Comprehensive Psychiatry 112 (2022) 152270

Contents lists available at ScienceDirect

Comprehensive Psychiatry

journal homepage: www.elsevier.com/locate/comppsych

Assessment of subjective sleep quality and issues in aggression: Intermittent Explosive Disorder compared with psychiatric and healthy controls

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ARTICLE INFO

Keywords:
Aggression
Intermittent Explosive Disorder
Sleep quality
Sleepiness

ABSTRACT

Background: While prior research has linked clinical sleep issues and aggression, little is known about how clinical sleep issues among individuals with Intermittent Explosive Disorder (IED), which is characterized by a pervasive pattern of impulsive aggression and associated with consequences across multiple life-domains. The present study aims to examine clinical sleep issues among individuals with IED in contrast to individuals with other psychopathology and healthy controls.

Methods: 257 adults, including 100 healthy controls, 85 psychiatric controls and 72 individuals with IED, took part in this study. Participants completed the Structured Clinical Interview for DSM-V Diagnoses, Assessment of clinical sleep issues included the Pittsburgh Sleep Quality Inventory (PSQI), obstructive sleep apnea (OSA) screening, and the Epworth Sleepiness Scale (ESS) as well as assessments of aggression and impulsivity.

Results: IED study participants reported significantly worse sleep quality, increased sleep latency, greater daytime sleepiness and symptoms of OSA. Daytime sleepiness and sleep quality was correlated with impulsivity and aggression.

Conclusions: This study suggests that individuals with IED have clinically relevant sleep anomalies, and that these are directly associated with measures of impulsivity and aggression. Clinicians treating aggressive individuals are advised to assess and treat such individuals for sleep issues.

1. Introduction

Sleep problems have been posited as a potential factor in the cause and maintenance of aggressive behavior [1–4]. Sleep deprivation has been shown to influence interpersonal responses to frustration by impacting prefrontal cortex functioning and control of emotion [5]. In addition, prior research suggests that clinical sleep issues may differentially impact individuals with externalizing psychopathology, further increasing their potential for aggressive behavior [1,6,7]. In one study, males with antisocial personality disorder (APD) had greater self-report of impaired sleep quality than did healthy controls and subjective poor sleep quality was strongly associated with increased aggression among APD participants [6]. Reduced quantity and quality of sleep were both associated with increased hostility and aggression among incarcerated male adolescents [7]. Conversely, sleep improvement may be useful in decreasing impulsive aggression and case series have demonstrated reduced aggressive behavior among violent individuals following treatment of clinical sleep issues [8,9]. Despite this, little has been established about the effect of clinical sleep issues on aggressive behavior among individuals with Intermittent Explosive Disorder (IED).

IED is a pervasive, long-term pattern of impulsive aggression which is problematic and contributes to a broad spectrum of dysfunction; commonly including life-consequences in occupational, legal, financial, and social domains [10,11]. Among adults in the United States the estimated prevalence of IED is 4.0% (lifetime) and 2.6% (past-year) [10]. Additionally, another similarly sized group exhibit recurrent impulsive aggression despite failing to meet full DSM-5 IED criteria [12]. In light of these epidemiological findings, it is clear that recurrent impulsive aggression impacts a significant segment of the population.

The neurobiology of IED is thought to involve dysfunction of circuits involved in executive function and emotional control as well as dysregulation of serotonergic neurotransmission [13–15]. These neural underpinnings of IED thus, raise the likelihood that this disorder may be associated with clinically relevant sleep issues. Prior work suggests the deleterious impact of lost sleep on executive function, regulation of aggression and serotonergic function may mediate the association

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https://doi.org/10.1016/j.comppsych.2021.152270

Available online 8 September 2021

between lost sleep and aggression in non-IED samples [1,16]. The present study aims to explore clinical sleep issues including those associated with obstructive sleep apnea in study participants with DSM-5 IED compared with non-aggressive healthy and psychiatric controls. We hypothesized that individuals with IED would have elevated scores on measures of sleep quality and sleepiness compared with non-aggressive psychiatric and healthy controls. We also hypothesized that these findings would not be due to depression or body mass index. Finally, we anticipated that these sleep variables would be associated with aggression and impulsivity.

2. Methods

2.1. Study participants

Participants were 257 physically healthy adults recruited to a larger study investigating impulsive aggression. Participants gave informed consent and were assessed regarding aggression and other related behaviors and psychological issues. Recruitment occurred via public announcements, print and other media, with solicitations requesting individuals endorsing: a) psychosocial problems connected to anger or, b) no personal history of psychopathology. The Institutional Review Board at the University of Chicago granted approval for this protocol.

2.2. Diagnostic assessment

DSM-5 criteria [17] were employed for psychiatric diagnosis using information from: (a) the Structured Clinical Interview for DSM Diagnoses (SCID) [18] (b) a diagnostic assessment and, (c) a review of clinical data. Research interviews were administered by a master's or doctorate-level degree holder in Clinical Psychology. All raters underwent rigorous training. These procedures resulted in good to excellent interrater reliability (kappa 0.84 ± 0.05; with range of 0.79–0.93) comprising anxiety, substance use, mood, and impulse control disorders. Ultimately, diagnoses were given by research psychiatrists and clinical psychologists (team-best estimate consensus protocol) [19]. Current substance use disorder, lifetime diagnosis of intellectual disability, bipolar disorder, or psychotic disorder, because these are mutually exclusive with IED.

One hundred Healthy Controls (HC) (no psychiatric diagnosis) and 85 Psychiatric Controls (PC) (non-aggressive psychiatric disorder), and 72 IED participants were identified after diagnostic assessment. Of IED and PC study participants, a majority (72.3%) reported previous psychiatric assessment or care (56.1%) or a mental health disturbance for which they did not undergo assessment or care despite others thinking they should (16.2%).

2.3. Clinical sleep issues

Assessment of clinical sleep issues included the Pittsburgh Sleep Quality Inventory (PSQI) [20] and the Epworth Sleepiness Scale (ESS) [21]. The PSQI is a widely used questionnaire about sleep habits and issues in the past month. It includes nine multi-item sleep related questions as well as five screening questions assessing obstructive sleep apnea (OSA). PSQI has a Total Score ranging from 0 to 21, and seven components: a) subjective sleep quality (i.e., 0 = very good to 3 = very bad); b) sleep duration; c) sleep latency; d) sleep efficacy; e) sleep disturbance; f) sleep aid medication; g) sleep-related daytime problems. The latter four parts are scored using a 0–3 Likert scale (0 = absent past month; 1 = less than once weekly; 2 = once or twice weekly; 3 = three or more weekly). PSQI OSA screening questions, not part of the total PSQI score, represent participants' report of what their sleep partners tell them about their sleep behavior (i.e., loud snoring; long intervals between breaths; legs twitching/jerks during sleep; disorientation/confusion during sleep; and restlessness during sleep). These items were scored on a 0–3 Likert scale (0 = none during past month; 1 = less than once weekly; 2 = one or two times weekly; 3 = three or more times weekly). The ESS is an eight-item Likert scale assessment of daytime sleepiness (i.e., 0 = no likelihood of dozing off to 3 = high likelihood of dozing off) in various situations (e.g., while sitting reading; while watching TV) and yields a total score from 0 to 24. It is widely used and has good psychometric properties.

2.4. Aggression and impulsivity

The Aggression subscale of the Life History of Aggression assessment (LHA) [22] and the Aggression (Physical and Verbal) subscale from the Buss-Perry Aggression questionnaire (BPA) was used to measure aggression [23]. The LHA assesses prior aggressive behavior and BPA characterizes trait aggressiveness as a feature of personality. Impulsivity was determined using the Life History of Impulsive Behavior (LHIB) [24] and Barratt Impulsivity Scale (BIS) [25]. The LHIB counts the times a person has engaged in impulsive behavior. BIS-11 characterizes participants' propensity for impulsivity. The psychometric properties of these instruments are good to excellent.

2.5. Statistical analyses

Parametric and nonparametric methods were used to analyze and compare between-group data. Chi-Square (χ^2) tests assessed group differences (IED & PC) in sample characteristics (i.e. sex, ethnicity, and psychological diagnoses), with post-hoc single df χ^2. Analyses of variance and covariance (ANOVA/ANCOVA) assessed other sample characteristics and psychometric values. The first analysis was performed on the PSQI Total Score using ANCOVA. Follow-up analyses were similarly performed on the seven PSQI components, on the PSQI OSA screen score, and on the ESS Total Score. A composite score for Aggression and Impulsivity was generated by taking the mean *Z*-score of the sets of variables (LHA/BPA and LHIB/BIS). Significance was set with a two-tailed alpha (α) value of 0.05, unless noted. SPSS software (Version 27.0, SPSS. Inc.) was used to perform all analyses.

3. Results

3.1. Sample characteristics

IED and control groups did not differ by age or sex, but did differ by ethnicity and socioeconomic score with IED study participants having the lowest proportion of whites and the lowest SES scores (Table 1). Accordingly, subsequent analyses co-varied for all demographic characteristics. As expected, aggression and impulsivity (LHIB/BIS-11) were elevated in IED study participants when contrasted with PC and with HC groups. IED and PC groups also significantly varied in history of Current and Lifetime PTSD, and Lifetime SUD. However, rates of comorbidity between IED and PC groups did not differ significantly. Table 3 contains

Table 1
Demographic and BMI characteristics of study participants.

	HC (N = 100)	PC (N = 85)	IED (N = 72)	P	Group differences
Age	32.2 ± 8.7	31.4 ± 9.3	34.8 ± 10.9	=0.058	HC = PC = IED[a]
Gender (% Female)	54.0%	62.4%	55.6%	=0.492	HC = PC = IED[b]
Race (% White)	61.1%	60.0%	30.6%	<0.001	HC = PC > IED[b]
SES score	48.9 ± 10.2	46.2 ± 11.8	38.4 ± 12.9	<0.001	HC = PC > IED[a]
Body mass index	26.4 ± 4.8	25.7 ± 4.6	27.8 ± 5.8	=0.037	HC = IED/PC; IED > PC[a]
Normal BMI (% BMI ≤ 25.0)	40.0%	47.1%	36.1%	=0.362	HC = PC = IED[b]

details of DSM-5 disorders among participants.

3.2. PSQI scores (Table 2)

PSQI Total Score differed significantly among study participants with IED participants scoring highest compared with PC and HC controls who did not differ from each other. Examined as a function of clinically abnormal PSQI score, [20] three quarters of IED (75%), compared with about half of PC (51.8%) and HC (57.0%), participants had a PSQI Score > 5 ($X^2 = 9.54$, df $= 2$, $p = 0.008$). Given the known association between current depressive syndromes and sleep difficulty we removed the 20 participants with a current depressive syndrome from this analysis and found that PSQI Total Scores remained significantly higher in IED compared with control participants (7.11 ± 2.92 vs. 6.06 ± 2.64; F [1231] = 6.14, p = 0.014). Despite the observation that IED study participants had a greater frequency of comorbid PTSD (current and lifetime) and comorbid Substance Use Disorder (lifetime), neither diagnostic condition was associated with a significantly higher PSQI Total Score compared with controls.

3.3. PSQI components (Table 2)

Among the seven PSQI component scores all but one, was statistically different among the groups. With five PSQI components, IED participants were significantly different than HC/PC (Subjective Sleep Quality), significantly different from HC (Sleep Disturbance, Daytime Dysfunction), or significantly different from PC (Sleep Duration, Sleep Latency).

Table 2
Sleep and behavioral variables in study participants.

	HC (N = 100)	PC (N = 85)	IED (N = 72)	P	Group differences
Sleep variables					
PSQI global score	6.26 ± 2.68	6.14 ± 2.96	7.62 ± 3.22	=0.005	HC = PC < IED[a]
PSQI component scores					
Subjective sleep quality	0.96 ± 0.59	0.96 ± 0.65	1.30 ± 0.69	=0.002	HC = PC < IED[a]
Sleep latency	1.08 ± 0.82	0.96 ± 1.01	1.34 ± 0.93	=0.039	HC = PC; PC < IED[a]
Sleep duration	0.72 ± 0.82	0.42 ± 0.56	0.74 ± 0.75	=0.006	HC > PC; IED > PC[a]
Sleep efficacy	1.07 ± 0.96	0.72 ± 0.83	0.98 ± 0.88	=0.024	HC > PC; IED = PC[a]
Sleep disturbance	1.03 ± 0.36	1.31 ± 0.54	1.44 ± 0.65	<0.001	HC < IED; IED = PC[a]
Sleep medication	0.23 ± 0.69	0.45 ± 0.91	0.38 ± 0.77	=0.149	HC = PC = IED[a]
Daytime dysfunction	1.17 ± 0.45	1.32 ± 0.66	1.44 ± 0.69	=0.020	HC < IED; IED = PC[a]
OAS/Sleepiness scores					
PSQI sleep apnea screen	1.16 ± 2.07	1.26 ± 2.09	2.28 ± 3.06	=0.009	HC = PC < IED[a]
ESS total score	6.50 ± 3.69	7.66 ± 4.64	9.31 ± 4.40	< 0.001	HC = PC < IED[a]
Psychometric variables					
LHA aggression	4.1 ± 3.1	6.5 ± 4.9	17.9 ± 4.2	<0.001	IED > PC > HC[a]
BPA aggression	26.4 ± 7.2	30.3 ± 8.8	41.9 ± 130	<0.001	IED > PC > HC[a]
LHIB impulsivity	26.4 ± 7.2	37.5 ± 14.0	53.9 ± 22.3	=0.001	IED > PC = HC[a]
BIS-11 impulsivity	54.0 ± 9.4	60.8 ± 10.3	68.0 ± 12.3	<0.001	IED > PC > HC[a]

Table 3
DSM-5 disorder diagnoses among study participants.

	PC (N = 85)	IED (N = 72)	P
Current disorders:			
Any depressive disorder	8 (9.4%)	12 (16.7%)	=0.174
Any anxiety disorder	20 (23.5%)	18 (25.0%)	=0.831
Post-traumatic stress disorder	5 (5.9%)	16 (22.2%)	=0.003*
Obsessive-compulsive disorders	1 (1.2%)	3 (4.2%)	=0.236
Eating disorders	0 (0.0%)	0 (0.0%)	=0.999
Non-IED impulse control disorders	0 (0.0%)	4 (2.5%)	=0.028
Lifetime disorders:			
Any depressive disorder	46 (54.1%)	40 (55.6%)	=0.857
Any anxiety disorder	34 (40.0%)	22 (30.6%)	=0.218
Any substance use disorder	15 (17.6%)	32 (44.4%)	<0.001*
Post-traumatic stress disorder	21 (29.2%)	6 (7.1%)	<0.001*
Obsessive-compulsive disorders	2 (2.4%)	4 (5.6%)	=0.287
Eating disorders	4 (4.7%)	1 (1.4%)	=0.238
Non-IED impulse control disorders	1 (1.2%)	7 (9.7%)	=0.015

* $p < 0.05$ after correction for multiple comparisons (uncorrected $p < 0.004$).

3.4. ESS daytime sleepiness and PSQI obstructive sleep apnea (OSA) scores (Table 2)

Total ESS, and PSQI OSA, scores were significantly different among the groups with IED participants having higher scores than either PC or HC participants. These differences, respectively remained even after body mass index (BMI) was added as a covariate (F [2249] = 8.29, $p <$ 0.001, F [2,249] = 5.15, p = 0.005). The percentage of IED (34.7%) participants with clinically elevated ESS scores [21] (i.e., at least mild daytime sleepiness) was higher than that of PC (22.4%) and HC (12.0%) participants ($X^2 = 12.71$, df = 2, p = 0.002). While differences noted between IED and HC participants was significant ($X^2 = 9.62$, df = 1, p = 0.002), the difference between IED and PC participants was at a trend level of significance ($X^2 = 2.96$, df = 1, $p = 0.086$).

3.5. Correlates of sleep variables with aggression and impulsivity

PSQI Total Score was significantly associated with Composite Aggression ($\beta = 0.28$, $p < 0.001$), and with Composite Impulsivity ($\beta =$ 0.24, $p < 0.001$), scores examined separately. When placed in the same model, both variables contributed uniquely to PSQI Total Score ($\beta =$ 0.22, p = 0.003; $\beta = 0.16$, p = 0.021), though to a lesser degree. A composite score reflecting both aggression and impulsivity variables (Composite Impulsive Aggression) yielded a medium-sized correlation with PSQI Total Score ($\beta = 0.30$, $p < 0.001$). ESS Total Score correlated nearly as highly as PSQI Global Score with Composite Impulsive Aggression ($\beta = 0.28$, $p < 0.001$) while PSQI OSA scores correlated Composite Impulsive Aggression score to a small degree at a marginal level of statistical degree of significance ($\beta = 0.13$, p = 0.035). Total PSQI and ESS scores were only modestly correlated ($r = 0.28$, $p < 0.001$) and the Composite PSQI/ESS score correlated with Composite Impulsive Aggression at a somewhat higher level ($\beta = 0.36$, $p < 0.001$); Fig. 1). Finally, adding Composite Impulsive Aggression to the statistical models rendered the group differences, reported above, non-significant for PSQI (F [1245] = 1.46, p = 0.234), ESS (F [2245] = 1.05, p = 0.351), and PSQI/ESS Composite (F[1245] = 0.56, p = 0.571).

4. Discussion

In this study, IED participants were found to differ significantly from HC and PC groups in measures of PSQI global score, subjective sleep quality, daytime sleepiness (ESS), and symptoms of OSA. IED participants exhibited significantly worse global PSQI, a finding that persisted even after removing 20 IED participants with comorbid depression, a condition which is known to interact with sleep quality [26]. In addition, IED participants reported worse subjective sleep quality than their PC or HC counterparts. IED participants also scored significantly higher

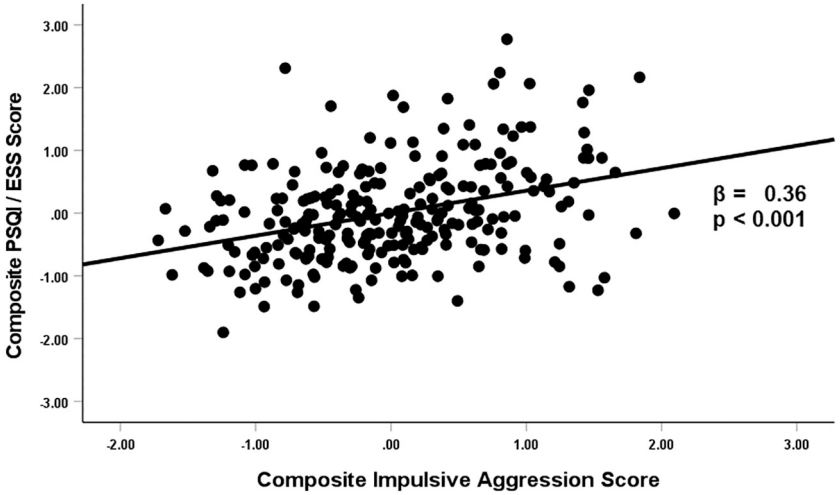

Fig. 1. Partial Plot between composite PSQI and ESS total score and composite impulsive aggression score.

than either PC or HC participants regarding symptoms of OSA, even after controlling for BMI, suggesting that IED may be associated with OSA, though that cannot be confirmed with this kind of data alone and further studies in this regard are warranted. Correlational analyses were accordant with our hypotheses and with existing literature [1,3,8]. Global PSQI and ESS scores were both related to aggression and impulsivity and controlling for degree of impulsive aggression among participants eliminated differences between the IED and HC/PC groups. Unexpectedly, comorbid PTSD was not independently related to poor sleep quality. While Studies of sleep and PTSD are mixed, sleep abnormalities in PTSD may exist [27].

These data correspond with findings reporting that healthy males, typically sleeping 7–8 h/night, have higher anger and hostility scores compared with those typically sleeping 9–10 h/night [28]. While other studies [29,30] have not reported the same, another study [31] has reported a correlation between shorter sleep duration and high hostility. These relationships are also observed in those with dispositional anger and aggression. One study reported that 80% of those with Antisocial Personality Disorder, and high aggression scores, have elevated PSQI scores >5, suggesting poor sleep quality, [32] while another noted that victims of intimate partner violence reported worse aggressive behavior from partners after their partner had 'a poor night's sleep.' [33].

Emerging evidence suggests a behavioral, neurobiological and genetic linkage between circadian rhythm misalignment and aggression [34]. While more work in this area is required, altered SIRT1 expression may contribute to both circadian misalignment and increased aggression via a cascade involving brain-derived neurotrophic factor (BDNF), arginine vasopressin (AVP), dopamine and serotonin. What are these relationships hold true and patients with well-characterized IED remains unclear.

A few studies suggest that polysomnographic sleep recordings may differ as a function of aggression. In healthy adults, aggressive tension and impulsiveness are positively associated with quantity of superficial sleep [33]. Individuals with Antisocial Personality, and a history of violent crime, exhibit greater nocturnal awakenings, and more self-reported sleep problems, compared with control subjects [35]. Autonomic function during sleep may be indicative of a mediational relationship between hyperarousal, sleep problems and aggression. In a small study, male subjects with high anger scores showed more cardiovascular hyperactivity when asleep compared to those scoring lower in anger [36].

Overall, these findings suggest that poor sleep quality, latency, daytime sleepiness, and possibly OSA symptomology are clinically relevant sleep issues in individuals with IED and that each may be targets for reducing impulsive aggression in IED. While previous work has linked personality traits and sleep quality, [37] this is, to our knowledge, the first study to assess clinical sleep issues in IED. In addition, a potential relationship between IED and OSA in the present study aligns with one small retrospective report that found continuous-positive airway pressure (CPAP) reduced aggression among a sample of sex offenders [38] and that there is some evidence that surgical treatment of OSA may improve aggression in children [9,39,40].

This study cannot definitively comment on why impulsive aggression may correlate with sleep problems in human subjects. That said, some studies have shown that serotonin (5-HT) activity is inversely related both to sleep [41] and aggression [42] and that individuals with IED have reduced measures of 5-HT [43,44]. Since measures of 5-HT function were not obtained in this study this remains speculative. Another possibility is that reduced sleep may reduce pre-frontal cortical function [45] and this may lead to difficulties in impulse control which is a hallmark of IED. That said, these data cannot speak to the direction this relationship and it is possible that poor sleep leads to aggressive behavior, rather than the reverse.

The present study has implications for research as well as clinical practice. While polysomnographic research studies of aggression and clinical sleep issues are few, [1] existing literature suggests potentially clinically salient sleep differences between aggressive individuals and healthy controls [46–48]. Building on the findings of this study, sleep physiology could have a role in future research among IED individuals. These findings also offer preliminary evidence that clinical sleep issues may be relevant to the care of patients with IED and suggest that mental health practitioners screen those with IED for clinical sleep issues and make appropriate referrals to Sleep Medicine specialists when indicated.

Strengths of this study included the use of validated instruments measuring clinical sleep issues (PSQI, ESS) and a sizable sample of individuals with IED contrasted with two control groups with and without other psychopathology. Subsequent studies should include greater sample sizes and more assessments to build upon our work. One limitation was that the IED and control groups differed in distribution of ethnicity and in socioeconomic scores. IED participants exhibited the lowest proportion of whites and the lowest SES scores. However, this is broadly consistent with prior epidemiological work describing the IED population and thus, does not likely compromise the external validity of these results [49]. Another limitation was the use of self-report clinical sleep measures. Prior research has found discrepancies between objective sleep measures (i.e. polysomnography) and subjective self-report, with metrics derived from polysomnography contributing less to individuals' perception of sleep quality than PSQI [50]. However, while self-report measures have obvious utility, recall biases and impression management can influence participants' responses. Finally, we used the

limited screening questions from the PSQI to assess OSA and these may not be optimal in this regard [51]. Future studies should use the recently validated STOP-Bang questionnaire for this purpose [52].

In summary, these findings contribute to a small, but developing, study-base that suggests the involvement of clinical sleep issues in impulsive aggression. This study is the first to assess clinical sleep issues as potentially modifiable factors in IED. Subsequent analysis are needed to continue to explore the potential to modulate IED symptoms, including impulsive aggression via treatment of comorbid clinical sleep issues.

Acknowledgements

This research was supported in part by grants from the National Institutes of Health: RO1 MH104673 and RO1 AA26664 (Dr. Coccaro).

Disclosures

While Dr. Hall has nothing to disclose, Dr. Coccaro reports being a member and consultant to the Scientific Advisory Boards of Azevan Pharmaceuticals, Inc. and of Avanir Pharmaceuticals, Inc., and is a current grant recipient of awards from NIMH and NIAAA.

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