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Objective Sleep Patterns and Severity of Symptoms in Pediatric Obsessive Compulsive Disorder: A Pilot Investigation

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Abstract

Sleep disturbances are common among youth with anxiety disorders, yet objective assessments of sleep in children with obsessive compulsive disorder (OCD) have been the focus of scant research. We therefore compared a small group of non-medicated, non-depressed children with primary OCD (ages 7–11 years) to matched healthy controls using home-based actigraphy during a 7-day prospective assessment. Validated parent and child sleep measures also were collected, and associations among objective sleep variables and severity of obsessions and compulsions were examined. We found significantly fragmented sleep patterns in the OCD group compared to controls including reduced total sleep time (TST) and longer wake periods after sleep onset. Severity of compulsions showed a significant negative correlation with TST. These preliminary findings indicate the presence of sleep abnormalities in pre-pubescent OCD patients with potential implications for future examinations of early developmental processes and features of the disorder.

Keywords

obsessive compulsive disorder (OCD); objective sleep assessment; actigraphy; symptom severity; children

1. Introduction

Onset of obsessive compulsive disorder (OCD) can occur anytime from the preschool years through adulthood but at least a third of adults report an onset prior to adolescence (Rasmussen & Eisen, 1992). Although the clinical presentation of OCD in children is similar to that of adults, important differences also exist. For example, whereas OCD is equally common in adults of both genders (Castle, Deale & Marks, 1995), boys are more commonly affected than girls (ratio of 3:2) and have an earlier age of onset (Fireman, Koran, Leventhal & Jacobson, 2001; Geller et al., 1998; Last & Strauss, 1989; Masi et al., 2005). Children are also more likely to present with compulsions in the absence of specific obsessions (Geller et al., 1998; Last & Strauss, 1989), comorbid tics and attention deficit/ hyperactivity disorder (Fireman et al, 2001; Swedo, Rapoport, Leonard, Lenane, & Cheslow, 1989), while secondary depression is far more common in adult OCD patients (Mancebo et al. 2008).

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These collective differences designate a distinct neurodevelopmental subtype of OCD during childhood (Geller et al., 2001) and underscore the need for a developmental framework in examining the disorder's early pathophysiology.

Emerging neuroimaging investigations provide further evidence of discrete developmental differences. Hyperactivity in cortico–striatal–thalamic (CST) circuits, including the basal ganglia, orbitofrontal cortex, cingulate cortices, and caudate nuclei, is a relatively consistent finding in adults with OCD compared to controls (Maia, Cooney, & Peterson, 2008; Maltby, Tolin, Worhunsky, O'Keefe, & Kiehl, 2005; Whiteside, Port, & Abramowitz, 2004) and successful pharmacological treatment has been shown to result in decreased CST activity (Perani, et al. 1995). However, the opposite pattern (i.e., reduced activity) has been reported in pediatric OCD patients, with more severe patients showing the greatest decreases in CST activity (Gilbert et al., 2009). Neurodevelopmental differences have similarly been reported for specific structural involvement and grey and white matter abnormalities (Busatto et al., 2001; Carmona et al., 2007; Friedlander & Desrocher, 2006; Huyser, Veltman, de Haan & Boer, 2009). Although collective data are not conclusive, findings may be interpreted as the anatomical and functional expression of progressive and enduring OCD (Pujol et al., 2004).

One aspect of development that has failed to generate empirical investigation in early-onset OCD is sleep. Because early brain maturation, cortical plasticity and the regulation of emotional and behavioral responses are highly dependent upon adequate amounts of sleep (Dahl, 1996; Peirano & Algarin, 2007; Scher, Hall, Zaidman-Zait, & Weinberg, 2010), objective sleep data in pediatric samples may serve to inform several areas of inquiry including pathoetiologic models of the disorder. Early sleep disturbances are also dependably linked with the later development of a range of psychiatric problems, and anxiety disorders in particular (Gregory et al., 2004; 2005; Ong, Wickramaratne, Tang & Weissman, 2006; Wong, Brower, Nigg & Zucker, 2010), the specific mechanisms of which remain unknown.

A few studies have reported abnormal objective sleep patterns in adults with OCD, though it remains unclear whether comorbid depression may in fact account for these findings (Bobdey et al., 2002; Hohagen et al., 1994; Insel et al., 1982; Kluge, Schussler, Dresler, Yassouridis, & Steiger, 2007; Robinson, Walsleben, Pollack & Lerner, 1998). Objective sleep assessments in children with OCD are lacking, yet subjective reports indicate a significant portion of pediatric patients to experience problems sleeping (Alfano, Pina, Villalta & Zerr, 2010; Storch et al., 2008). In both children and adults, less sleep has been associated with greater OCD severity (Robinson et al., 1998; Storch et al., 2008). In the only published study of adolescents, the sleep patterns of 9 teenagers with OCD and matched healthy controls were compared (Rapoport et al., 1981). Reduced total sleep time, shortened latency to rapid eye-movement (REM) sleep, and longer sleep onset latencies were found in the OCD group. However, the use of an adolescent sample, together with the fact that most patients had a history of major depressive disorder, prohibits inferences for younger patients.

The current investigation aimed to preliminarily address this research gap by comparing the sleep of a small group of children with primary OCD and a matched, healthy control group. Children were between the ages of 7 and 11 years, did not meet criteria for comorbid major depressive disorder, and were not taking any psychotropic medications at the time of assessment. Naturalistic sleep patterns were assessed in the home environment over a week-long period using wrist actigraphs. Based on previous findings, we expected to find greater levels of sleep disturbance in children with OCD based on both objective and subjective measures. Associations among objective sleep variables and OCD severity also were examined, with significant correlations predicted for reduced total sleep time and more severe OCD symptoms.

2. Method

2.1. Participants

The sample included 12 children, ages 7 to 11 years; 6 met DSM-IV criteria for a primary diagnosis of OCD and 6 were recruited as controls matched for all demographic variables. Specifically, the groups were matched in terms of age, gender, race/ethnicity, family income, academic placement and parent marital status. Descriptive statistics and clinical characteristics are presented in Table 1. Controls completed the same diagnostic interview and battery of measures as children with OCD and were free of any psychiatric diagnoses, significant emotional/ behavioral problems, or medical problems.

The OCD sample was recruited from children presenting to the Child and Adolescent Anxiety Program (CAAP) at Children's National Medical Center in Washington, D.C. for assessment/treatment services. Diagnoses were determined based on structured diagnostic interviews (Anxiety Disorders Interview Schedule for DSM-IV: Child and Parent Versions; ADIS-C/P; Silverman & Albano, 1996), the Children's Yale –Brown Obsessive Compulsive Scale (CY-BOCS; Scahill et al., 1997) and a battery of self and parent report measures. Exclusion criteria included current treatment with any psychotropic medication (or other medication that might affect sleep patterns), comorbid bipolar disorder, psychosis, major depressive disorder (MDD), suicidal ideation, mental retardation or chronic medical illness.

All children with OCD (100%) had at least one additional psychiatric diagnosis. Secondary disorders included attention deficit/hyperactivity disorder (n=2), generalized anxiety disorder (n=2), social anxiety disorder (n=1), separation anxiety disorder (n=1), oppositional defiant disorder (n=1), and Tourette's disorder (n=1). Although no child met criteria for secondary MDD, one child did receive a comorbid dysthymia diagnosis. However, examination of sleep variable scores for this participant compared to the remaining OCD group did not reveal any significant differences.

2.2. Psychosocial Measures

2.2.1. The Anxiety Disorders Interview Schedule for DSM-IV: Child and Parent Versions—(ADIS-C/P; Silverman & Albano, 1996) was administered separately to all children and their parents to establish the presence of clinical diagnoses. Diagnoses were assigned by the clinician (i.e., licensed clinical psychologist, postdoctoral fellow, or doctoral student in clinical psychology) based on information from both the child and parent. Any discrepancies were addressed using procedures outlined by Silverman and Albano (1996). The ADIS-C/P generates impairment ratings for each diagnosis present using the Clinician Severity Rating (CSR, range = 0–8; ≥ 4 required to assign a diagnosis). A primary diagnosis is defined as the disorder with the highest CSR. Inter rater reliability for the ADIS-C/P is excellent (Silverman, Saavedra & Pina, 2001).

2.2.2. Children's Yale-Brown Obsessive Compulsive Scale—(CY-BOCS; Scahill et al., 1997) is a 10-item semi-structured measure used to evaluate the severity and interference of specific obsessions and compulsions. The CY-BOCS was administered with the parents and children together by the same clinician completing the ADIS-C/P. Clinician ratings yield a total score as well as two subscale scores (obsessions and compulsions). Each subscale consists of five items rated on a Likert scale (0 = none, 4 = extreme), for a score ranging from 0–20. Excellent reliability and validity estimates for the CY-BOCS have been reported (Storch et al., 2006; Yucelen et al., 2006).

2.2.3. Children's Depression Inventory—(CDI; Kovacs, 1985) is a 27-item self-report form used to assess cognitive, affective, and physical symptoms of depression in children

age 7 to 17 years. Total CDI scores were used in the current study. In both clinical and community samples, the CDI shows high internal consistency, test-retest reliability, and convergent and discriminant validity (Kovacs, 1991; Smucker, Craighead, Craighead, & Green, 1986; Craighead, Curry, & Ilardi, 1995).

2.3. Sleep Measures

2.3.1. Actigraphy—The ActiGraph GT1M (ActiGraph, Pensacola, FL) The GT1M is an accelerometer-based activity monitor that records movement (for up to 20 days) ranging in magnitude from 0.05 to 2.5 g's at a sample rate of 30 Hz. Data are stored by the unit until downloaded using ActiGraph software via USB cable. Downloaded data are scored using the algorithm developed by Sadeh and colleagues (1989) which is based on total activity counts obtained during 1-minute epochs. Actigraphy has been shown to be a reliable and valid method for assessing the naturalistic sleep of children and adults (Sadeh & Acebo, 2002; Sadeh, Raviv, & Gruber, 2000).

2.3.2. Children's Sleep Habits Questionnaire—(CSHQ; Owens, Spirito, & McGuinn, 2000a) is a parent-report measure of sleep problems that yields a total score as well as several subscale scores. CSHQ total scores above 41 are indicative of the presence of clinically significant sleep problems. The CSHQ has shown adequate internal consistency and reliability in clinic and community samples of children (Owens et al., 2000a).

2.3.3. Sleep Self Report—(SSR; Owens, Maxim, Nobile, McGuinn, & Msall, 2000b) is a 26-item child-report measure measuring the same sleep domains as the CSHQ. The SSR yields a total sleep problems score. It has shown good internal consistency and reliability (Owens et al., 2000b).

2.4. Procedures

Following the diagnostic evaluation, all participants wore actigraphs on their non-dominant wrist 24-hours a day during a continuous 7-day period. All children, together with a parent, also kept a sleep log during the one-week assessment to confirm actigraphy records. Sleep logs included nightly information about bedtimes, nighttime awakenings, daytime naps, and morning wake times. Actigraphy variables examined in the current study included bedtime/time in bed (TIB), total sleep time in minutes (TST), wake minutes after sleep onset (WASO), number of awakenings (NA), and duration of awakenings in minutes (DA). Study procedures were approved by the IRB at Children's National Medical Center.

2.5. Preliminary Analyses

An independent samples t-test was used to compare the total number of days with complete actigraphy data between the groups. A non-significant difference was found (see Table 2). Non-significant within group differences were also found for weekday versus weekend sleep. Actigraphy sleep variables were therefore averaged across the entire assessment period. Subjective sleep scores (CSHQ and SSR) were non-normally distributed (i.e., skew and kurtosis) so data were log transformed to meet test assumptions of normality.

Although no child with OCD had secondary MDD, we examined possible differences in depressive symptoms between the groups using total CDI scores. Results revealed significantly higher CDI scores among the OCD group ($M = 10.17$, $SD = 6.1$) compared to controls ($M = 1.00$, $SD = 1.2$) [$t(10) = -3.58$, $p < .01$]. Three of 6 (50%) children with OCD had CDI scores falling within or approaching the clinical range. Based on the potential mediating role of depression on sleep in adult OCD patients (Bobdey et al., 2002), CDI scores were used as a covariate in subsequent analyses.

3. Results

3.1. Objective Sleep Patterns

To address the study's primary aim, a multivariate analysis of covariance (MANCOVA) was conducted for all actigraphy variables (TIB, TST, WASO, NA, and DA). The overall model was significant [(F (1,9) = 6.69, $p < .05$; partial eta^2= .87]. Follow-up univariate tests indicated significant group differences for 3 of the 5 sleep variables examined in the model. On average, children with OCD evidenced significantly reduced TST, increased WASO and increased DA compared to controls. Differences for TIB and NA were non-significant, indicating similar bedtimes and number of nighttime awakenings between the groups. Means, standard deviations, and effect sizes for objective sleep variables are reported in Table 2.

3.2. Subjective Sleep Reports

Univariate ANCOVAs were used to compare CSHQ and SSR total scores between the groups. After controlling for depressive symptoms, the group difference for CSHQ scores was non-significant [(F (1,11) =.72, $p > .05$]. Similarly, SSR scores between the OCD and controls groups did not significantly differ [(F (1,11) =.60, $p > .05$]. See Table 2.

3.3. Associations among Sleep Variables and OCD Severity

Correlational analyses were conducted to investigate possible relationships among objective sleep variables and severity of OCD symptoms. Specifically, partial correlations were calculated for actigraphy variables and CY-BOCS obsessions and compulsions scores. The overall matrix revealed a significant negative association between TST and CY-BOCS compulsions [$r = -.97$, $p < .05$].

4. Discussion

The current study is the first (that we are aware of) to compare the objective sleep patterns of pre-pubescent children with primary OCD and a non-psychiatric control group. OCD patients were medically healthy, did not meet criteria for MDD, and were not taking any psychotropic medications. Thus, in lieu of a small sample size, sleep findings appear representative of the primary disorder of interest. On average, children with OCD received more than one hour less sleep than controls. Even though our data did not permit reliable assessment of sleep onset latency, the overall difference in TST was evidently due to the OCD group spending a greater amount of time awake during the night. Interestingly, while the total number of awakenings was similar across groups, the average duration of wake episodes was twice as long in children with OCD. These objective findings indicate the presence of significant sleep fragmentation and overall inadequate amounts of sleep in pediatric OCD patients worthy of further investigation.

After controlling for any depressive symptoms, parent report of sleep problems failed to differentiate the groups even though CSHQ scores for all children with OCD fell in the clinical range (Owens et al., 2000a). Similarly, despite having SSR scores suggestive of sleep difficulties (Owens et al., 2000b), the OCD group did not differ from controls on a self-report sleep measure. However, because our study was inadequately powered to detect anything but large differences, more research is needed to understand whether subjective sleep reports sufficiently reflect the objectively measured sleep patterns of children with OCD.

The strong negative association found for TST and CY-BOCS compulsions is somewhat novel. Robinson et al. (1998) reported a marginally-significant negative correlation (r=−.51)

between TST and total Y-BOCS scores in a sample of 13 non-medicated, non-depressed adults with OCD, though separate associations with specific types of symptoms were not examined. Even though pediatric patients sometimes present with compulsions only (Geller et al., 1998; Last & Strauss, 1989), all of the children in the current sample reported both obsessions and compulsions. While our findings require replication, it is interesting nonetheless to speculate on possible mechanisms linking insufficient sleep with more severe compulsive behaviors. Notably, sleep loss has the most profound effects on functions of the prefrontal cortex including the ability to monitor and inhibit behavior (see Muzur, Pace-Schott & Hobson, 2002). Since the same types of executive functioning deficits are established features of OCD (Andres et al., 2007; Greisberg & McKay, 2003; Huyser, Veltman, Wolters, de Haan, & Boer, 2010), behavioral inhibition of compulsions/rituals may be more likely to fail in combination with inadequate sleep.

Despite some strengths, a clear limitation of this pilot investigation is its small sample size and associated lack of statistical power. Although effect sizes for univariate tests of objective sleep variables provide some confidence that our results are clinically, in addition to statistically, significant, research among larger samples of children with OCD is necessary. Also, as discussed, research exists suggesting that sleep is more disrupted in patients with greater OCD severity (Storch et al., 2008; Kluge et al., 2007). Since 5 of the 6 patients in this study had CY-BOCS scores in the severe range, future research utilizing a broader array of pediatric patients will better elucidate this relationship. It is also feasible that the sleep of OCD patients in this study may have been more disrupted as a function of wearing the actigraph. However, because none of the children (or their parents) reported or demonstrated difficulty wearing the actigraph during the one-week assessment, this possibility seems unlikely.

In summary, objective findings indicate significantly disrupted sleep patterns in pre-adolescent children with OCD as well as an association with more severe compulsions. In light of the limited evidence for sleep abnormalities in adult patients, our preliminary findings appear to fit with a larger body of research highlighting distinct developmental differences in the presentation of OCD during childhood. Nonetheless, other actigraphy-based studies of sleep in the home environment are absent from the empirical literature. In this study we found significantly reduced total sleep among children with OCD compared to controls. This difference was primarily explained by nighttime awakenings that were more than twice as long in the OCD group. More research is required to establish the representativeness of these findings in larger samples of pediatric patients including possible associations with OCD symptomatology.

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Table 1

Demographic and Clinical Characteristics of the OCD and Control groups

	OCD Group	Control Group	*p* value
Age (M/SD)			< .05
	9.33 (1.86)	9.66 (.81)	
Gender (n/%)			<.05
Males	5 (83)	5 (83)	
Females	1 (17)	1 (17)	
Race/Ethnicity (n/%)			<.05
Caucasian	5 (83)	5 (83)	
African American	1 (17)	1(17)	
Family Income (n/%)			<.05
Less then $10, 000	1 (17)	0 (00)	
Between $50–100,000	0 (00)	2 (33)	
More than $100,000	5 (83)	4 (67)	
Marital Status (n/%)			<.05
Married to child's other parent	5 (83)	6 (100)	
Single	1 (17)	0 (00)	
Academic Placement (n/%)			<.05
Regular/mainstream	3 (50)	5 (83)	
Private	2 (33)	1 (17)	
Not reported	1 (17)	0 (00)	

Table 2

Means and Standard Deviations for Sleep Variables by Group controlling for Depressive Symptoms

	OCD Group	Control Group	*F*-value	Partial Eta^2
Total days of actigraphy	6.2	7.0	4.31	
Bedtime/Time in bed [TIB] (*M/SD* in military time)	22:32	22:20	0.14	.04
Total Sleep Time [TST] (*M/SD* in minutes)	389.0 (32.9)	480.0 (21.5)	32.15**	.65
Wake after sleep onset [WASO] (*M/SD* in minutes)	141.5 (36.9)	62.6 (26.6)	18.02**	.57
Number of Awakenings [NA] (*M/SD*)	21.5 (3.8)	21.3 (7.7)	0.03	.02
Duration of Awakenings [DA] (*M/SD* in minutes)	9.2 (2.1)	4.0 (.70)	32.17**	.59
CSHQ Total (*M/SD*)	54.8 (13.7)	38.0 (4.1)	0.72	.09
SSR Total (*M/SD*)	21.2 (5.4)	14.0 (1.7)	0.60	.07

Note:

** $p < .001$