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Short communication

Obsessive compulsive disorder prevalence increases with latitude

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ABSTRACT

Many individuals with obsessive compulsive disorder (OCD) report difficulty falling asleep until later than desired. This may reflect a misalignment between the sleep-wake cycle and the natural light dark cycle. Delayed bedtimes are related to disruptions in cognitive processes, increases in repetitive negative thinking, and OCD symptoms. Misalignment is more common in higher latitudes. AIMS: We hypothesized that the prevalence of OCD would be positively correlated with latitude. A systematic review of the literature identified peer-reviewed publications with estimates of OCD prevalence in the general population. Twenty-four estimates of the lifetime prevalence of OCD were identified and showed that the prevalence of OCD was significantly positively correlated with latitude. Other potential alternative individual, community and study specific factors were not significantly correlated with OCD prevalence. Finally, parallel analyses of a "psychiatric control" (panic disorder) failed to find a significant relationship between panic disorder and latitude. Findings from this study support a relation between latitude and OCD and suggest potential specificity of the relation to OCD vs factors related to mental health concerns broadly. These findings are consistent with recent results suggesting that the timing of sleep may be important in OCD. Future work in this area is warranted.

There is increasing evidence that many individuals with obsessive compulsive disorder (OCD) frequently report an inability to go to sleep until later than desired. Several studies have shown that delays in the timing of sleep relative to the light-dark cycle are associated with increased OCD symptoms (Coles, Schubert, & Sharkey, 2012; Schubert & Coles, 2013, 2015). Further, an inability to go to sleep until later than desired has been linked to increased perseverative thinking (Nota & Coles, 2015), deficits in response inhibition (Nota, Schubert, & Coles, 2016), and poorer treatment response (Mukhopadhyay et al., 2008; Turner et al., 2007). Finally, case studies have shown that interventions that address sleep timing/circadian rhythms including behavioral interventions (Coles & Sharkey, 2011), light boxes (Brinkhuijsen, Koenegracht, & Meesters, 2003; Hoflich, Kasper, & Moller, 1992), and the medication agomelatine[1] (da Rocha & Correa, 2011; De Berardis et al., 2012; Fornaro, 2011; Fornaro, Prestia, Colicchio, & Perugi, 2010), lead to reductions in OCD symptom severity. In combination, these studies are consistent with a role of delayed sleep timing, and potentially circadian rhythm disruptions, in OCD.

Strong entrainment of our internal biological clocks, such as our sleep-week cycle, with the external environment of the light-dark cycle has been referred to as "the key to good behavioral, cognitive and emotional well-being" (Wirz-Justice, 2007) page 424. Disruptions in when we are exposed to light or inadequate exposure to light can lead to malentrainment and disruptions in both mood and cognitive functions (Harrison, Jones, & Waterhouse, 2007; Lo et al., 2012; Wirz-Justice, 2007). Maintaining alignment is dependent on repeated, strong, cues to adjust our internal clocks, such as regular exposure to sunlight in the morning.[2] Therefore, it is not surprising that living in more northern latitudes (i.e., areas with reduced sunlight), is associated with increased rates of misalignment of the circadian system (Hewig, Hagemann, Seifert, Naumann, & Bartussek, 2005; Reinberg, Ashkenazi, & Smolensky, 2007; Stokkan & Reiter, 1994). Further, misalignment of the sleep-wake cycle is believed to play a role in a variety of illnesses that have also been associated with latitude including cancer (Borisenkov, 2011a), multiple sclerosis (Simpson, Blizzard, Otahal, Mei, & Taylor, 2011), rheumatoid arthritis (GEO-RA Group, 2016), and mental health conditions such as non-seasonal major depression (Patten, Williams, Lavorato, Wang, & Bulloch, 2017) and characteristics of bipolar disorder (Kohno et al., 2012).

In the present paper, we examined whether there is an association

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[1] Agomelatine, a medication used for the treatment of depression, has been shown to shift circadian phase via melatonin agonism and $5HT_{2c}$ antagonism.(Fornaro et al., 2010) Recently, agomelatine has been utilized in case studies of treatment-resistant OCD as both an augmentation to SRI medication (da Rocha & Correa, 2011) and as a standalone treatment. (Fornaro, 2011) Fifty-seven percent of the cases (n = 7, collapsing across both studies) achieved significant (> 35%) reductions in Y-BOCS scores. Further, patients who reported subjective sleep disturbances at baseline were all treatment responders. (Fornaro, 2011).

[2] Although there are clearly many influences on circadian rhythms, light exposure is typically viewed as the most potent influence.

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between latitude and the lifetime prevalence rates of OCD in adults in published studies. Our primary aim was to test the hypothesis that the prevalence of OCD would be higher in regions further from the equator. We also conducted secondary analyses to look at other potential factors that could explain an apparent link between latitude and OCD. These included individual factors (Karno, Golding, Sorenson, & Burnam, 1988; Ruscio, Chiu, Stein, & Kessler, 2010) *gender and marital status*]; (Nestadt, Ch, Bienvenu, Cai, & Samuels, 1998) community factors [*socioeconomic status*]; (Ruscio, Stein, Chiu, & Kessler, 2010) [*gender, marital status, education*]) and study specific factors (sample size, year of publication, diagnostic interview, and diagnostic criteria employed). Finally, we tested whether a relation between latitude and OCD prevalence reflects factors related to mental health concerns broadly. Specifically, we conducted parallel analyses for panic disorder.

1. Methods

Literature searches were conducted to identify potential articles documenting the prevalence of OCD. The searches included publications through the year 2017. The following search terms were used: "obsessive compulsive disorder," "prevalence," "incidence," "epidemiological," and the names of 233 countries currently recognized at the time of the study. Titles returned from database searches were then examined for potential relevance to the study aims. Reviews of article reference sections were also conducted to identify additional studies that were potentially relevant to our study. The first author reviewed all studies for inclusion. Four project assistants were trained to extract the information from the articles and required to demonstrate proficiency by matching the PI on practice articles. The following data was extracted from each relevant article: lifetime prevalence, sample size, gender composition, marital status, and year of publication. No limit on publication date was imposed and attempts were made to identify and include articles published in languages other than English. In cases where overlap in the data were found, information was only taken from the primary source. Prevalence in each study was assessed by interview (e.g., CIDI, SCID, or DIS) and conformed to DSM III, DSM IV, or ICD-10 criteria for OCD. Exclusion criteria were as follows: (1) reporting only prevalence data in relations to other disorders (e.g., prevalence of comorbid OCD in schizophrenia); (2) reporting anxiety prevalence and not OCD specifically; (3) reporting only prevalence of symptoms within individuals with OCD (e.g., gender differences in OCD symptoms); (4) reporting only the prevalence of obsessions and/or compulsions but not whether they met full criteria for the disorder (e.g., whether there was significant interference or distress); and (5) treatment studies. After compiling the OCD estimates we paired each estimate to an estimate for panic disorder. For 58% (14/24) of the OCD estimates an estimate for panic disorder was also available from the study/dataset. For the remaining estimates we matched each OCD estimate to the most similar estimate for panic that we could find based on the region sampled, what year the data were published and the version of diagnostic criteria that were used.

Table 1
Relations of OCD prevalence with hypothesized correlates (latitude, sunlight) and hypothesized control variables (e.g., sample size, GDP.

Correlation of prevalence rate with…	OCD r	Psychiatric Controls r
Latitude	.64***	.03
Minimum hours of sun/day	−.51**	.03
Maximum hours of sun/day	.51 **	.01
Sample size (N)	.01	–
Year of data collection	− .12	–
% female	− .12	–
% married	.07	–
GDP	.28	–

Note. Psychiatric control group was comprised of individuals with Panic Disorder *** = $p \leq .001$, ** = $p \leq .01$, * = $p \leq .05$, N = 25.

Latitude for each nation, recorded as the absolute value of degrees from the equator, was extracted from Worldatlas (www.worldatlas.com). If a specific city or region was reported the corresponding latitude was used. If no information regarding specific locations within the country was provided, the latitude of the capital city was used. Estimates for the maximum and minimum number of hours of sunlight per day for each nation were extracted from the Astronomical Applications Department of the U.S. Naval Observatory website (http://www.aa.usno.navy.mil). The gross domestic product of each nation for which prevalence data were available was extracted from the International Monetary Fund World Economic Outlook (www.statisticstimes.com).

2. Analytic plan

Pearson product moment correlations were computed to examine the strength of relation between the prevalence of OCD and latitude and between prevalence of OCD and other potential confounding variables (e.g. GDP, hours of sunlight etc, see Table 1). ANOVAs were used to test whether the diagnostic interview, or the version of diagnostic criteria used were associated with different rates of OCD. In addition, pearson correlation coefficients were also calculated as above for the psychiatric control disorder (panic disorder).

3. Results

Initially, 117 studies were found that provided 138 prevalence estimates. A total of 81 studies were excluded because they did not provide new prevalence estimates for OCD in adults in a published paper (e.g., student papers, only presented prior data, only included youth, did not include OCD). This yielded 60 estimates of the prevalence of OCD,[3] with 24 of these being lifetime prevalence rates (see Table 2). The distribution of the estimates is shown in Fig. 1, which reflects that many of the estimates were from Asia and North America (6 and 10 estimates respectively) while there were far fewer from the other continents (n = 9 total). In addition, almost half of the estimates were from sites between 30° and 39° latitude (n = 11 estimates), 6 were from latitudes less than 29° and 8° were from 40° or higher.

Pearson correlation coefficients were then used to address the primary aims of the study with significance level set at $p < .05$. Consistent with our hypothesis, lifetime OCD prevalence was significantly associated with latitude, $r = .64$, $p < .001$. OCD was more common in regions further from the equator. In addition, both the maximum and minimum number of hours of sunlight per day was related to prevalence with longer periods of sunlight related to lower rates of OCD and shorter periods of sunlight with higher rates of OCD.

In order to rule out other potential alternative factors that could account for the increased prevalence of OCD we examined correlations between rates of OCD and individual factors (gender, marital status, see Table 2) and community factors (Gross Domestic Product, GDP) and study specific factors (sample size, year). None of these correlations were statistically significant. We also conducted 2 ANOVAs to examine potential differences due to study specific factors of diagnostic interview and diagnostic criteria. Both of these ANOVAs failed to reach statistical significance, diagnostic instrument: $F(4,18) = .98$, $p = .44$, Diagnostic criteria used, $F(3,18) = .58$, $p = .63$

Finally, we tested whether a relation between latitude and OCD prevalence reflects factors related to mental health concerns broadly. Specifically, we conducted parallel analyses for panic disorder (see Table 2). Findings did not support a relation between latitude and the

[3] Due to inconsistency in the type of prevalence rates provided (e.g, point prevalence, 1 month, lifetime, etc) it was impossible to use data from all of the studies. Therefore, given that lifetime prevalence estimates were the most commonly reported, we focus on them herein.

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