/27/15; Revision accepted 10/14/15

The first studies of seasonal affective disorder (SAD) began to appear in the psychiatric research literature in 1984 with the influential article by Norman Rosenthal and colleagues at the National Institutes of Mental Health. In 1987, the *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed., rev.; *DSM-III-R*; American Psychiatric Association, 1987) included a "seasonal pattern" modifier for diagnoses of major depression and bipolar disorder (including *not otherwise specified* versions of both disorders). Subsequent editions of the *DSM* also included an optional modifier for these diagnoses (*DSM-IV*—American Psychiatric Association, 1994; *DSM-IV-TR*—American Psychiatric Association, 2000; *DSM-5*—American Psychiatric Association, 2013). Regardless of *DSM* edition, the basic criteria for diagnosing seasonal pattern are meeting the diagnostic criteria for major depression and experiencing recurrences that correspond to particular seasons. The most commonly reported pattern is that of symptoms emerging in the fall and winter and remitting in the spring and summer.

The close correspondence in time between the emergence of SAD in the psychiatric literature and the inclusion of a seasonal pattern modifier in *DSM-III-R* suggests that the research base for major depression with seasonal pattern was a small number of SAD studies (Hansen, Skre, & Lund, 2008). Following their meeting with Rosenthal and his research colleague, Michael Terman, Robert L. Spitzer, chair of the Work Group to Revise *DSM-III*, and Janet B. W. Williams, text editor, reported that the seasonal pattern modifier was included in *DSM-III-R* (Spitzer & Williams, 1989). Seasonal pattern had not been considered by the *DSM-III-R* Mood Disorders Advisory Committee. The inclusion of the seasonal pattern modifier was justified because it was considered to be more diagnostically valid than other included mood diagnoses, such as melancholia and dysthymia. Consideration was given to creating a separate diagnosis for SAD, but this idea was rejected because it would have

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placed by default all other mood disorders in a nonseasonal mood disorder category (Spitzer & Williams, 1989).

Work on the *DSM-IV* revision permitted consideration of research findings relevant to major depression with seasonal variation, much of which, again, centered primarily on the SAD literature, rather than *DSM*-defined depression literature (Bauer & Dunner, 1993). Eliminating the concept of seasonality was considered, but major depression with seasonal pattern was ultimately retained in *DSM-IV* primarily based on response to treatment data (light therapy studies) and "natural history" (Bauer & Dunner, 1993, p. 166). Prior to the publication of *DSM-5*, Rosenthal (2009) argued that the SAD construct had garnered enough scientific support to warrant inclusion in the *DSM-5* as a separate disorder. Although SAD was not included in *DSM-5*, the category of major depression with seasonal pattern as an optional modifier was continued.

Research on SAD has provided the basis for major depression with seasonal pattern, but much of the research on SAD has used the Seasonal Pattern Assessment Questionnaire (SPAQ) for case identification (Kasper, Wehr, Bartko, Gaist, & Rosenthal, 1989; Levitt & Boyle, 2002; Magnusson, 1996; Rosen et al., 1990; Rosenthal, Bradt, & Weir, 1987; Steinhausen, Gundelfinger, & Metzke, 2009; Zubieta, Engleberg, Yargic, Pande, & Demitrack, 1994). Despite its frequent use in studies of SAD, the SPAQ is not without significant problems that seriously challenge its validity as a measure of major depression with seasonal variation.

First, the SPAQ does not measure major depression as defined by the *DSM*. Six items on the SPAQ compose the Global Seasonality Scale (Murray, 2004), and these items query the extent to which certain behaviors (mood, eating, weight, sleep, energy, social activity) "change" with the seasons. In contrast, the *DSM-5* diagnostic criteria for major depression specify possible symptoms of depressed mood, fatigue, and weight loss during the previous two weeks. *DSM-5* major depression criteria, such as feelings of worthlessness or guilt, concentration difficulties, and thoughts of suicide, form no part of the SPAQ assessment of SAD (Hansen et al., 2008).

Second, the SPAQ relies on recall of past depressive episodes to establish cases of SAD. In clinical settings, recall of events is often a starting point in formulating diagnoses, but corroboration of self-reports by significant others and retrospective review of records may be of considerable value in supporting or ruling out diagnostic considerations. However, to establish the existence of a clinical syndrome, methods that do not rely solely on recall of multiple distant past events are clearly preferable. The SPAQ requires recall of mood variations over at least one year, possibly longer, which respondents may not be able to report reliably.

A question of the validity of retrospective recall of symptoms was of concern in establishing the *DSM* diagnosis of premenstrual dysphoric disorder (PMDD). Research on PMDD that did rely on retrospective recall produced inflated prevalence estimates. The *DSM* diagnostic criteria for PMDD require daily symptom ratings over two consecutive menstrual cycles with symptom reduction evident between cycles (Zachar & Kendler, 2014). Similarly, prevalence of SPAQ-identified SAD cases tends to drop when *DSM*-consistent major depression measures are employed (Blazer, Kessler, & Swartz, 1998; Levitt & Boyle, 2002; Nayyar & Cochrane, 1996; Steinhausen et al., 2009). Research studies that have utilized both the SPAQ and some form of *DSM*-based diagnostic criteria suggest that major depression is not strongly related to SPAQ-identified SAD (Magnusson, 1996; Mersch et al., 2004; Steinhausen et al., 2009; Thompson & Cowan, 2001; Thompson, Thompson, & Smith, 2004).

Between the publication of *DSM-IV* and that of *DSM-5*, evidence accumulated contradicting the claim that some recurrent episodes of major depression are linked to seasonal changes. These studies have two characteristics in common: (a) They use measures of depression that more closely approximate *DSM* major depression diagnostic criteria, and (b) they are cross-sectional or longitudinal studies based on larger, or population-representative samples. For example, a retrospective study of 1,500 patient records found no relationship between season and diagnoses of depression based on *DSM-IV* criteria (Posternack & Zimmerman, 2002). Because of the SPAQ's reliance on recall, the authors of another study administered the Hospital Anxiety and Depression Scale (HADS), a measure of current depression, to seasonal cohorts randomly selected from a population registry during four seasons (Magnusson, Axelsson, Phil, Karlsson, & Oskarsson, 2000). They reported no seasonal variation in mean depression scores, a finding that held after adjusting for age and place of residence. A smaller longitudinal study reported a pronounced seasonal pattern when using the SPAQ but not the HADS (Nayyar & Cochrane, 1996). More recently, Kerr and colleagues (2013) reported on seasonal variations in depressive symptoms in two longitudinal study samples in which participants completed depression scales over the course of several years. The authors found little if any association between seasonal change or solar radiation exposure and depression. Although the study findings are compelling, the authors report that samples were not population-representative and participants lived in the U.S. Midwest and Northwest. This latter circumstance limited variation in latitude of residence, a factor that supposedly corresponds with seasonal mood variation, particularly at latitude extremes.

We are left with doubts of whether SAD research provides any basis for the creation of the novel diagnostic category major depression with seasonal variation. Historically, major depression with seasonal variation has been entangled with the SAD construct, and SAD research has relied to a large extent on the SPAQ. The SPAQ has little overlap with *DSM* depression criteria and is vulnerable to recall and other forms of bias. However, irrespective of the validity of the SAD construct, confidence in the validity of major depression with seasonal variation would be strengthened if seasonal variation in the prevalence of depression were demonstrated in a study that (a) utilizes a depression measure consistent with *DSM* diagnostic criteria; (b) is based on a large, population-representative sample; (c) is conducted such that interviewers and respondents are unaware of the seasonal hypothesis; and (d) controls for the effects of variables other than seasonality known to be correlated with depression (e.g., sex, employment status; Dooley, Prause, & Ham-Rowbottom, 2000; Hasin, Goodwin, Stinson, & Grant, 2005). These are the salient characteristics of the current study, which is designed to investigate whether depression scores in the general population, as well as prevalent cases of major depression, display seasonal variation as predicted by SAD theory and as specified in *DSM-5*.

Method

Materials and procedure

The research described in this article was exempt from review by the Institutional Review Board at Auburn University at Montgomery.

The Behavioral Risk Factor Surveillance System (BRFSS) is an annual health behavior survey that gathers current information regarding health risk behaviors, health care access, and preventative measures (Centers for Disease Control and Prevention [CDC], 2013). The standardized questionnaire is administered as a random-digit dialing telephone survey performed in the United States at the state level (including territories) to gather information about current risk behaviors and health practices (CDC, 2013). The 2006 BRFSS data set was selected for this study because incentives for administering the Anxiety and Depression Module were available that year, and 36 states gave this part of the survey (CDC, 2007). This survey module includes the Patient Health Questionnaire–8 (PHQ-8), a measure of current depression (Kroenke et al., 2009; Kroenke & Spitzer, 2002).

The Selected Metropolitan/Micropolitan Area Risk Trends (SMART) is a subset of the 2006 BRFSS created to provide county-level estimates of health behaviors and risks within metropolitan or micropolitan statistical areas (CDC, 2011). Metropolitan statistical areas are counties with 50,000 or more inhabitants, and micropolitan statistical areas are counties with at least 10,000 but fewer than 50,000 inhabitants (CDC, 2011). The SMART data set contained data from 21 states (63 counties) that had administered the PHQ-8.

Participants: Total sample

The study cohort began with 34,876 survey respondents. Age was missing for 329 respondents, and the interview year was coded as 2007 instead of 2006 for 253 respondents. These 582 participants were excluded from analysis, leaving a final sample of 34,294 adult respondents, or 98.3% of the original study cohort. Participants ranged in age from 18 to 99 years with a mean age of 52 years (SD = 16.7). Table 1 summarizes basic demographic information about the respondents.

Participants: Depressed sample

If major depression with seasonal variation is a rare disorder, then evaluating seasonal change in depression scores of the total sample may have the effect of concealing this pattern. To account for this possibility, we reran all of our analyses on the subsample of respondents who scored within the depressed range on the PHQ-8 depression scale (PHQ-8 ≥ 55; see next section). This depressed sample consisted of 1,754 participants between 18 and 93 years of age with a mean age of 48.2 years (SD = 14.3). Table 1 also summarizes demographic information about this depressed sample.

PHQ-8 Depression Scale

The PHQ-8 is an adaptation of the Patient Health Questionnaire–9 (PHQ-9; Kroenke & Spitzer, 2002). The PHQ-9 consists of 9 items that reflect the symptoms of major depressive episode as specified in *DSM-5* (Dhingra, Kroenke, Zack, Strine, & Balluz, 2011). The PHQ-8 comprises eight questions that ask how many days during the past two weeks the participant experienced a given symptom of depression. The PHQ-9 contains an item about suicidal ideation that is omitted from the PHQ-8. The item is eliminated because interviewers collecting data for large-scale telephone surveys lack the resources to conduct a clinical assessment or arrange a proper intervention for respondents who express thoughts of suicide or self-harm. The PHQ-9 is a valid and reliable measure of depression consistent with *DSM* diagnostic criteria, and the PHQ-8 has similar operating characteristics (Kroenke et al., 2009; Kroenke & Spitzer, 2002).

PHQ-8 scores were determined by summing across the 8 item scores. Thus PHQ-8 scores ranged from 0 to 112 total symptom days. This method of scoring the

Table 1. Demographic Characteristics and Seasonal Variables for Total and Depressed Samples

	Total sample (N = 34,294)		Depressed sample (n = 1,754)	
Variable	*n*	Weighted %	*n*	Weighted %
Latitude				
Northern	14,951	19.6	674	16.1
Middle	15,327	57.7	842	60.3
Southern	4,016	22.7	238	23.6
Duration of sunlight exposure				
8’–9’59”	7,587	10.5	347	10.3
10’–11’59”	11,704	39.6	620	44
12’–13’59”	8,505	32.7	439	26.1
14’ or more	6,498	17.3	348	19.6
Season				
Spring	9,448	27.5	481	25.4
Summer	8,668	25.2	441	23.7
Autumn	8,811	25.9	445	22.8
Winter	7,367	21.4	387	28.1
Sex				
Women	21,336	51.4	1,264	65.7
Men	12,958	48.6	490	34.3
Race				
White	26,279	58.5	1,178	47.3
Black	3,484	12.2	250	15.2
Other non-Hispanic	1,020	4.9	65	4.8
Multiracial non-Hispanic	606	1.7	75	3
Hispanic	2,606	22	172	28.9
Unknown	299	0.7	14	0.8
Education				
None or kindergarten	48	0.7	4	3.4
Grades 1–8 (elementary)	882	5.1	83	6.3
Grades 9–11 (some high school)	1,939	7.1	207	12.1
Grade 12/GED (high school)	8,749	23.7	560	29.9
College 1–3 years (some college or technical school)	9,264	25.8	559	31.3
College 4 years or more	13,362	37.4	341	17
Unknown	50	0.2	—	—
Employment				
Employed for wages	20,109	63.2	662	43
Unemployed	1,411	5.8	218	13
A homemaker	2,535	8.6	107	7.2
A student	753	4	42	3.6
Retired	7,555	13.7	200	7.9
Unable to work	1,870	4.6	524	25.3
Unknown	61	0.2	1	0.02
Marital status				
Married	18,356	58.1	612	35.7
Divorced	5,407	9.7	449	16.9
Widowed	3,948	5.4	167	5.6
Separated	744	2.5	105	5.7
Never married	4,703	18.7	341	28.9
Member unmarried couple	1,032	5.4	71	7
Unknown	104	0.3	9	0.2

PHQ-8, known as PHQ-8 Days, and using a cut score of 55 symptom days, has a sensitivity of .91 and specificity of .99 when compared with scores produced by a *DSM*-based PHQ-8 scoring algorithm (Dhingra et al., 2011).

Season

Season was constructed as a continuous variable following Kerr et al. (2013). The 2006 winter solstice was December 21, and this date was designated as 0, with successive days serially numbered 1 to 364. To approximate a sinusoidal function, we constructed a polynomial regression model for the continuous season variable that also included the square and cube of this variable to model quadratic and cubic effects.

Latitude

Respondents were classified as living in northern, middle, or southern latitudes based on residence at the time of the survey. Respondents in the northernmost latitude, between 42.3°N and 45.2°N latitudes, lived in Maine, Michigan, Minnesota, New Hampshire, Oregon, Vermont, Wisconsin, and Wyoming. The middle latitude communities, between 32.4°N and 36.1°N latitudes, were in Alabama, Arkansas, California, Georgia, Mississippi, Nevada, New Mexico, Oklahoma, South Carolina, Tennessee, and parts of Texas. The communities in the southernmost latitudes, between 27.6°N and 30.4°N latitudes, were located in Florida, Louisiana, and Texas.

Sunlight exposure

The U.S. Naval Observatory website provides duration of daylight in hours and minutes for every day of the year for most U.S. cities and towns (U.S. Naval Observatory [USNO] Astronomical Applications Department, 2014). The sunlight data for each 2006 date were obtained for every community and county in the BRFSS SMART county-level data set. The range of sunlight on any date within each latitude band was as follows: Northern latitude ranged from 8 hours 43 minutes to 15 hours 37 minutes, middle latitude ranged from 9 hours 42 minutes to 14 hours 37 minutes, and southern latitude ranged from 10 hours 11 minutes to 14 hours 7 minutes.

Using the interview date, state, and county data included in the BRFSS data, the latitude variable, and the USNO data on sunlight, a four-category sunlight exposure variable was created. Respondents were classified into one of four groups based on amount of daylight on the day of interview: (a) 8 to 9 hours 59 minutes, (b) 10 to 11 hours 59 minutes, (c) 12 to 13 hours 59 minutes, and (d) 14 hours or more of sunlight. The numbers of respondents within each latitude band, sunlight exposure category, and season (as categories based on 2006 dates of solstices and equinoxes; USNO, n.d.) of interview are summarized in Table 1.

Design

The study design is cross-sectional and we conducted different analyses in an effort to discover a relationship between sunlight exposure and depression. The first analysis evaluated the relationship of season modeled as a continuous variable and depression. If depression prevalence is related to season, then a polynomial regression model should yield significant cubic effect for the season variable.

The second analysis sought to determine if latitude or season, either independently or in interaction, could explain significant variation in depression scores. Interaction effects of latitude and season consistent with SAD theory would manifest as higher depression scores among people living at northern latitudes during the winter season, and lower depression scores among people in southern latitudes during summer.

Latitude and season are proxy variables for sunlight exposure duration, which is the hypothesized causal variable responsible for seasonal variation in depression. Because of the relationship among these variables, it is not reasonable to include the sunlight duration variable in the same model with the latitude and season variables. There is an additional practical reason for excluding sunlight duration from the model that contains the latitude and season variables. Within the southernmost latitude band, there are no days with sunlight duration of less than 10 hours per day. Thus, placing this variable in interaction with latitude band produces an empty cell. The categorical sunlight exposure variable was evaluated separately in an analysis that excludes the latitude and season variables.

The separate multiple regression models were constructed as described earlier with PHQ-8 depression score as the criterion variable. Each model included a set of control covariates typically associated with depression. Control covariates were age (in years) and age squared, race/ethnicity (six categories), sex (male, female), educational level (seven categories), marital status (seven categories), and employment status (seven categories). Variables were entered simultaneously in these regression analyses. All analyses were conducted for the total and depressed samples.

Statistical analysis employed the SAS PROC SURVEYREG module (SAS Institute, 2008), which accommodates data from surveys administered using complex sampling strategies. The analyses were weighted using the BRFSS variable designed for use with the SMART data set (_cntywt). Weighting the analysis adjusts standard errors for sampling strategy effects of nonresponse and number of household telephones. Survey design effects including first sampling stage stratification (state, phone density, geographic region) and clustering of phone numbers were also specified in the analyses.

Results

Season

Models were constructed with PHQ-8 scores as the criterion variable and including the season variable along with the quadratic and cubic terms to determine if a sinusoidal function fit the data as predicted by SAD theory. An absence of effect with a model that included the quadratic term but not the cubic term meant that the cubic term would also not be significant. Nevertheless, we present the results of the third order polynomial model for both the total and depressed samples. Results indicated that the season variables were not significantly related to depression scores in either sample. The absence of a curvilinear function means that a linear model is suitable for describing the relationship of depression and season. Table 2 summarizes the results of regression models for season plus all control covariates for the total and depressed samples. Several control covariates were significantly related to depression scores in both samples, with only the model control covariates accounting for a significant proportion of variance in depression scores, $F(29, 34{,}150) = 25.76$, $p < .0001$, $R^2 = .1406$, for the total sample, $F(28, 1{,}650) = 16.77$, $p < .0001$, $R^2 = .1316$, for the depressed sample. For each variable in both the total and depressed samples, semipartial r^2 are presented as estimates of the unique effects associated with season and each control covariate.

Latitude band and season

The next set of analyses evaluated the relationship of latitude of residence and season to determine if these

Table 2. Relationship of Season to Patient Health Questionnaire–8 Depression Scores for the Total and Depressed Samples

	Model for total sample (N = 34,294)			Model for depressed sample (n = 1,754)[a]		
Variable	Semipartial r^{2b}	F	Numerator df^c	Semipartial r^{2b}	F	Numerator df^d
Season (days since winter solstice)	.0000	0.11	1	.0020	1.29	1
Season^2	.0000	0.01	1	.0026	1.51	1
Season^3	.0000	0.12	1	.0033	1.88	1
Age	.0008	4.08*	1	.0128	7.27**	1
Age^2	.0013	9.16**	1	.0120	8.43**	1
Sex	.0078	52.16***	1	.0107	4.98*	1
Race	.0009	1.35	5	.0364	3.59**	5
Education	.0098	8.98***	6	.0174	1.59	5
Employment	.0765	38.02***	6	.0224	2.15	6
Marital status	.0116	11.49***	6	.0033	0.31	6
Full model R^2		.1406			.1316	

[a]For the depressed sample, there was one respondent in the education = unknown category, which was dropped from the analysis. [b]Represents the total unique effect for each variable. [c]Denominator df = 34,150. [d]Denominator df = 1,650.
*p < .05. **p < .01. ***p < .0001.

commonly used proxy variables for sunlight exposure were related to current depression while controlling for the covariates. Table 3 summarizes these statistically significant regression models for the total sample, $F(31, 34{,}150) = 25.76$, $p < .0001$, $R^2 = .1407$, and the depressed sample, $F(30, 1{,}650) = 16.77$, $p < .0001$, $R^2 = .1320$. Only the model control covariates contributed to the statistical significance of the models. There were no significant main effects for season or latitude, nor was there a significant interaction of these variables for either the total or depressed samples. Semipartial r^2 values are reported in Table 3 to indicate unique effects attributable to each variable in the model.

Sunlight exposure

Finally, models were constructed to determine if sunlight exposure was related to depression for either the total or depressed samples. Table 4 presents the results of the analyses for the total and depressed samples. For both samples, the models accounted for a significant proportion of the variance in depression scores, $F(29, 34{,}150) = 27.12$, $p < .0001$, $R^2 = .1408$ for the total sample, $F(28, 1{,}650) = 18.04$, $p < .0001$, $R^2 = .1242$, for the depressed sample. However, a significant effect for sunlight exposure duration on depression scores was not found in either sample.

Discussion

Major depression with seasonal variation was included in the *DSM–III-R* (American Psychiatric Association, 1987) largely based on research on SAD. However, the SAD construct and typical method of measuring it (i.e., the SPAQ) have little in common with the *DSM* construct of major depression. SAD theory holds that some affective disturbances are triggered by lack of sunlight, and many studies of SAD have investigated mood changes associated with proxies for this variable, such as seasonal changes or residence at various distances from the equator.

The purpose of this study was to determine if major depression was associated with these proxies for sunlight exposure, as well as sunlight exposure itself. There was no indication that depression is associated with seasonal changes in either the total sample or the sample of individuals with elevated depression scores. Had the data been characterized by seasonal fluctuations in depression, the polynomial regression model would have fit the data better than the linear model, but this is not the case. The prevalence of depression as measured by the PHQ-8 is quite stable across the seasons.

Likewise, we found no association of depression with latitude of residence. The hypothesis that affect is related to latitude has received inconsistent support in the literature. Rosen et al. (1990) reported that prevalence of SPAQ-identified SAD cases declined across northerly to southerly U.S. latitudes. However, a number of studies have failed to replicate this finding using both the SPAQ and *DSM*-based criteria for depression (Blazer et al., 1998; Brancaleoni, Nikitenko, Grassi, & Hansen, 2009; Haggarty, Cernovsky, & Husni, 2001; Levitt & Boyle, 2002; Mersch, Middendorp, Bouhuys, Beersma, & Van den Hoofdakker, 1999).

Table 3. Relationship of Season and Latitude to Patient Health Questionnaire–8 Depression Scores for the Total and Depressed Samples

Variable	Model for total sample (N = 34,294) Semipartial r^{2b}	F	Numerator df^c	Model for depressed sample (n = 1,754)[a] Semipartial r^{2b}	F	Numerator df^d
Days since winter solstice (season)	.0000	0.20	1	.0000	2.76	1
Latitude	.0000	0.28	2	.0046	1.50	2
Season × latitude	.0004	1.24	2	.0005	0.18	2
Age	.0007	4.16*	1	.0127	7.06**	1
Age^2	.0014	9.30**	1	.0118	8.22**	1
Sex	.0077	51.35***	1	.0101	4.78*	1
Race	.0009	1.29	5	.0366	3.10**	5
Education	.0098	8.99***	6	.0149	1.48	5
Employment	.0769	37.85***	6	.0250	2.23*	6
Marital status	.0115	11.45***	6	.0040	0.32	6
Full model R^2		.1407			.1320	

[a]For the depressed sample, there was one respondent in the education = unknown category, which was dropped from the analysis. [b]Represents the total unique effect for each variable. [c]Denominator df = 34,150. [d]Denominator df = 1,650.
*p < .05. **p < .01. ***p < .0001.

Finally, there is no indication that depression is related to sunlight exposure on the day of the interview. This finding is not surprising. If the proxy variables for sunlight are unrelated to depression, then unless these are very poor proxy variables, we would not expect sunlight exposure and depression to be related, either. Sunlight duration on the day of the interview is a reasonable estimation of the potential sunlight exposure around the time of the interview. Inspection of the sunlight tables from the USNO indicates that sunlight duration typically only varies 0 to 2 minutes from day to day. There have been other reports that support this finding and cast doubt on sunlight exposure as a causal factor in depression. Hansen et al. (2008) reported no increase in depression in northern Norway during the two-month-long "dark period" (p. 121). A large-scale study of residents of Tromsø, Norway, a city north of the arctic circle and also subject to the two-month polar night, found neither an increase in self-reported mental distress during the polar night nor a decrease in reported mental distress during the polar day (Johnsen, Wynn, & Bratlid, 2012).

Table 4. Relationship of Sunlight Exposure to Patient Health Questionnaire–8 Depression Scores for the Total and Depressed Samples

Variable	Model for total sample (N = 34,294) Semipartial r^{2b}	F	Numerator df^c	Model for depressed sample (n = 1,754)[a] Semipartial r^{2b}	F	Numerator df^d
Sunlight exposure	.0008	1.77	3	.0018	0.32	3
Age	.0008	4.36*	1	.0117	6.82**	1
Age^2	.0014	9.67**	1	.0108	7.87**	1
Sex	.0077	51.18***	1	.0090	3.98	1
Race	.0009	1.33	5	.0375	3.91**	5
Education	.0097	8.91***	6	.0149	1.41	5
Employment	.0769	37.86***	6	.0246	1.97	6
Marital status	.0116	11.48***	6	.0037	0.30	6
Full model R^2		.1408			.1242	

[a]For the depressed sample, there was one respondent in the education = unknown category, which was dropped from the analysis. [b]Represents the total unique effect for each variable. [c]Denominator df = 34,150. [d]Denominator df = 1,650.
*p < .05. **p < .01. ***p < .0001.

The idea that depression occurs along with seasonal changes or worsens in winter appears to be a well-entrenched folk theory. A Google search for news items of the term "winter depression" yielded 993,000 hits. Similar search terms yielded the indicated number of news item hits: "winter blues" (7,460,000), "seasonal affective disorder" (19,800), and "seasonal depression" (34,300). SAD research participants, who are frequently identified using the SPAQ, may reconstruct past experiences in accordance with this folk theory. Early SAD research (e.g., Rosenthal et al., 1984) in particular has been criticized for recruiting participants by advertisement (Bauer & Dunner, 1993; Hansen et al., 2008), a technique predisposed to self-selection bias. Researchers employing this recruitment technique may begin the project expecting to discover a particular pattern of behavior and absent experimental safeguards those expectancies would be subject to confirmation bias.

Whether by accident or design, this combination of methodological shortcomings is nearly ideal for confirming a folk theory. However, establishing psychiatric diagnoses is a consequential activity and evidence from studies that allow the possibility of disconfirmation should be given substantial weight (Meehl, 1978; Popper, 1962). The particular strengths of the present study are the measurement of depression in a manner consistent with *DSM* criteria and the absence of expectation of any relationship between current depression and seasonality among respondents or interviewers. The sample is representative of the U.S. population, and large enough to bring sufficient statistical power to the design, which also controlled for the effects of variables that are associated with depression.

The results of this study add to the findings of other studies that have used measures consistent with *DSM* major depression criteria (Kerr et al., 2013; Magnusson et al., 2000; Nayyar & Cochrane, 1996; Posternack & Zimmerman, 2002). The findings cast serious doubt on major depression with seasonal variation as a legitimate psychiatric disorder. In clinical cases of recurrent depression, stressful life events associated with episodes may coincidentally co-occur with seasonal changes for some people. Identifying sunlight exposure as the putative cause of depression would necessitate separating its effects from the effects of co-occurring stressors.

The current study cannot rule out the possibility that major depression with seasonal variation exists, but at a low base rate. For example, Blazer et al. (1998) in an analysis of National Comorbidity Study data found that 1.6% of the major depression cases (representing 0.3% of the general population), reported seasonally related recurrent depression episodes. One problem with large-scale epidemiological studies such as reported here is that it is difficult to detect conditions with low base rates. Low base rates pose difficulties for case identification even with instruments that have excellent sensitivity and specificity (Glaros & Kline, 1988).

The findings of Blazer et al. (1998), however, do not validate the presence of such a taxon. Although they used an instrument consistent with *DSM* criteria for major depression, Blazer et al. (1998) also relied on questioning participants about past episodes of depression. Their method was more stringent than found in studies using the SPAQ, but nevertheless, it is subject to the problem of recall bias identified earlier.

Depression is a recurrent illness (Burcusa & Iacono, 2007). Because all episodes of depression occur in some season, chance occurrence in two consecutive winters would explain some apparent seasonality. The role of chance as an explanation diminishes in cases where episodes are experienced in three or more consecutive winters. Even so, the existence of such cases would not in themselves demonstrate that changes in sunlight exposure are responsible for the depression. Merely being depressed *during* winter is not evidence that one is depressed *because* of winter.

If major depressive disorder with seasonal variation is a folk psychological construct with limited empirical support, the implications of including it in the *DSM* are that the expected course of legitimate cases of depression may be misconstrued and improperly treated. Societal consequences also inevitably accrue; for example, employees with SAD have won lawsuits against employers who failed to accommodate the disorder (*Ekstrand v. School District of Somerset*, 2012; Twohey, 2010). The weight of accumulating evidence, including the evidence presented here, indicates that the burden of proof for including the seasonal variation modifier for major depression in *DSM* has shifted to those who would continue to do so.

Author Contributions

M. K. Traffanstedt and S. G. LoBello developed and S. Mehta contributed to the study concept and design. M. K. Traffanstedt gathered data from the USNO and performed the data analysis with S. G. LoBello. Programming entailed the combining of BRFSS with USNO data and this was done by S. G. LoBello and M. K. Traffanstedt. M. K. Traffanstedt interpreted the results under the supervision of S. G. LoBello and S. Mehta. M. K. Traffanstedt drafted the manuscript, and S. G. LoBello and S. Mehta provided critical revisions. All authors approved the final version of the manuscript for submission.

Acknowledgments

We are very grateful for the assistance of Peter Zachar, Auburn University at Montgomery.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

References

American Psychiatric Association. (1987). *Diagnostic and statistical manual of mental disorders* (3rd ed., rev.). Washington, DC: Author.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders, Text Revision* (4th ed., text rev.). Washington, DC: Author.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

Bauer, M. S., & Dunner, D. L. (1993). Validity of seasonal pattern as a modifier for recurrent mood disorders for *DSM-IV*. *Comprehensive Psychiatry*, *34*, 159–170. doi:10.1016/0010-440x(93)90042-3

Blazer, D. G., Kessler, R. C., & Swartz, M. S. (1998). Epidemiology of recurrent major and minor depression with seasonal pattern. *British Journal of Psychiatry*, *172*, 164–167.

Brancaleoni, G., Nikitenko, E., Grassi, L., & Hansen, V. (2009). Seasonal affective disorder and latitude of living. *Epidemiology and Psychiatric Science*, *18*, 336–343.

Burcusa, S. L., & Iacono, W. G. (2007). Risk for recurrence in depression. *Clinical Psychology Review*, *27*, 959–985. http://doi.org/10.1016/j.cpr.2007.02.005

Centers for Disease Control and Prevention. (2007). *Behavioral Risk Factor Surveillance System* (Data file and code book). Retrieved from http://www.cdc.gov/brfss/annual_data/annual_2006.htm

Centers for Disease Control and Prevention. (2011). *Behavioral Risk Factor Surveillance System. SMART: BRFSS city and county* (Data file and documentation). Retrieved from http://www.cdc.gov/brfss/smart/smart_2006.htm

Centers for Disease Control and Prevention. (2013). *Behavioral Risk Factor Surveillance System. BRFSS frequently asked questions*. Retrieved from http://www.cdc.gov/brfss/about/brfss_faq.htm#1

Dhingra, S. S., Kroenke, K., Zack, M. M., Strine, T. W., & Balluz, L. S. (2011). PHQ-8 days: A measurement option for *DSM-5* major depressive disorder (MDD) severity. *Population Health Metrics*, *9*, 11. doi:10.1186/1478-7954-9-11

Dooley, D., Prause, J., & Ham-Rowbottom, K. (2000). Underemployment and depression: Longitudinal relationships. *Journal of Health and Social Behavior*, *41*, 421–436.

Ekstrand v. School District of Somerset, No. 11-1949 (7th Cir., June 26, 2012).

Glaros, A. G., & Kline, R. B. (1988). Understanding the accuracy of tests with cutting scores: The sensitivity, specificity, and predictive value model. *Journal of Clinical Psychology*, *44*, 1013–1023.

Haggarty, J. M., Cernovsky, Z., & Husni, M. (2001). The limited influence of latitude on rates of seasonal affective disorder. *Journal of Nervous and Mental Disease*, *189*, 482–484. doi:10.1097/00005053-200107000-00011

Hansen, V., Skre, I., & Lund, E. (2008). What is this thing called "SAD"? A critique of the concept of seasonal affective disorder. *Epidemiologia e psichiatria sociale*, *17*, 120–127.

Hasin, D. S., Goodwin, R. D., Stinson, F. S., & Grant, B. F. (2005). Epidemiology of major depressive disorder: Results from the national epidemiologic survey on alcoholism and related conditions. *Archives of General Psychiatry*, *62*, 1097–1106.

Johnsen, M. T., Wynn, R., & Bratlid, T. (2012). Is there a negative impact of winter on mental distress and sleeping problems in the subarctic: The Tromsø Study. *BMC Psychiatry*, *12*, 225. doi:10.1186/1471-244X-12-225

Kasper, S., Wehr, T. A., Bartko, J. J., Gaist, P. A., & Rosenthal, N. E. (1989). Epidemiological findings of seasonal changes in mood and behavior. *Archives of General Psychiatry*, *46*, 823–833.

Kerr, D. C. R., Shaman, J., Washburn, I. J., Vuchinich, S., Neppl, T. K., Capaldi, D. M., & Conger, R. D. (2013). Two longterm studies of seasonal variation in depressive symptoms among community participants. *Journal of Affective Disorders*, *151*, 837–842. http://doi.org/10.1016/j.jad.2013.07.019

Kroenke, K., & Spitzer, R. L. (2002). The PHQ-9: A new depression diagnostic and severity measure. *Psychiatric Annals*, *32*, 509–515. doi:10.3928/0048-5713-20020901-06

Kroenke, K., Strine, T. W., Spitzer, R. L., Williams, J. B. W., Berry, J. T., & Mokdad, A. H. (2009). The PHQ-8 as a measure of current depression in the general population. *Journal of Affective Disorders*, *114*, 163–173. doi:10.1016/j.jad.2008.06.026

Levitt, A. J., & Boyle, M. H. (2002). The impact of latitude on the prevalence of seasonal depression. *Canadian Journal of Psychiatry*, *47*, 361–367.

Magnusson, A. (1996). Validation of the Seasonal Pattern Assessment Questionnaire (SPAQ). *Journal of Affective Disorders*, *40*, 121–129. doi:10.1016/0165-0327(96)00036-5

Magnusson, A., Axelsson, J., Phil, D., Karlsson, M., & Oskarsson, H. (2000). Lack of seasonal mood changes in the Icelandic population: Results of a cross-sectional study. *American Journal of Psychiatry*, *157*, 234–238. doi:10.1176/appi.ajp.157.2.234

Meehl, P. E. (1978). Theoretical risks and tabular asterisks: Sir Karl, Sir Ronald and the slow progress of soft psychology. *Journal of Consulting and Clinical Psychology*, *46*, 806–834.

Mersch, P. A., Middendorp, H. M., Bouhuys, A. L., Beersma, D. M., & Van den Hoofdakker, R. H. (1999). Seasonal affective disorder and latitude: A review of the literature. *Journal of Affective Disorders*, *53*, 35–48. doi:10.1016/S0165-0327(98)00097-4

Mersch, P. P. A., Vastenburg, N. C., Meesters, Y., Bouhuys, A. L., Beersma, D. G. M., van den Hoofdakker, R. H., & den Boer, J. A. (2004). The reliability and validity of the Seasonal Pattern Assessment Questionnaire: A comparison between patient groups. *Journal of Affective Disorders*, *80*, 209–219.

Murray, G. (2004). How common is seasonal affective disorder in temperate Australia? A comparison of BDI and SPAQ estimates. *Journal of Affective Disorders*, *81*, 23–28.

Nayyar, K., & Cochrane, R. (1996). Seasonal changes in affective state measured prospectively and retrospectively. *British Journal of Psychiatry*, *168*, 627–632.

Popper, K. (1962). *Conjectures and refutations: The growth of scientific knowledge*. New York, NY: Basic Books.

Posternack, M. A., & Zimmerman, M. (2002). Lack of association between seasonality and psychopathology in psychiatric outpatients. *Psychiatry Research*, *112*, 187–194. doi:10.1016/S0165-1781(02)00235-4

Rosen, L. N., Targum, S. D., Terman, M., Bryant, M. J., Hoffman, H., Kasper, S. F., . . . Rosenthal, N. E. (1990). Prevalence of seasonal affective disorder at four latitudes. *Psychiatry Research*, *31*, 131–144. doi:10.1016/0165-1781(90)90116-M

Rosenthal, N. E. (2009). Issues for DSM-V: Seasonal affective disorder and seasonality. *American Journal of Psychiatry*, *166*, 852–853. doi:10.1176/appi.ajp.2009.09020188

Rosenthal, N. E., Bradt, G. H., & Wehr, T. A. (1987). *Seasonal Pattern Assessment Questionnaire*. Washington, DC: National Institute of Mental Health.

Rosenthal, N. E., Sack, D. A., Gillin, J. C., Lewy, J. C., Goodwin, F. K., Davenport, Y., . . . Wehr, T. A. (1984). Seasonal affective disorder: A description of the syndrome and preliminary findings with light therapy. *Archives of General Psychiatry*, *41*, 72–80. doi:10.1001/archpsyc.1984.01790120076010

SAS Institute. (2008). *SAS/STAT 9.2 user's guide*. Cary, NC: Author.

Spitzer, R. L., & Williams, J. B. W. (1989). The validity of seasonal affective disorder. In N. E. Rosenthal & M. C. Blehar (Eds.), *Seasonal affective disorders and phototherapy* (pp. 79–84). New York, NY: Guilford.

Steinhausen, H., Gundelfinger, R., & Metzke, C. (2009). Prevalence of self-reported seasonal affective disorders and the validity of the seasonal pattern assessment questionnaire in young adults: Findings from a Swiss community study. *Journal of Affective Disorders*, *115*, 347–354. doi:10.1016/j.jad.2008.09.016

Thompson, C., & Cowan, A. (2001). The Seasonal Health Questionnaire: A preliminary validation of a new instrument to screen for seasonal affective disorder. *Journal of Affective Disorders*, *64*, 89–98. doi:10.1016/S0165-0327(00)00208-1

Thompson, C., Thompson, S., & Smith, R. (2004). Prevalence of seasonal affective disorder in primary care: A comparison of the seasonal health questionnaire and the seasonal pattern assessment questionnaire. *Journal of Affective Disorders*, *78*, 219–226. doi:10.1016/S0165-0327(02)00314-2

Twohey, M. (2010, March 3). Seasonal affective disorder increasingly a workplace issue. *Los Angeles Times*. Retrieved from http://articles.latimes.com/2010/mar/03/nation/la-na-sad-workplace4-2010mar04

U.S. Naval Observatory. (n.d.). *Earth's seasons: Equinoxes, solstices, perihelion, and aphelion, 2000–2020*. Retrieved from http://www.usno.navy.mil/USNO/astronomical-applications/data-services/earth-seasons

U.S. Naval Observatory, Astronomical Applications Department. (2014). *Duration of daylight/darkness table for one year*. Retrieved from http://aa.usno.navy.mil/data/docs/Dur_OneYear.php

Zachar, P., & Kendler, K. S. (2014). A DSM insider's history of premenstrual dysphoric disorder. In K. S. Kendler & J. Parnas (Eds.), *Philosophical issues in psychiatry III: The nature and sources of historical change* (pp. 350–370). Oxford, England: Oxford University Press.

Zubieta, J., Engleberg, N., Yargic, L., Pande, A., & Demitrack, M. A. (1994). Seasonal symptom variation in patients with chronic fatigue: Comparison with major mood disorders. *Journal of Psychiatric Research*, *28*, 13–22. doi:10.1016/0022-3956(94)90033-7