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Inaccuracy Between Subjective Reports and Objective Measures of Sleep Duration and Clinical Correlates in Bipolar Disorder

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Abstract

Background: Sleep disturbances are common in Bipolar Disorder (BD) and are often assessed by self-report at clinic visits over the course of BD treatment. Self-report may be subject to recall bias based upon current mood/affect states. This study sought to identify the degree of inaccuracy between subjective and objective measures of sleep duration in those with and without BD, and to assess the demographic and clinical correlates of this inaccuracy.

Methods: Thirty-one individuals with BD and 54 healthy control (HC) participants reported on the number of hours slept a night over the past month and subsequently completed up to 14 days/nights of wrist actigraphy which provided an objective measure of sleep duration. We compared the subjective rating to the average of all nights of objective sleep duration, and correlated the magnitude of inaccuracy with demographic and clinical characteristics in the BD and HC groups.

Results: On average, both BD and HC groups overestimated their sleep, and there were no differences in inaccuracy between groups. In the BD group, greater inaccuracy was associated

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Contributors

CNK conceived of project, completed data analyses, and wrote the manuscript. LTE oversaw analyses, and wrote the manuscript. MZN wrote the manuscript. EEL, HKY, DW, and CAD provided feedback on the manuscript.

with lower functioning, even after controlling individually for objective and subjective sleep measures.

Limitations: Cross-sectional study, only focus on sleep duration, and less severe bipolar symptoms of sample.

Conclusions: Inaccuracy in reports of sleep duration was associated with lower functioning among BD patients. Better identifying discrepancies in reports of sleep duration in clinical practice could help in more efficient monitoring and management of BD symptoms.

Keywords

bipolar disorder; sleep; subjective; objective; inaccuracy

INTRODUCTION

Sleep disturbances are common in bipolar disorder (BD),[1] and clinically relevant as they exacerbate mood disturbances,[2] are associated with adverse events,[3] and hamper treatment effectiveness.[4] Hence, a central component of BD treatment/management is regulation of sleep and circadian patterns.[5]

Oftentimes, sleep is monitored through patient self-report (number hours slept a night). While providing some clinically useful information on patient's usual sleep, recall bias could yield over or under-estimates of true sleep duration possibly due to current affect.[6] Thus, there are reasons to expect those with BD have more inaccurate sleep duration estimates than those without. If inaccuracy is higher in BD patients, this might be a target of treatment to increase awareness of sleep to prompt compensatory actions. It is also important to identify subgroups of BD patients who have greater inaccuracy—these individuals could be targeted for more intensive sleep assessments.

Two studies explored misestimation of sleep timing in BD with conflicting results. Ritter and colleagues found, among euthymic participants, those with BD underestimated sleep duration as compared to healthy controls.[7] Gonzalez et al. found that subjective sleep duration in BD was consistent with that from wrist actigraphy, but greater depression was associated with greater inaccuracy.[8] Both studies assessed self-report sleep duration concurrently with wrist actigraphy, possibly less relevant to clinical settings where sleep duration is often asked retrospectively. In addition, because self-report of sleep duration was assessed nightly, results between the two studies may have been conflicting due to variations in when the participant self-reported their sleep (relative to their night of sleep). These studies also excluded patients based upon symptom severity. In our study, we use a single retrospective self-report of sleep duration (in BD and non-BD individuals) as it may be more clinically relevant than frequent estimations over time. Better understanding the extent to which sleep is inaccurately reported, and identification of patients with greatest inaccuracy, may identify patients needing more intensive sleep monitoring.

We investigated discrepancies between subjective and objective sleep duration. We characterized degree of inaccuracies by comparing subjective (self-report) and objective (wrist actigraphy) measures of sleep duration in BD compared to a healthy control (HC)

sample. We also examined correlates of sleep duration inaccuracy. We hypothesized subjects with BD would be more inaccurate (vs. HCs), and more severe BD symptoms would correlate with greater inaccuracy over and above any relationship to subjective or objective duration alone.

METHODS

Study design and participants

We used baseline data from a longitudinal study examining trajectories of cognitive and inflammatory response in BD. Subjects were recruited from outpatient clinics, community, and ongoing studies at our center. Exclusion criteria included acute illness or pregnancy, recent vaccination, history of dementia, seizures, Parkinson's, stroke, or head trauma, history of cancer treatment, uncontrolled diabetes/hypertension, among others. Each baseline evaluation consisted of a 2-week burst of assessments where participants had three clinic visits and completed wrist actigraphy to measure sleep. The study was approved by the UCSD IRB.

Our study included 31 BD patients and 54 healthy controls (HCs). BD patients were on average 49.9 (SD = 7.37) years old and had 14.4 (SD = 2.28) years education. Over half were female, and most (58.1%) Caucasian. Twenty-three percent were married/cohabitating. HCs averaged 47.4 (SD = 8.05) years old and had 15.4 (2.11) years education (see Supplemental Table 1 for additional measures).

Measures

Subjective sleep duration.—Subjective sleep duration came from one item on the Pittsburg Sleep Quality Index (PSQI): "Over the past month, how many hours of actual sleep did you get at night?"[9]

Objective sleep duration.—We employed wrist-worn actigraphy which utilizes a device called an actisleep-BT (Actigraph, Pensacola, FL) with a sensitive tri-axial accelerometer that continuously detects movement allowing for approximation of sleep/wake patterns each night using previously validated algorithms.[10] The wActiSleep-BT has been validated against polysomnography.[11] Subjects wore device for up to 14 nights. Each night's data was processed to provide an estimate of nightly total sleep time (time in minutes a subject was asleep). Our objective estimate was the average duration of all nights recorded over the two-weeks.

Covariates.—We assessed age, education, gender, race/ethnicity, and marital status. The BD group also reported age of onset (from which we calculated illness duration), and lifetime number of manic, depressive, and mixed episodes. BD group also completed the Young Mania Rating Scale (YMRS),[12] Hamilton Depression Rating Scale (HAM-D),[13] Brief Psychiatric Rating Scale (BPRS),[14] MATRICS cognitive battery[15] (we used the global cognitive and working memory T-scores), and a clinician-rated global assessment of functioning.

Analyses

We assessed correlations between subjective and objective sleep duration, and compared between BD and HC groups. Second, we subtracted the subjective from the objective sleep duration variable. Because few subjects were under reporters (N=28, 32.9%) and proportion of under reporters was comparable in groups (38.7% for BD, 29.6% for HC, $\chi^2_{(1)}$=0.735, p=0.391), we took the absolute value of discrepancy as our measure of the degree of inaccuracy. We compared absolute inaccuracy between BDs and HCs using t-tests. Third, within groups, we correlated demographic/clinical characteristics (predictors) with absolute inaccuracy (outcome) using linear regression. We also computed regression models with objective and subjective sleep duration as outcomes. Bonferroni corrections accounted for multiple comparisons. Finally, to determine whether associations with inaccuracy were driven by relationships with individual components of the inaccuracy value (i.e., subjective and objective sleep duration), we repeated analyses for significant variables while controlling for subjective or objective sleep duration.

RESULTS

BD subjects self-reported 7.0 (SD=2.05) hours sleep, but had 6.5 (SD=1.25) hours objective total sleep time. HCs self-reported 7.1 (SD=1.03) hours sleep, and had 6.8 (SD=0.95) hours total sleep time. Subjective and objective sleep duration were correlated ($r_{(83)}$=0.25, p=0.022), and while not significant in the BD ($r_{(29)}$=0.26, p=0.162) and HC ($r_{(52)}$=0.24, p=0.076) groups individually, correlations showed moderate effect sizes. Most subjects overreported sleep duration relative to objective duration (67.1%). When examining absolute inaccuracy, there were no significant differences between BD and HC groups (Figure 1).

In BD, greater absolute inaccuracy was significantly associated with lower education, higher depression, and lower functioning (Table 1). There was a marginally significant relationship between the BPRS and inaccuracy as well. After Bonferroni correction, only functioning remained significant (Supplemental Figure 1)—every ten-point decrease in GAF score was associated with 30 additional minutes of inaccuracy. In HCs, no covariates were correlated with inaccuracy. There were no significant relationships between covariates and objective and subjective sleep duration for BDs (Table 1), but there were associations between gender and race/ethnicity with objective sleep duration for HCs. After controlling for subjective and objective sleep duration, functioning in BDs remained significant (B=−0.04, 95% CI=−0.07, −0.01, p=0.012 controlling for subjective duration; B=−0.05, 95% CI=−0.08, −0.02, p=0.005 controlling for objective duration), indicating correlations were due to inaccuracy and not solely underlying components contributing to the inaccuracy measure. Finally, given there is some evidence to suggest that depression and other psychopathology is correlated with functioning in BD patients,[16] and that prior to Bonferroni correction a relationship was found between HAM-D (and to a lesser extent BPRS) with inaccuracy, we conducted analyses examining functioning with inaccuracy after controlling for these variables. Results showed functioning to still be associated with inaccuracy (B=−0.04, 95% CI=−0.07, −0.00 after controlling for HAM-D; B=−0.04, 95% CI=−0.08, −0.01 after controlling for BPRS).

DISCUSSION

This study characterized degree of inaccuracy of subjective report of sleep duration compared to objective measurement in BD and HC groups, and identified characteristics associated with greater inaccuracy. Most subjects over-reported sleep duration, but inaccuracy between BD and HCs did not differ. Some with BD showed higher inaccuracy, and those with higher inaccuracy also exhibited lower functioning—an association remaining significant even after accounting for subjective and objective sleep duration. Findings suggest inaccuracy in sleep duration estimation is common, but in BD, higher inaccuracy is associated with lower functioning.

We hypothesized greater inaccuracy in BDs compared to HCs. Results did not support this hypothesis, suggesting BD itself does not predispose a patient to be inaccurate in estimating sleep duration. There was substantially more variability in over-/under-estimation of sleep duration in BD suggesting differences between BDs and HCs may exist for certain subgroups. Additionally, individuals agreeing to be in a study using wrist actigraphy may be different from those who do not (e.g., more accurate sleep estimation) possibly leading to more similar BD and HC groups.

Functioning was correlated with absolute inaccuracy in BD. Studies examining perceptions of sleep duration show individuals are inaccurate in estimating sleep timing, potentially due to reporting what is believed to be usual for the population rather than one's own sleep.[17] Inaccuracy being correlated with functioning may be from disorganization or problems with time estimation affecting both duration estimation and everyday functioning. Of note, inaccuracy was not associated with both global cognition and working memory meaning that any impact of functioning on inaccuracy was distinct from cognitive deficits.

Observed relationships between functioning and inaccuracy persisted after controlling for subjective and objective sleep duration, suggesting inaccuracy itself may capture a unique feature related to BD clinical characteristics. Indeed, there were no significant relationships between correlates and objective (except for gender and race/ethnicity in the HC group) and subjective sleep duration. It could be expected that the more inaccurate one is in estimating sleep duration, the less equipped one is to make compensatory actions for managing fatiguing effects of poor sleep. There is an interesting parallel in the literature on subjective versus objective cognitive abilities and functioning among those with schizophrenia.[18] Harvey and colleagues found overestimation of objective cognitive abilities was associated with lower functioning, perhaps from failure to compensate for under-recognized deficits.[18] If future studies find a causal link between sleep estimation inaccuracy and functional outcomes, the inaccuracy could be a target for intervention for improving BD outcomes.

Clinicians may consider objective sleep measurement to monitor BD patients, especially those with greater propensity for inaccuracy. It may be important to consider making improvements of sleep reporting accuracy as a treatment target, helping the patient monitor, compensate, and manage sleep disturbances and BD symptoms. Past studies show greater insight into illness improves social functioning.[19] Our study suggests insight about one's sleep may also improve outcomes.

Some limitations should be noted. First, subjective sleep duration was assessed over prior month while objective duration was assessed over subsequent two-weeks. If there was aberrant sleep during wrist actigraphy, this may result in greater apparent inaccuracy. However, patients in clinic are usually asked retrospectively to describe habitual sleep duration, so our method may have more clinical relevance than concurrent assessment via sleep diaries. Second, our focus was sleep duration, but there are other aspects of sleep (including sleep fragmentation) which may also be important and could influence sleep duration self-reports. We could not assess these as our subjects were not asked to estimate these indices on same time scale (e.g., percent of time spent asleep at night). In a similar vein, our subjects were not assessed for obstructive sleep apnea, which commonly worsens sleep fragmentation, and may influence a person's perceptions of their usual sleep timing—future research should account for sleep apnea. Third, our study was cross-sectional. Fourth, wrist actigraphy only assesses movement as a proxy for sleep activity, however, sleep duration gathered via accelerometry is generally accurate when compared to lab-based objective sleep measures.[11] Fifth, we did not have data on depressive symptoms in the HC group and the group as a whole reported very low levels of "sadness" on cell phone surveys, thus we are unable to determine whether there was a similar relationship between depression and degree of misestimation in the HC group to that seen in the BD group. Finally, BD symptoms in our sample were low which may not generalize to those with BD but not in treatment or those experiencing severe BD symptoms.

Overall, we showed lower-functioning people with BD are less accurate in estimating sleep duration, necessitating future research to assess inaccuracy in other types of sleep characteristics and examine clinical correlates in discrepancies of these other indices. Better identifying discrepancies in sleep duration reporting could inform clinical management and improve the lives of those with BD.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Conflict of Interest

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Highlights

- Those with and without bipolar disorder over-estimated objective sleep duration; no differences between groups
- In bipolar disorder, greater inaccuracy was associated with lower functioning
- Functioning was related to inaccuracy above and beyond objective and subjective sleep duration individually

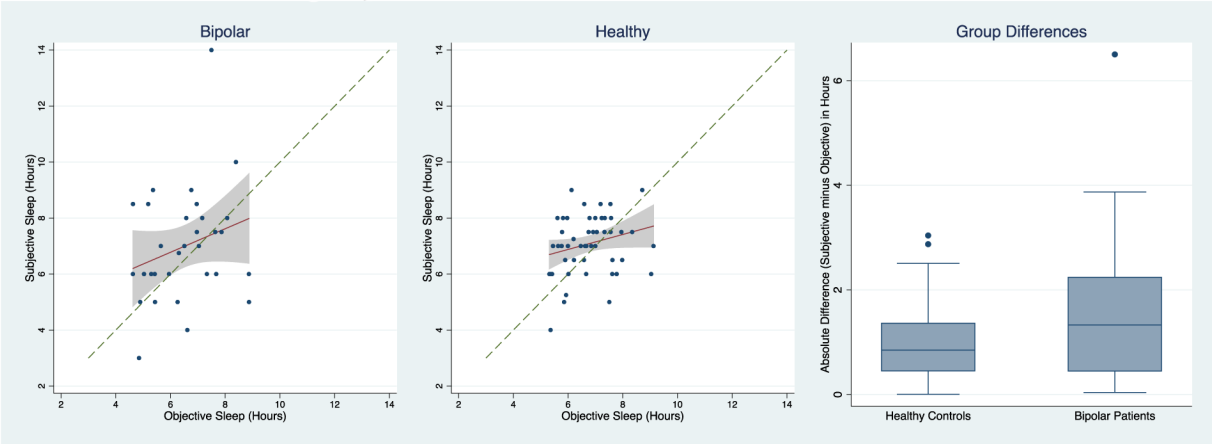

Figure 1.

Correlations between subjective and objective sleep duration in bipolar patients and healthy controls and absolute discrepancy scores.

Notes: Green dashed line corresponds to line of unity. Red solid line represents fitted regression line. Shaded area represents 95% confidence interval.

Table 1.

Demographic and clinical correlates of inaccuracy in subjective and objective total sleep time in bipolar patients.

	Absolute Inaccuracy		*Objective*		*Subjective*	
Variable	**B (95% CI)**	***p*-value**	**B (95% CI)**	***p*-value**	**B (95% CI)**	***p*-value**
Age	−0.06 (−0.13, 0.02)	0.128	0.02 (−0.05, 0.08)	0.577	−0.04 (−0.15, 0.06)	0.417
Education	**−0.25 (−0.48, −0.02)**	**0.034**	0.17 (−0.02, 0.37)	0.082	0.07 (−0.27, 0.41)	0.671
Gender						
Female	Ref.		Ref.		Ref.	
Male	0.22 (−0.90, 1.34)	0.688	−0.34 (−1.28, 0.60)	0.461	0.97 (−0.53, 2.48)	0.196
Race/Ethnicity						
Caucasian	Ref.		Ref.		Ref.	
Non-Caucasian	0.61 (−0.49, 1.71)	0.265	−0.20 (−1.15, 0.74)	0.665	−0.48 (−2.02, 1.06)	0.526
Marital Status						
Single/Divorced/Separated/Widowed	Ref.		Ref.		Ref.	
Married/Cohabitating	0.63 (−0.70, 1.96)	0.338	0.12 (−1.00, 1.24)	0.826	0.20 (−1.66, 2.06)	0.827
Age of Onset	−0.02 (−0.10, 0.06)	0.567	−0.01 (−0.07, 0.06)	0.805	−0.04 (−0.14, 0.07)	0.474
Duration of Illness	−0.02 (−0.08, 0.04)	0.495	0.01 (−0.04, 0.06)	0.575	0.00 (−0.08, 0.08)	0.942
Young Mania Rating Scale (YMRS)	0.01 (−0.09, 0.11)	0.807	−0.02 (−0.11, 0.06)	0.583	−0.05 (−0.19, 0.08)	0.424
Hamilton Depression Rating Scale (HAM-D)	**0.06 (0.02, 0.11)**	**0.011**	0.03 (−0.01, 0.08)	0.114	0.06 (−0.02, 0.13)	0.119
Brief Psychiatric Rating Scale (BPRS)	0.06 (−0.00, 0.12)	0.059	0.03 (−0.03, 0.08)	0.326	0.01 (−0.08, 0.10)	0.909
Current Global Assessment of Functioning (GAF) Score	**−0.05 (−0.08, −0.02)**	**0.003** *	−0.02 (−0.05, 0.01)	0.248	−0.03 (−0.08, 0.01)	0.151
# Mania Episodes	−0.00 (−0.01, 0.01)	0.391	−0.01 (−0.02, 0.00)	0.173	0.00 (−0.02, 0.01)	0.524
# Depressive Episodes	−0.00 (−0.01, 0.01)	0.449	0.00 (−0.01, 0.01)	0.810	−0.01 (−0.02, 0.01)	0.372
# Mixed Episodes	−0.00 (−0.02, 0.01)	0.601	0.00 (−0.02, 0.01)	0.777	0.01 (−0.02, 0.04)	0.583
Global Cognitive T-Score	−0.01 (−0.08, 0.06)	0.758	−0.01 (−0.07, 0.04)	0.636	0.03 (−0.06, 0.12)	0.522
Working Memory T-Score	−0.04 (−0.09, 0.01)	0.111	−0.01 (−0.06, 0.04)	0.686	−0.02 (−0.09, 0.06)	0.650

Notes: Based upon absolute inaccuracy, B = beta coefficient from linear regression model, CI = Confidence Interval, Higher beta coefficients correspond to higher absolute inaccuracy.

* = Statistically significant after Bonferroni correction