Author/s:
Jenkins, CA;Thompson, KN;Chanen, AM;Hartmann, JA;Nicol, K;Nicholas, CL

Title:
Subjective and objective sleep in young people with borderline personality disorder features

Date:
2022-04-01

Citation:
Jenkins, C. A., Thompson, K. N., Chanen, A. M., Hartmann, J. A., Nicol, K. & Nicholas, C. L. (2022). Subjective and objective sleep in young people with borderline personality disorder features. Journal of Sleep Research, 31 (2), https://doi.org/10.1111/jsr.13463.

Subjective and Objective Sleep in Young People with Borderline Personality Disorder Features

Claire A. Jenkins[1,2,3], Katherine N. Thompson[2,3], Andrew M. Chanen[2,3], Jessica A. Hartmann[2,3], Katie Nicol[2,3], Christian L. Nicholas[1,4]

[1]Melbourne School of Psychological Sciences, The University of Melbourne, Parkville, Victoria, Australia

[2]Orygen, Parkville, Victoria, Australia

[3]Centre for Youth Mental Health, The University of Melbourne, Parkville, Victoria, Australia

[4]Institute for Breathing and Sleep, Heidelberg, Victoria, Australia

Author Note

There are no known conflicts of interest to disclose.

Correspondence concerning this article should be addressed to Dr. Christian Nicholas, Redmond Barry Building, Level 12, Sleep Laboratory, The University of Melbourne, Parkville, Victoria, 3010, Australia. Tel: +61-3-8344-3935. Fax: +61-3-9347-6618. Email: cln@unimelb.edu.au

Co-Author Contact Information

Claire A Jenkins: cjenkins@student.unimelb.edu.au

Katherine N Thompson: dr.katherine@optusnet.com.au

Andrew M Chanen: andrew.chanen@orygen.org.au

Jessica A Hartmann: jessica.hartmann@orygen.org.au

Katie Nicol: katie.nicol@orygen.org.au

Word Count: 5586

Funding:

This work was supported by NorthWestern Mental Health Seeding Grant and the John T Reid Foundation. Funding bodies had no involvement in design of the study, and were not involved in collection, analysis and interpretation of data or in writing the manuscript.

Acknowledgements:
We acknowledge the invaluable contributions made by young people and their families who have attended Orygen and participated in the current research. The authors would also like to acknowledge the support of our clinical and research colleagues at Orygen.

Abstract

Characterising sleep in young people (aged 15-25 years) with borderline personality disorder (BPD) features is crucial given the association between BPD features and sleep disturbance, negative consequences of poor sleep, and normative developmental sleep changes that occur in this age group. This study aimed to characterise the sleep profile of young people with BPD to determine whether this profile is non-normative and specific to BPD. Participants were 96 young people (40 with BPD features, 38 healthy individuals and 18 young people seeking help for mental health difficulties, without BPD). Sleep was measured subjectively (self-report questionnaires) and objectively (10 days of actigraphy). Young people with BPD features reported poorer subjective sleep quality, greater insomnia symptoms and later chronotype than same-age healthy and clinical comparison groups. Young people with BPD features also displayed irregular sleep timing, later rise times, greater time in bed and longer sleep durations than healthy young people. Those with BPD features had superior sleep quality (greater sleep efficiency, less wake after sleep onset) and longer sleep durations than the clinical comparison group. Sleep profiles were similar across young people with BPD features with and without co-occurring depression. Overall, the findings revealed a subjective-objective sleep discrepancy and suggest that sleep-improvement interventions might be beneficial to improve subjective sleep in young people with BPD features.

Keywords*: sleep, young people, BPD, actigraphy, psychiatry*

Subjective and Objective Sleep in Young People with Borderline Personality Disorder Features

Borderline personality disorder (BPD) is a severe mental disorder characterised by extreme sensitivity to perceived interpersonal slights, an unstable sense of self, intense and

volatile emotions and impulsive behaviours (American Psychiatric Association, 2013). Sleep disturbances are among the most common complaints of individuals with BPD (Hafizi, 2013) but they are infrequently studied, especially in young people aged 15-25 years.

This age range aligns with the United Nations and World Health Organisation's definitions of 'youth'. This period (from puberty to 25 years) is distinct and developmentally continuous in economically developed societies (Dahl et al., 2018; Sawyer et al., 2018). Moreover, developmental processes underpinning identity formation, executive functioning and personality development extend beyond 18 years of age and into the third decade of life (Arnett et al., 2014; Chanen et al. 2021; Dahl et al., 2018; Newton-Howes et al., 2015). A wealth of evidence also speaks to the distinctiveness and developmental coherence of this age range in BPD (Chanen, Nicol, Betts & Thompson, 2020; Chanen et al. 2021).

Focussing on this developmental period is important because it co-occurs with the clinical onset and peak prevalence of mental disorders including BPD (Chanen et al., 2017; Kessler et al., 2005), during which there are also normative developmental changes in sleep (Ohayon et al., 2004). BPD is associated with adverse long-term personal, social and economic outcomes that include severe and persistent functional impairment, poor physical health, co-occurring mental health disorders, family and carer burden, suicide and premature mortality (Leichsenring et al. 2011; Gunderson 2011; Chanen, Nicol, Betts, Bond, et al., 2020; Chanen et al. 2017; Kaess et al., 2013). Sleep disturbances are independently associated with functional impairment, reduced quality of life, and a poorer prognosis for BPD recovery (Adams et al., 2017; Plante et al., 2013). Further, sleep disturbances can aggravate suicide and self-harm risk, and heighten emotional dysregulation and impulsivity (Goldschmied, 2019; Van Veen et al., 2017; Winsper & Tang, 2014). Improving sleep is essential to minimise adverse outcomes associated with sleep disturbance and BPD, and might serve as a beneficial treatment target to help promote broader symptomatic and functional recovery (Jenkins, Thompson et al., 2021; Vanek et al., 2021). Research is therefore needed to inform the development of sleep-improvement interventions for this population (Jenkins, Thompson et al., 2021).

Limited research indicates that young people with BPD features experience poor subjective sleep quality and an increased susceptibility to delayed sleep phase syndrome (Jenkins, Thompson et al., 2021; Wall et al., 2020). This suggests that the normative adolescent shift toward a later chronotype (an individual's natural inclination towards morning or evening preference for activity) might be exacerbated in BPD. One study has used actigraphy to objectively assess sleep in this population (Huỳnh et al., 2016). Compared

with healthy young people, those with BPD woke up later (by ~1hr) and displayed greater variability in rise time and sleep duration across the week. On weekends, young people with BPD slept longer, woke up later and spent more time in bed.

Within this small literature, there is wide variability in BPD and sleep assessment methods, limited inclusion of clinical comparison groups, small sample sizes, and lack of comparisons between subjective and objective sleep measures (Jenkins, Thompson et al., 2021). Only one study included a clinical comparison group, comprised of young people with bipolar disorder (Huỳnh et al., 2016). While sleep profiles were largely similar across BPD and bipolar groups, further comparisons with a mixed-presentation clinical comparison group are warranted to elucidate which, if any, sleep disturbances are specific to BPD, rather than associated with psychopathology *per se* or help-seeking more generally given that sleep disturbance is transdiagnostic across psychiatric disorders (Harvey, 2008).

Previous research has often ignored, or excluded, participants based on depressive symptomatology (Jenkins, Thompson et al., 2021). Although sleep disturbances in BPD are not solely attributable to co-occurring depression, sleep profiles of these disorders overlap considerably (Wall et al., 2020; Winsper et al., 2017). Depressive symptoms are common and intrinsic to BPD, and excluding individuals with co-occurring depression results in atypical, unrepresentative samples (Oltmanns & Oltmanns, 2015). Instead, the role of depression should be considered by comparing sleep profiles across young people with BPD features with or without co-occurring depression. To the authors' knowledge, research has yet to explore this.

Aims and Hypotheses

The current study aimed to address the shortcomings of previous studies and to characterise the sleep profile of young people with BPD by utilising a combination of subjective and objective sleep measures, including healthy and clinical comparison groups, considering differences between those with BPD features with and without co-occurring depression, and including a larger sample than previous studies. The primary research question was whether sleep in BPD is non-normative and/or specific to BPD.

It was hypothesised that young people with BPD features would report poorer sleep quality, greater insomnia, later chronotype, and greater daytime sleepiness than same-age healthy individuals. Further, young people with BPD features would display later rise times, longer total sleep time, and greater variability in total sleep time and rise times across the week, as well as greater time in bed on weekends, compared with healthy young people.

Differences in sleep profiles of young people with BPD features with and without depression, and differences between young people with BPD features and young people with other mental disorders were also examined. Given the limited existing research, these analyses remained exploratory and no specific hypotheses were made.

Method

Participants

BPD and clinical comparison participants were recruited at Orygen, the government-funded specialist mental health service for young people in Western and Northwestern metropolitan Melbourne, Australia. Healthy individuals were recruited via word of mouth and social media advertisements (Facebook, Inc. and Instagram®) and matched to the BPD group on age, sex and socioeconomic status.

Participants in the BPD group had three or more BPD features, as assessed by the Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5), Research Version (SCID-5-RV; First et al., 2015). Individuals with 3-4 BPD features were included, given the clinical significance and comparable functional impairment in those with sub-threshold BPD, compared with those who meet full diagnostic criteria (Karukivi et al., 2017; Thompson et al., 2019). Participants with BPD features did not have a current DSM-5 diagnosis of any schizophrenia spectrum disorder or bipolar I disorder, or a diagnosis of sleep apnoea or a score above 0.5 on the multivariable apnoea risk index (MAPI), indicating risk of sleep apnoea (Maislin et al., 1995).

Clinical comparison participants were recruited as part of a larger study involving a transdiagnostic sample of help-seeking young people with emerging mental illness. (Hartmann et al., 2019). Clinical comparison individuals did not have a current DSM-5 diagnosis of any schizophrenia spectrum disorder or bipolar I disorder, and had zero or one feature(s) of BPD. Given the clinical significance of sub-threshold BPD, analyses were conducted including only individuals in the clinical comparison group with zero features of BPD, and repeated including those with ≤ 1 feature. As no difference in the pattern of findings was observed, the data presented includes clinical comparison participants with ≤ 1 feature of BPD, in order to maximise sample size and statistical power.

Healthy participants had zero BPD features, had never received any mental health treatment or been diagnosed with any mental or sleep disorders (eg. sleep apnoea, insomnia), and had a score below 0.5 on the MAPI.

Measures

Psychopathology

Diagnoses were assessed using the SCID-5-RV (First et al., 2015) and SCID-5 Personality Disorders (SCID-5-PD; First et al. 2016). Healthy individuals did not complete the SCID-5-RV. The SCID is a diagnostic instrument and is not suitable for screening healthy participants, due to its length. This would be unnecessarily burdensome on participants. Instead, participants were asked to report mental disorder diagnoses (past or present) and any history of help-seeking (eg. seeing a school counsellor or psychologist). Healthy and clinical comparison participants only completed the BPD module of the SCID-5-PD.

Subjective Sleep

Epworth Sleepiness Scale (ESS). The ESS is an 8-item measure of an individual's general level of daytime sleepiness (Johns, 1991), with good internal consistency, $\alpha = 0.88$ (Johns, 1992). Individuals rate their chances of dozing off or falling asleep while engaged in eight different activities (eg. sitting and reading; lying down to rest in the afternoon) on a scale of 0 (never) to 3 (high chance). A total sleepiness score is calculated by summing the eight ratings.

Insomnia Severity Index (ISI). The ISI is a 7-item measure of an individual's clinical level of insomnia over the past two weeks (Morin & Barlow, 1993). The index addresses difficulties initiating and maintaining sleep, sleep-related satisfaction and distress, and the level of impact on the individual's life. For example "How worried/distressed are you about your current sleep?". Each item is rated on a scale from 0-4, and a sum of all the ratings produces a total score. The ISI has high internal consistency, $\alpha = 0.90$ (Morin et al., 2011).

Munich Chronotype Questionnaire (MCTQ). The MCTQ is a self-report measure of an individual's chronotype over the past 4 weeks (Roenneberg et al., 2003). Items include "I go to bed at…." and "I wake up at…". The MCTQ has been validated against sleep diaries and actigraphy (Roenneberg et al., 2007; Santisteban et al., 2018). Chronotype is estimated based on the midpoint between sleep onset and offset on weekend days, corrected for "oversleep" due to the sleep debt that individuals accumulate over the week. Chronotype can only be reliably calculated in individuals who do not use an alarm clock on free days, given the strong influence of the circadian clock on free days (Roenneberg et al., 2003).

Pittsburgh Sleep Quality Index (PSQI). The PSQI is a 9-item measure of global sleep quality over the past month (Buysse et al., 1989), with good internal consistency ($\alpha = 0.87$; Backhaus et al., 2002).. Items include "I cannot get to sleep within 30 minutes" and

"…how would you rate your sleep quality overall?". Seven component scores are derived including subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction, each scored 0 (no difficulty) to 3 (severe difficulty). The component scores are summed to produce a global score (ranging from 0 to 21), where a score > 5 indicates poor sleep quality.

Multivariate Apnea Prediction Index (MAPI). The MAPI is a 13-item screening tool for obstructive sleep apnea (OSA) over the past month (Maislin et al., 1995). Items such as loud snoring, snorting and gasping are rated on a scale from 0 (never) to 4 (always; 5-7 times per week). The measure combines self-reported apnea symptom frequency (snoring, snorting or gasping, cessation of breathing/choking) with age, sex, and body mass index to derive an index of probability for OSA. Final scores range from 0–1, where 1 represents the highest risk of OSA. This questionnaire has good internal consistency (α = 0.93), sensitivity (78%), and specificity (67%; Maislin et al., 1995).

Consensus Sleep Diary. This is a widely used and validated 15-item self-report measure of subjective experiences of sleep to be completed each morning (Carney et al., 2012; Maich et al., 2016). The diary assesses sleep timing, quality and behavioural factors that might affect sleep (eg. caffeine and alcohol intake, napping, medication use). Items include "What time did you try to go to sleep?" and "What time was your final awakening?".

Actigraphy

A GENEActiv® Original (ActivInsights Ltd, Cambridge, UK) accelerometry-based activity monitor, was used to obtain activity counts (per minute) in the BPD and healthy groups, configured with a sampling frequency of 50Hz. In the clinical comparison group, activity counts were obtained using the Actiwatch-2® (Philips Respironics Mini-Mitter, Pennsylvania, United States). GENEActiv and Actiwatch-2 data stored in 60-second epochs were downloaded for analysis using GENEActiv PC software (Activinsights; version 3.2) and Philips Actiware (version 6.0.0), respectively. Actigraphy data were visually checked against sleep diary data to confirm bed and rise times for all participants. The Philips Respironics algorithm was used to convert raw activity counts to binary sleep/wake scores and calculate sleep parameters for both devices (Oakley, 1997). Research supports the interchangeable use of these devices using a common algorithm and device-specific wake thresholds (40 for Actiwatch-2; 115 GENEActiv; Jenkins, Tiley et al., 2021). These thresholds were used in the current study to minimise differences across devices (see Jenkins, Tiley et al., 2021 for more information).

Procedure

Ethical approval was obtained from the Melbourne Health Human Research Ethics Committee (#2017.153, #2015.218). Informed consent was obtained from all participants and from a parent or guardian for participants aged under 18 years. Following screening for exclusion criteria, participants completed the psychopathology interviews (SCID-5-RV; SCID-5-PD) and self-report questionnaires. Note that the clinical comparison group did not complete the ESS, PSQI or MAPI, as participants in this group were part of a larger study that did not include these measures.

An actigraph was provided and participants were instructed to wear the device continuously on their non-dominant wrist, and complete a sleep diary each day, for the following 10 days. Data collection took place during the educational term/semester (not during vacation or break periods) for participants engaged in education.

Statistical Analyses

All analysis was conducted using SPSS (IBM inc. V25). Time-based data (chronotype, bedtimes, rise times) were converted to minutes for analysis. Midnight was treated as zero. Times before midnight were converted to negative values (eg. 11:30pm = -30mins) and times after midnight were converted to positive values (eg. 3:00am = 180mins).

Actigraphy-derived sleep parameters included bedtime, rise time, time in bed, total sleep time, sleep onset latency, sleep efficiency and wake after sleep onset, for definitions see Table 1.

[Insert Table 1 about here]

Intra-individual variability in total sleep time and time in bed was assessed using a coefficient of variation (CV = standard deviation/mean), as has been used in previously when investigating sleep in young people with mental disorders (Huỳnh et al., 2016). As CV can only be calculated using true ratio data, intra-individual variability in bed and rise times were assessed using individual standard deviations. Objective sleep parameters were separated into weeknights (Sunday-Thursday) and weekends (Friday-Saturday nights), and separate analyses were conducted on weeknights, weekend and combined data.

Missing data were minimal within subjective sleep measures (~0.1% of the data) and were calculated for inclusion based on the individual's average score for the scale/subscale from which the item was missing. Outliers were also minimal and were winsorised to two standard deviations for the ESS, ISI and PSQI. Given that intra-individual variability in objective sleep was an outcome of interest, outliers were left in for the actigraphy data and

non-parametric tests were used. Similarly, outliers were left in and non-parametric tests were used for the MCTQ given the small final sample for this measure.

One-way ANOVAs confirmed consistencies in age and socioeconomic status across groups. Differences between BPD and healthy comparison groups for the PSQI and ESS were explored using independent samples t-tests. Group differences for all other variables (ISI, MCTQ, actigraphy-derived variables) were assessed using one-way ANOVAs (or equivalent non-parametric Kruskal-Wallis H test or Welch's ANOVA if indicated) with subsequent paired comparisons. For all variables, differences between individuals with features of BPD with and without co-occurring depression (determined by a SCID-5-RV diagnosis of major *or* persistent depressive disorder) were examined using non-parametric Mann-Whitney U tests due to unequal sample sizes, and Benjamini-Hochberg's procedure was applied to correct for multiple comparisons and reduce the false discovery rate.

Power Analysis

Power analyses were performed using G*Power 3.1, based on current sample sizes. Estimated power for independent samples t-tests for PSQI and ESS at small, medium and large effect sizes were .14, .59 and .94, respectively.

The estimated power of one-way ANOVAs for ISI at small, medium and large effect sizes were .13, .57 and .94, respectively. For MCTQ analyses using one-way ANOVAs, the estimated power was .10, .41, and .82 at small, medium and large effect sizes, respectively. Actigraphy-based analyses using one-way ANOVAs had estimated power of .12, .55 and .93 at small, medium and large effect sizes, respectively.

Co-occurring depression analyses using Mann-Whitney U tests had estimated power of .08, .26 and .55 at small, medium and large effect sizes, respectively.

Results

Participants

Participants were 96 young people, aged 15-25 years, which comprised 40 participants in the BPD group, 38 in the healthy comparison group, and 18 in the clinical comparison group. By design, there were no significant group differences in age (p = .597) or socioeconomic status (p = .477), and sex demographics were similar across all groups. The proportion of females was high, reflecting high rates of females with BPD in clinical settings (American Psychiatric Association, 2013; Lieb et al., 2004). Notably, this was not representative of the balanced BPD sex ratio observed in the community (Lenzenweger et al.,

2007). Thirty (75%) of those with BPD features had a current, co-occurring SCID-5-RV diagnosis of major *or* persistent depressive disorder. Full sample characteristics are displayed in Table 2.

[Insert Table 2 about here]

ESS, ISI and PSQI data were analysable for all participants. Following exclusion of participants who used an alarm clock on free days, the final sample size for the MCTQ was 66 (31 BPD, 26 healthy comparison, 9 clinical comparison). Actigraphy data were not analysable for four females (3 BPD, 1 healthy comparison), one due to a failure to return the actigraph, one due to concerns of dermal irritation, and two due to insufficient wear time (one and two days, respectively). Further, one healthy female and one clinical comparison male from the clinical comparison group did not have full weekend watch data due to shortened wear times (eg. five days) or completing the 10 days of data collection sporadically rather than continuously. The final sample size for weekday and combined actigraphy data was 92 (37 BPD, 37 healthy comparison, 18 clinical comparison) and the final sample for weekend actigraphy data was 90 (37 BPD, 36 healthy comparison, 17 clinical comparison) .

Subjective Sleep Measures

Young people with BPD features reported poor sleep quality, greater insomnia severity and later chronotype than healthy and clinical comparison individuals, see Figure 1. For group means across subjective sleep measures, see Supplementary Information (Table S1). Subjective sleep measures displayed good to excellent internal consistency; ESS α = 0.77, PSQI α = 0.80, ISI α = 0.92, MAPI α = 077. Note that Cronbach's alpha could not be calculated for the sleep diary or MCTQ given that these questionnaires are comprised of a combination of Likert-scale and time-based responses.

[Insert Figure 1 about here]

Sleep Quality

An independent samples t-test revealed that individuals with BPD features had significantly higher PSQI scores (reflecting poorer sleep quality) compared with healthy young people, $t(76) = 6.92$, $p < .001$, Cohen's $d = 1.55$. Of those with BPD features, 90% were reportedly poor sleepers (PSQI score > 5), compared with 39% of healthy young people.

Insomnia Severity

Welch's ANOVA revealed a significant group difference in insomnia severity *Welch's* $F(2, 39.20) = 46.43$, $p < .001$, *est.* $\omega^2 = .49$. Subsequent Games-Howell comparisons revealed that those with features of BPD features reported more severe insomnia than healthy ($p < .001$, $d = 2.05$) and clinical comparison groups ($p = .046$, $d = 0.67$). The clinical comparison group also reported more severe insomnia than healthy individuals ($p = .001$, $d = 1.54$). In the BPD group, 40% reported experiencing moderate clinical insomnia (ISI score 15–21) and 15% had severe clinical insomnia (ISI score 22-28). No healthy individuals reported moderate or severe clinical insomnia, whilst 28% of the clinical comparison group had moderate clinical insomnia.

Daytime Sleepiness

An independent samples t-test revealed that there were no significant differences between BPD and healthy comparison groups in daytime sleepiness ($p = .625$).

Chronotype

The mean chronotype was 5:51AM (*SD* = 103.23mins**)** in the BPD group, 4:49AM (*SD* = 58.45mins) in the healthy comparison group, and 4:26AM (*SD* = 62.31mins) in the clinical comparison group. A Kruskal-Wallis test indicated a significant group difference in chronotype, $H(2) = 11.66$, $p = .003$, $\eta^2_H = .15$. Subsequent Dunn-Bonferroni pairwise comparisons with Bonferroni-corrected *p* values revealed that young people with BPD features reported a significantly later chronotype than both the healthy ($p = .014$) and clinical comparison groups ($p = .019$).

BPD Features With and Without Depression

Mann-Whitney U tests revealed no significant differences between young people with BPD features with and without co-occurring depression for any subjective sleep measures, see Table 6.

Actigraphy

Actigraphy data were separated into weekends, weeknights and combined data. Across combined days, young people with BPD features displayed later rise times, more time in bed, longer total sleep times and greater variability in bed and rise times compared with healthy young people. Young people with BPD features also had longer total sleep times, greater sleep efficiency, and less wake after sleep onset than the clinical comparison group. The clinical comparison group displayed longer time in bed and greater wake after sleep onset compared with healthy young people. See Table 3.

[Insert Table 3 about here]

On weekends, young people with BPD features displayed later rise times, longer time in bed, and greater rise time variability compared with healthy individuals. Those with BPD features and healthy young people both displayed greater sleep efficiency and less wake after sleep onset than the clinical comparison group. See Table 4.

[Insert Table 4 about here]

On weeknights, young people with BPD features displayed later rise times, more time in bed, longer total sleep times and greater variability in bed and rise times, compared with healthy young people. Individuals in BPD and healthy groups both had greater sleep efficiency, and less wake after sleep onset than clinical comparison individuals. Compared with the clinical comparison group, young people with BPD features had longer total sleep times and healthy individuals spent less time in bed. See Table 5.

[Insert Table 5 about here]

Across weeknights, weekends and combined data, Mann-Whitney U tests with Benjamini-Hochberg adjusted *p* values revealed that individuals with BPD features without co-occurring depression spent more time in bed ($U = 42.00$, $z = -3.18$, $p = .015$, $r = -.52$) and displayed longer total sleep times ($U = 44.00$, $z = -3.11$, $p = .015$, $r = -.51$) on weekends compared with those with co-occurring depression. There were no significant differences between young people with BPD features with and without co-occurring depression for bedtime, rise time, sleep onset latency, sleep efficiency, wake after sleep onset, or any intra-individual variability sleep parameters. See Table 6.

[Insert Table 6 about here]

While young people aged 15-25 years represent a developmentally coherent age group (Chanen et al., 2020; Chanen et al. 2021), we acknowledge that there might still be meaningful age-related differences given that sleep patterns differ across adolescence and young adults (Ohayon et al., 2004). Mann-Whitney U tests with Benjamini-Hochberg's procedure revealed no significant differences between adolescents (15-17yrs) and young adults (18-25yrs) with BPD features, however further research is needed to replicate these findings in a larger sample. See Table 7.

[Insert Table 7 about here]

Discussion

This study aimed to characterise the sleep profile of young people with BPD features. The current study built upon previous research through utilising a combination of subjective

and objective sleep measures, comparing sleep in BPD with healthy and clinical comparison groups, exploring differences between those with BPD features with and without co-occurring depression, and including a larger sample than previous studies. Subjective sleep in young people with BPD features was non-normative and specific to BPD, while objective sleep was less disturbed. Sleep profiles were largely similar across young people with BPD features with or without co-occurring depression, however additional research using larger sample sizes is needed to support this finding.

Subjectively, young people with BPD features reported poorer sleep quality, more severe insomnia and later chronotypes than the healthy or clinical comparison groups. Later chronotype has been associated with greater insomnia symptoms and poorer subjective sleep quality (Ong et al., 2007; Selvi et al., 2012), suggesting that these factors might be interrelated in young people with BPD features . Chronotype disturbances warrant specific clinical attention as they exacerbate BPD features and have been identified as an important, unmet, treatment need for adults with BPD (McGowan & Saunders, 2021). Overall, subjective sleep findings were consistent with hypotheses and previous research (Jenkins, Thompson et al., 2021) and indicate that subjective sleep is disturbed in young people with BPD features. Subjective sleep disturbance was ubiquitous among those with BPD features such that 90% were classified as poor sleepers and more than half experienced moderate or severe clinical insomnia. No subjective sleep differences were observed between young people with BPD features with or without co-occurring depression, suggesting that the observed subjective sleep disturbances are independent of co-occurring depression. Those with BPD features did not report greater daytime sleepiness than healthy young people, likely due to the lack of objective sleep disturbance in the BPD group.

The objective sleep profile of young people with BPD features was largely normative and undisturbed. Young people with BPD features woke up later, spent more time in bed, more time asleep, and displayed more variable bed and rise times than healthy individuals. There were no group differences in total sleep time or bedtime variability on weekends. These findings largely supported the hypotheses and are consistent with previous research (Huỳnh et al., 2016).

The observed objective sleep profile of young people with BPD features likely results from a combination of chronotype, lifestyle factors and social functioning. Incongruous social and biological rhythms contribute to sleep restriction in healthy young people (Roenneberg et al., 2012). BPD is associated with poor social functioning, reduced engagement in social activities and high unemployment rates (Chanen, Nicol, Betts, Bond, et

al., 2020; Liebke et al., 2017). These factors likely alleviate social constraints on sleep timing which, combined with later (likely biologically and socially driven) chronotype, allows young people with BPD to sleep longer and later (Ong et al., 2007). Additionally, weekend sleep in healthy young people is less contingent on social rhythms (Fischer et al., 2008), which could explain why BPD and healthy groups displayed comparable weekend sleep duration. Further, sleep in older adolescents is less influenced by early school start times than younger adolescents. This could explain why longer sleep durations were specific to weekends in younger adolescents (aged 12-17) with BPD features (Huỳnh et al., 2016), but were observed across the week in the current study. As social functioning was not directly assessed in the current study, these suggestions remain speculative and warrant further investigation.

Individuals with BPD without depression slept longer and spent more time in bed on weekends than those with BPD and depression. This suggests that the objective sleep profile of this population, particularly patterns of longer sleep duration and more time in bed, is independent of co-occurring depression. However, given the small sample size of those with BPD without depression, additional research is needed to support this preliminary finding.

Compared with the clinical comparison group, young people with BPD features slept longer (by ~1hr) and better (greater sleep efficiency, less wake after sleep onset) than the clinical comparison group. Weekend sleep duration was comparable across groups. This illustrates that sleep quality in young people with BPD was more similar to healthy young people than those with other mental disorders. This was surprising and diverged from previous research indicating comparably poor sleep across BPD and clinical comparison groups in adults and young people (Huỳnh et al., 2016; Winsper et al., 2017). The conflicting findings might be due to differences between studies in the composition of the clinical comparison group. The current study used a mixed-presentation clinical comparison group, while previous studies predominantly used depressive or bipolar comparison groups. It is possible that sleep in BPD is more similar to depression or bipolar than psychopathology more broadly, however further research in this area is needed to clarify this.

Illness course and/or severity might also contribute to these conflicting findings. Objective sleep disturbances in BPD could increase over the course of the disorder. As such, young people with BPD, who are relatively early in the course of their disorder (Chanen et al., 2017), might display less disturbed objective sleep, compared with adults with BPD, who display similarly poor sleep to other clinical groups. Additionally, individuals with sub-

threshold BPD (3-4 BPD features) were included in the current study, while most previous research focussed on full-threshold (5+ BPD features) disorder (Oltmanns & Oltmanns, 2015; Winsper et al., 2017). Although sub- and full-threshold BPD are associated with comparable functional impairment and psychosocial morbidity (Karukivi et al., 2017; Thompson et al., 2019), sleep disturbances might be less pronounced in sub-threshold BPD. However, this cannot fully explain the current findings, as over 70% of the BPD group in the current study had full-threshold BPD. Associations between sleep, illness course and severity have been posited by other researchers (Bastien et al., 2008), however studies are yet to investigate these relationships. As such, current suggestions remain speculative and require further investigation.

This study identified subjective-objective sleep discrepancies in young people with BPD features. Possible explanations for this include that heightened subjective experiences are common in BPD and have been observed in other domains such as depression (Stanley & Wilson, 2006) and distress (Thompson et al., 2018). The current findings might therefore reflect a more generalised sensitivity in BPD. Additionally, later chronotype has been associated with heightened sensitivity to sleep disturbance and greater aversions to perceived sleep disturbance, which could exacerbate existing sensitivity in BPD (Ong et al., 2007).

Also, reporting biases in subjective sleep measures are common in psychiatric patients as they often require long retrospective recall (Hartmann et al., 2015). Responses can therefore be biased by negative mood and cognitions (Hartmann et al., 2015). Such biases might be particularly prevalent in individuals with BPD, which has been associated with negative memory biases and difficulties forgetting negative information (Baer et al., 2012). Psychiatric symptoms (eg. irritability, poor concentration) can also be misattributed as being the result of poor sleep, further biasing subjective sleep (Vanable et al., 2000).

Finally, although actigraphy is a well-accepted alternative to the gold-standard of sleep assessment, polysomnography, it cannot provide the same level of detailed sleep analysis and has limited specificity (Acebo, 2005). Instead of subjective over-reporting, it is possible that objective sleep disturbances (eg. awakenings) were underestimated in the current study. Future polysomnography studies will provide greater insight into subjective-objective discrepancies.

The findings highlight the importance of assessing and treating subjective sleep disturbances in young people with BPD features. Subjective reports reflect sleep-related-distress and dysfunctional beliefs about sleep, which can impede BPD recovery (Hartmann et al., 2015; Plante et al., 2013). Clinical experience also suggests that they are a strong driver

of requests for prescribed medication, especially hypnotic medication. Cognitive behavioural therapy and behavioural sleep education are effective in improving subjective sleep, even in absence of objective sleep disturbances (Crönlein et al., 2020). These interventions are likely to provide valuable adjuncts to current BPD treatments to improve subjective sleep alongside symptomatic and functional recovery from BPD.

While this was the largest study of objective sleep in young people with BPD features to date (Jenkins, Thompson et al., 2021), it is not without limitations. S ome comparisons involved small group sizes. Specifically, 9 clinical comparison individuals were included in MCTQ analyses, while only 10 young people with BPD features did not have co-occurring depression, and there were only 12 adolescents with BPD features. As such, these analyses had low statistical power and require further investigation. Given that there are known sleep differences between adolescents and young adults (Ohayon et al., 2004), additional research is needed to further explore age-related differences in sleep among individuals with BPD features in a larger sample. Moreover, data regarding subjective sleep quality, daytime sleepiness and other personality disorders were not obtained from the clinical comparison group. Further research is needed to explore these factors and multivariate analyses are necessary to identify factors independently associated with BPD.

Additionally, a number of participants were taking prescribed psychotropic medications. Although psychotropic medications often affect sleep, it would have been impractical and unethical to perform a pharmacological washout period in young people with severe mental illness, and excluding such individuals results in a selective, unrepresentative sample (Huỳnh et al., 2016). Given the sample size and potentially complex relationship between medication use and illness severity, it was not feasible to accurately control for medication use in the current study. Future studies should investigate the role of psychotropic medications in this population.

Data were collected across the year. Seasonal effects on sleep might therefore have impacted the current results (Golder & Macy, 2011). Moreover, data were separated into weekdays and weekends, however these days are not always clearly defined in young people due to varying education/work schedules. Data regarding daily activities would provide further insights into true schedule-free vs. schedule-present differences in future research.

It was beyond the scope of this study to explore mechanisms underlying sleep disturbance in this population, such as the role of social functioning or illness course. Many proposed explanations for the current findings therefore remain speculative and require investigation. Co-occurring depression analyses were also restricted to the dichotomous,

SCID-5-RV depression diagnosis in the BPD group. Future studies should continue to consider the role of depression in the sleep profile of young people with BPD features and include a continuous depression measure as a covariate across groups.

Overall, t his study makes a significant contribution to the literature. Young people with BPD reported disturbed subjective sleep, while objective sleep was less disturbed. Additional research is needed to replicate the current findings and further explore age-, sex- and depression-related differences in sleep profiles among young people with BPD features. Overall, the findings suggest that cognitive and behavioural sleep interventions might be effective in improving subjective sleep in this population.

References

Acebo, C. (2005). Actigraphy. In L. Teofilo (Ed.), *Sleep: A comprehensive handbook* (pp. 1035-1038). John Wiley & Sons.

Adams, R. J., Appleton, S. L., Taylor, A. W., Gill, T. K., Lang, C., McEvoy, R. D., & Antic, N. A. (2017). Sleep health of Australian adults in 2016: results of the 2016 Sleep Health Foundation national survey. *Sleep Health, 3*(1), 35-42. https://doi.org/10.1016/j.sleh.2016.11.005

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders (DSM-5®)*. American Psychiatric Publishing, Inc.

Arnett, J. J., Žukauskienė, R., & Sugimura, K. (2014). The new life stage of emerging adulthood at ages 18–29 years: implications for mental health. *The Lancet Psychiatry, 1*(7), 569–576. https://doi.org/10.1016/S2215-0366(14)00080-7

Backhaus, J., Junghanns, K., Broocks, A., Riemann, D., & Hohagen, F. (2002). Test–retest reliability and validity of the Pittsburgh Sleep Quality Index in primary insomnia. *Journal of psychosomatic research, 53*(3), 737-740.

Baer, R. A., Peters, J. R., Eisenlohr-Moul, T. A., Geiger, P. J., & Sauer, S. E. (2012). Emotion-related cognitive processes in borderline personality disorder: a review of the empirical literature. *Clinical Psychology Review, 32*(5), 359-369. https://doi.org/10.1016/j.cpr.2012.03.002

Bastien, C. H., Guimond, S., St-Jean, G., & Lemelin, S. (2008). Signs of insomnia in borderline personality disorder individuals. *Journal of Clinical Sleep Medicine, 4*(5), 462-470. https://doi.org/10.5664/jcsm.27283

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and

research. *Psychiatry Research, 28*(2), 193-213. https://doi.org/10.1016/0165-1781(89)90047-4

Carney, C. E., Buysse, D. J., Ancoli-Israel, S., Edinger, J. D., Krystal, A. D., Lichstein, K. L., & Morin, C. M. (2012). The consensus sleep diary: standardizing prospective sleep self-monitoring. *Sleep, 35*(2), 287-302. https://doi.org/10.5665/sleep.1642

Chanen, A. M., Betts, J. K., Jackson, H., Cotton, S. M., Gleeson, J., Davey, C. G., Thompson, K., Perera, S., Rayner, V., & Chong, S. Y. (2021). A Comparison of Adolescent versus Young Adult Outpatients with First-Presentation Borderline Personality Disorder: Findings from the MOBY Randomized Controlled Trial. *The Canadian Journal of Psychiatry.* https://doi.org/10.1177/0706743721992677

Chanen, A. M., Nicol, K., Betts, J. K., & Thompson, K. N. (2020). Diagnosis and Treatment of Borderline Personality Disorder in Young People. *Current Psychiatry Reports, 22*(5), 25. https://doi.org/10.1007/s11920-020-01144-5

Chanen, A. M., Nicol, K., Betts, J. K., Bond, G. R., Mihalopoulos, C., Jackson, H. J., Thompson, K. N., Jovev, M., Yuen, H. P., & Chinnery, G. (2020). INdividual Vocational and Educational Support Trial (INVEST) for young people with borderline personality disorder: study protocol for a randomised controlled trial. *Trials*, *21*(1), 1-12. https://doi.org/10.1186/s13063-020-04471-3

Chanen, A. M., Sharp, C., Hoffman, P. & the Global Alliance for Prevention and Early Intervention for Borderline Personality Disorder (2017). Prevention and early intervention for borderline personality disorder: a novel public health priority. *World Psychiatry, 16*(2), 215-216. https://doi.org/10.1002/wps.20429

Crönlein, T., Wetter, T. C., Rupprecht, R., & Spiegelhalder, K. (2020). Cognitive behavioral treatment for insomnia is equally effective in insomnia patients with objective short and normal sleep duration. *Sleep Medicine, 66*, 271-275. https://doi.org/10.1016/j.sleep.2018.10.038

Dahl, R. E., Allen, N. B., Wilbrecht, L., & Suleiman, A. B. (2018). Importance of investing in adolescence from a developmental science perspective. *Nature, 554*(7693), 441–450. https://doi.org/10.1038/nature25770

First, M., Williams, J. B., Benjamin, L. S., & Spitzer, R. L. (2016). *Structured clinical interview for DSM-5 personality disorders: SCID-5-PD*. American Psychiatric Association Publishing

First, M., Williams, J., Karg, R., & Spitzer, R. (2015). *Structured clinical interview for DSM-5—Research version: SCID-5-RV)*. American Psychiatric Association Publishing

Fischer, F. M., Nagai, R., & Teixeira, L. R. (2008). Explaining sleep duration in adolescents: the impact of socio-demographic and lifestyle factors and working status. *Chronobiology International, 25*(2-3), 359-372. https://doi.org/10.1080/07420520802110639

Golder, S. A., & Macy, M. W. (2011). Diurnal and seasonal mood vary with work, sleep, and daylength across diverse cultures. Science, 333(6051), 1878-1881.

Goldschmied, J. R. (2019). How Sleep Shapes Emotion Regulation. In Z. Križan (Ed.), *Sleep, Personality, and Social Behavior* (pp. 83-97). Springer International Publishing. https://doi.org/10.1007/978-3-030-30628-1_6

Grove, J. L., Smith, T. W., Crowell, S. E., & Ellis, J. H. (2017). Preliminary evidence for emotion dysregulation as a mechanism underlying poor sleep quality in borderline personality disorder. *Journal of Personality Disorders, 31*(4), 542-552. https://doi.org/10.1521/pedi_2016_30_261

Gunderson, J. G. (2011). Borderline personality disorder. *New England Journal of Medicine*, *364*(21), 2037-2042. https://doi.org/10.1056/NEJMcp1007358

Hafizi, S. (2013). Sleep and borderline personality disorder: A review. *Asian Journal of Psychiatry, 6*(6), 452-459. https://doi.org/10.1016/j.ajp.2013.06.016

Hartmann, J. A., Carney, C. E., Lachowski, A., & Edinger, J. D. (2015). Exploring the construct of subjective sleep quality in patients with insomnia. *The Journal of Clinical Psychiatry*. https://doi.org/10.4088/jcp.14m09066

Hartmann, J. A., Nelson, B., Spooner, R., Paul Amminger, G., Chanen, A., Davey, C. G., McHugh, M., Ratheesh, A., Treen, D., & Yuen, H. P. (2019). Broad clinical high-risk mental state (CHARMS): methodology of a cohort study validating criteria for pluripotent risk. *Early Intervention in Psychiatry, 13*(3), 379-386. https://doi.org/10.1111/eip.12483

Harvey, A. G. (2008). Insomnia, psychiatric disorders, and the transdiagnostic perspective. *Current Directions in Psychological Science*, *17*(5), 299-303. https://doi.org/10.1111/j.1467-8721.2008.00594.x

Huỳnh, C., Guilé, J.-M., Breton, J.-J., & Godbout, R. (2016). Sleep-wake patterns of adolescents with borderline personality disorder and bipolar disorder. *Child Psychiatry & Human Development, 47*(2), 202-214. https://doi.org/10.1007/s10578-015-0557-8

Jenkins, C. A., Thompson, K. N., Nicholas, C. L., & Chanen, A. M. (2021). Sleep in Young People with Features of Borderline Personality Disorder: A Scoping Review. *Journal of Personality Disorders, 0*(0), 1-19 https://doi.org/10.1521/pedi_2021_35_525

Jenkins, C. A., Tiley, L. C. F. Lay, I., Hartmann, J. A., Chan,, J. K. M., & Nicholas, C. L., (2021). Comparing GENEActiv Against Actiwatch-2 Over Seven Nights Using a Common Sleep Scoring Algorithm and Device-Specific Wake Thresholds. *Behavioural Sleep Medicine,* 1-11. https://doi.org/10.1080/15402002.2021.1924175

Johns, M. W. (1991). A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep, 14*(6), 540-545. https://doi.org/10.1093/sleep/14.6.540

Johns, M. W. (1992). Reliability and factor analysis of the Epworth Sleepiness Scale. *Sleep, 15*(4), 376-381.

Kaess, M., von Ceumern-Lindenstjerna, I.-A., Parzer, P., Chanen, A., Mundt, C., Resch, F., & Brunner, R. (2013). Axis I and II comorbidity and psychosocial functioning in female adolescents with borderline personality disorder. *Psychopathology, 46*(1), 55-62. https://doi.org/10.1159/000338715

Karukivi, M., Vahlberg, T., Horjamo, K., Nevalainen, M., & Korkeila, J. (2017). Clinical importance of personality difficulties: diagnostically sub-threshold personality disorders. *BMC Psychiatry, 17*(1), 16. https://doi.org/10.1186/s12888-017-1200-y

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry, 62*(6), 593-602. https://doi.org/10.1001/archpsyc.62.6.593

Lenzenweger, M. F., Lane, M. C., Loranger, A. W., & Kessler, R. C. (2007). DSM-IV personality disorders in the National Comorbidity Survey Replication. *Biological Psychiatry, 62*(6), 553-564. https://doi.org/10.1016/j.biopsych.2006.09.019

Lieb, K., Zanarini, M. C., Schmahl, C., Linehan, M. M., & Bohus, M. (2004). Borderline personality disorder. *The Lancet, 364*(9432), 453-461. https://doi.org/10.1016/S0140-6736(04)16770-6

Leichsenring, F., Leibing, E., Kruse, J., New, A. S., & Leweke, F. (2011). Borderline personality disorder. *The Lancet, 377(*9759), 74–84. https://doi.org/10.1016/S0140-6736(10)61422-5

Liebke, L., Bungert, M., Thome, J., Hauschild, S., Gescher, D. M., Schmahl, C., Bohus, M., & Lis, S. (2017). Loneliness, social networks, and social functioning in borderline

personality disorder. *Personality Disorders: Theory, Research, and Treatment, 8*(4), 349. https://doi.org/10.1037/per0000208

Maich, K. H., Lachowski, A. M., & Carney, C. E. (2018). Psychometric properties of the consensus sleep diary in those with insomnia disorder. *Behavioral Sleep Mmedicine, 16*(2), 117-134. https://doi.org/10.1080/15402002.2016.1173556

Maislin, G., Pack, A. I., Kribbs, N. B., Smith, P. L., Schwartz, A. R., Kline, L. R., Schwab, R. J., & Dinges, D. F. (1995). A survey screen for prediction of apnea. *Sleep, 18*(3), 158-166. https://doi.org/10.1093/sleep/18.3.158

McGowan, N. M., & Saunders, K. E. A. (2021). The Emerging Circadian Phenotype of Borderline Personality Disorder: Mechanisms, Opportunities and Future Directions. *Current Psychiatry Reports, 23*(5), 30. https://doi.org/10.1007/s11920-021-01236-w

Morin, C. M., & Barlow, D. H. (1993). *Insomnia: Psychological Assessment and Management* (Vol. 104). Guilford Press New York.

Morin, C. M., Belleville, G., Bélanger, L., & Ivers, H. (2011). The Insomnia Severity Index: Psychometric Indicators to Detect Insomnia Cases and Evaluate Treatment Response. *Sleep, 34*(5), 601-608. https://doi.org/10.1093/sleep/34.5.601

Newton-Howes, G., Clark, L. A., & Chanen, A. (2015). Personality disorder across the life course. *The Lancet, 385*(9969), 727–734. https://doi.org/10.1016/S0140-6736(14)61283-6

Oakley, N. (1997). Validation with polysomnography of the Sleepwatch sleep/wake scoring algorithm used by the Actiwatch activity monitoring system. *Cambridge Neurotechnology*.

Ohayon, M. M., Carskadon, M. A., Guilleminault, C., & Vitiello, M. V. (2004). Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: developing normative sleep values across the human lifespan. *Sleep, 27*, 1255-1274. https://doi.org/10.1093/sleep/27.7.1255

Oltmanns, J. R., & Oltmanns, T. F. (2015). Borderline personality pathology, polysomnography, and self-reported sleep problems: a review. *Current Sleep Medicine Reports, 1*(2), 141-149. https://doi.org/10.1007/s40675-015-0011-2

Ong, J. C., Huang, J. S., Kuo, T. F., & Manber, R. (2007). Characteristics of insomniacs with self-reported morning and evening chronotypes. *Journal of Clinical Sleep Medicine, 3*(3), 289-294. https://doi.org/10.5664/jcsm.26801

Plante, D. T., Frankenburg, F. R., Fitzmaurice, G. M., & Zanarini, M. C. (2013). Relationship between maladaptive cognitions about sleep and recovery in patients with borderline

personality disorder. *Psychiatry Research, 210*(3), 975-979. https://doi.org/10.1016/j.psychres.2013.08.004

Roenneberg, T., Allebrandt, K. V., Merrow, M., & Vetter, C. (2012). Social jetlag and obesity. *Current Biology, 22*(10), 939-943. https://doi.org/10.1016/j.cub.2013.04.011

Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms, 18*(1), 80-90. https://doi.org/10.1177/0748730402239679

Santisteban, J. A., Brown, T. G., & Gruber, R. (2018). Association between the munich chronotype questionnaire and wrist actigraphy. *Sleep Disorders*, 2018. https://doi.org/10.1155/2018/5646848

Sawyer, S. M., Azzopardi, P. S., Wickremarathne, D., & Patton, G. C. (2018). The age of adolescence. *The Lancet. Child & Adolescent Health, 2*(3), 223–228. https://doi.org/10.1016/S2352-4642(18)30022-1

Selvi, Y., Aydin, A., Gulec, M., Boysan, M., Besiroglu, L., Ozdemir, P. G., & Kilic, S. (2012). Comparison of dream anxiety and subjective sleep quality between chronotypes. *Sleep and Biological Rhythms, 10*(1), 14-22. https://doi.org/https://doi.org/10.1111/j.1479-8425.2011.00511.x

Stanley, B., & Wilson, S. T. (2006). Heightened subjective experience of depression in borderline personality disorder. *Journal of Personality Disorders, 20*(4), 307-318. https://doi.org/10.1521/pedi.2006.20.4.307

Thompson, K. N., Allen, N. B., Chong, S., & Chanen, A. M. (2018). Affective startle modulation in young people with first-presentation borderline personality disorder. *Psychiatry Research, 263*, 166-172. https://doi.org/10.1016/j.psychres.2018.02.049

Thompson, K. N., Jackson, H., Cavelti, M., Betts, J., McCutcheon, L., Jovev, M., & Chanen, A. M. (2019). The clinical significance of subthreshold borderline personality disorder features in outpatient youth. *Journal of Personality Disorders, 33*(1), 71-81. https://doi.org/10.1521/pedi_2018_32_330

Van Veen, M. M., Karsten, J., & Lancel, M. (2017). Poor sleep and its relation to impulsivity in patients with antisocial or borderline personality disorders. *Behavioral Medicine, 43*(3), 218-226. https://doi.org/10.1080/08964289.2017.1313719

Vanable, P. A., Aikens, J. E., Tadimeti, L., Caruana-Montaldo, B., & Mendelson, W. B. (2000). Sleep latency and duration estimates among sleep disorder patients: variability as a function of sleep disorder diagnosis, sleep history, and psychological

characteristics. *Sleep: Journal of Sleep Research & Sleep Medicine*, *3*(1), 71–79. https://doi.org/10.1093/sleep/23.1.1d

Wall, K., Vanwoerden, S., Penner, F., Patriquin, M., Alfano, C. A., & Sharp, C. (2020). Adolescent Sleep Disturbance, Emotion Regulation and Borderline Features in an Inpatient Setting. *Journal of Clinical Child & Adolescent Psychology*, 1-15. https://doi.org/10.1080/15374416.2020.1772081

Winsper, C., & Tang, N. K. Y. (2014). Linkages between insomnia and suicidality: Prospective associations, high-risk subgroups and possible psychological mechanisms. *International Review of Psychiatry, 26*(2), 189–204. https://doi.org/10.3109/09540261.2014.881330

Winsper, C., Tang, N. K. Y., Marwaha, S., Lereya, S. T., Gibbs, M., Thompson, A., & Singh, S. P. (2017). The sleep phenotype of Borderline Personality Disorder: a systematic review and meta-analysis. *Neuroscience & Biobehavioral Reviews*. https://doi.org/10.1016/j.neubiorev.2016.12.008

Vanek, J., Prasko, J., Ociskova, M., Hodny, F., Holubova, M., Minarikova, K., Slepecky, M., & Nesnidal, V. (2021). Insomnia in Patients with Borderline Personality Disorder. *Nature and Science of Sleep, 13,* 239-250. https://doi.org/10.2147/NSS.S295030

Table 1

Actigraphy Outcome Variable Definitions

Outcome Variable	Definition
Bedtime	Based on the sleep diary item "What time did you try to go to sleep?"
Rise time	Based on the sleep diary item "What time was your final awakening?"
Time in Bed	The total time elapsed between bedtime and rise time
Sleep Interval	The sleep interval started at the first epoch of the first section of 5 consecutive (1 minute) epochs scored as sleep after bedtime. The sleep interval ended to the last epoch of the last section of 5 consecutive epochs scored as sleep before rise time.
Total Sleep Time	The total amount of epochs scored as sleep during the sleep interval
Sleep Efficiency	Total sleep time divided by the rest interval, expressed as a percentage
Sleep Onset Latency	The time elapsed between the start of the bedtime and the start of the sleep interval
Wake After Sleep Onset	Time spent awake during the sleep interval

Note. The sleep interval was not included as an outcome measure, but is included here for the purposes of clearly defining other outcome measures.

Table 2

Sample Characteristics and Demographics

Characteristic	**BPD (n = 40)**	**HC (n = 38)**	**CC (n = 18)**
Sex: Female	36 (90%)	34 (89.5%)	13 (72.2%)
Age	19.77 (SD = 2.51)	20.06 (SD = 2.52)	20.52 (SD = 3.14)
Socioeconomic Status (Index of Relative Socio-economic Disadvantage)	48.13 (SD = 25.32)	54.47 (SD = 30.37)	48.00 (SD = 27.80)
BPD Diagnosis			
Sub-threshold	11 (27.5%)	N/A	N/A
Full-threshold	29 (72.5%)		
BPD Symptoms			
1 – Abandonment	23 (57.5%)	N/A	-
2 – Relationship Instability	25 (62.5%)		-
3 – Identity Disturbance	24 (60%)		-
4 – Impulsivity	14 (35%)		1 (5.6%)
5 – Recurrent DSH	32 (80%)		1 (5.6%)
6 – Affective Instability	31 (77.5%)		-
7 – Emptiness	26 (65%)		-
8 – Anger	16 (40%)		-
9 – Stress Dissociation	19 (47.5%)		1 (5.6%)
Living Situation			
Renting (independent of family of origin)	14 (35%)	13 (34.2%)	4 (22.2%)
With family of origin	25 (62.5%)	24 (63.2%)	14 (77.8%)
Supported residential service	1 (2.5%)	-	-
Hostel-type accommodation	-	1 (2.6%)	-
Employment Status			
Full time work	3 (7.5%)	-	2 (11.1%)
Full time work and full time student	1 (2.5%)	-	-
Full time student	10 (25%)	15 (39.5%)	6 (33.3%)
Full time student and part-time work (11-30hrs)	4 (10%)	7 (17.9%)	2 (11.1%)

Full time student and part-time work (<11hrs)	1 (2.5%)	12 (31.6%)	5 (27.8%)
Part time student	5 (12.5%)	-	-
Part time student and part-time work (11-30hrs)	-	1 (2.6%)	-
Part time student and part-time work (<11hrs)	1 (2.5%)	-	-
Part time work (11-30hrs)	4 (10%)	3 (7.9%)	1
Part time work (<11hrs)	1 (2.5%)	-	-
Unemployed	10 (25%)	-	2 (11.1%)
Current Co-occuring Mental State Disorders*			
Acute Stress Disorder	1 (2.5%)	N/A	-
Agoraphobia	11 (27.5%)		-
Binge Eating Disorder	1 (2.5%)		-
Bulimia	4 (10%)		-
Generalized Anxiety Disorder	20 (50%)		5 (27.8%)
Major Depressive Disorder	21 (52.5%)		7 (38.9%)
Obsessive Compulsive Disorder	1 (2.5%)		-
Panic Disorder	7 (17.5%)		2 (11.1%)
Persistent Depressive Disorder	22 (55%)		1 (5.6%)
Posttraumatic Stress Disorder	22 (55%)		-
Social Anxiety	23 (57.5%)		4 (%)
Other specified anxiety disorder	-		2 (11.1%)
Current Co-occurring Personality Disorders			
Antisocial	4 (10%)	N/A	PDs other
Avoidant	12 (30%)		than BPD not
Dependent	4 (10%)		assessed
Histrionic	3 (7.5%)		
Obsessive Compulsive	5 (12.5%)		
Paranoid	10 (25%)		
Schizoid	2 (5%)		
PD not otherwise specified	2 (5%)		
Other Past Mental State Disorders			
Anorexia	10 (25%)	N/A	1 (5.6%)
Binge Eating Disorder	1 (2.5%)		-
Bulimia	1 (2.5%)		-

Generalized Anxiety Disorder	4 (10%)		1 (5.6%)
Major Depressive Disorder	17 (42.5%)		3 (16.7%)
Obsessive Compulsive Disorder	2 (5%)		-
Panic Disorder	7 (17.5%)		1 (5.6%)
Persistent Depressive Disorder	2 (5%)		1 (5.6%)
Posttraumatic Stress Disorder	5 (12.5%)		2 (11.1%)
Social Anxiety	1 (2.5%)		-
Medication			
Mood Stabilisers			
Lithium	1 (2.5%)	-	-
Antidepressants			
Fluoxetine	6 (15%)	-	1 (5.6%)
Escitalopram	1 (2.5%)	-	-
Sertraline	8 (20%)	-	-
Venlafaxine	2 (5%)	-	-
Mirtazapine	2 (5%)	-	-
Antipsychotics			
Latuda	1 (2.5%)	-	-
Quetiapine	1 (2.5%)	-	-
Lurasidone	1 (2.5%)	-	-
Risperidone	1 (2.5%)	-	-
Aripiprazole	2 (5%)	-	-
Benzodiazepine**			
Diazepam	4 (10%)	-	-
Lorazepam	1 (2.5%)	-	-
Temazepam	1 (2.5%)	-	-
Sleeping Medications (Non-Benzodiazepine)**			
Melatonin	2 (5%)	-	-
Zopiclone	2 (5%)	-	-
Other			
Progesterone	1 (2.5%)	-	-
Spironolactone	1 (2.5%)	-	-
Pregabalin	1 (2.5%)	-	1 (5.6%)

Thyroxine	1 (2.5%)	-	-
Carbamazepine	-	-	1 (5.6%)
Birth control pill	1 (2.5%)	13 (34.2%)	3 (7.9%)
Hormonal IUD (Mirena)	-	2 (5.3%)	-
Implanon	-	-	1 (5.6%)
Isotretinoin (Roaccutane)	-	1 (2.6%)	-
Epiduo	-	-	2 (5.3%)
Emtricitabine / Tenofovir	-	1 (2.6%)	-
Meloxican	-	-	1 (5.6%)
Pizotifen	-	-	1 (5.6%)
No medication			
No psychotropic medication	16 (40%)	38 (100%)	17 (94.4%)

Note. BPD = borderline personality disorder. HC = healthy comparison, CC = clinical comparison.

* Four participants in the clinical comparison group did not meet criteria for any current DSM-5 diagnoses, but were help-seeking individuals with sub-threshold anxiety and depressive symptoms.

** All sleep medications (benzodiazepines and non-benzodiazepines) were prescribed PRN and not taken during the actigraphy component of the study.

Table 3

Mean (SD) Actigraphy Sleep Parameters and Inter-Group Comparisons – Weeknight and Weekend Data Combined

Sleep Parameter	BPD (n = 37)	HC (n = 37)	CC (n = 18)	H	η^2_H	BPD vs. HC	BPD vs. CC	CC vs. HC
Bedtime (time ± min)	12:11AM (89.91)	12:22AM (58.92)	12:15AM (79.48)	0.78	-0.01	n.c.	n.c.	n.c.
Rise time (time ± min)	9:19AM (89.19)	8:18AM (65.43)	8:57AM (69.99)	11.97**	0.11	-21.32**	-7.76	13.56
Time in Bed (min)	548.82 (79.95)	476.25 (43.17)	523.44 (49.99)	19.15***	0.19	-25.87***	-3.54	22.33*
Total Sleep Time (min)	492.5 (92.20)	431.05 (66.59)	430.96 (42.85)	11.45**	0.11	-17.97*	-21.28*	3.31
Sleep Onset Latency (min)	7.68 (7.26)	6.04 (8.19)	5.29 (3.16)	5.17	0.04	n.c.	n.c.	n.c.
Sleep Efficiency (%)	89.79% (9.98%)	90.25% (10.70%)	82.87% (5.78%)	17.68***	0.18	-5.08	-26.40**	31.48
Wake After Sleep Onset (min)	45.14 (46.75)	36.16 (39.92)	78.81 (30.62)	20.64***	0.21	-8.32	-26.30**	34.62***
Variability								
Bedtime (SD-min)	99.68 (55.28)	64.77 (39.84)	69.25 (31.13)	10.06**	0.09	-19.41**	-13.51	5.90
Rise time (SD-min)	98.68 (43.65)	67.89 (27.36)	87.18 (32.28)	11.42**	0.11	-20.41**	-4.68	15.73
Time in Bed (CV)	0.20 (0.11)	0.18 (0.09)	0.18 (0.08)	0.89	-0.01	n.c.	n.c.	n.c.
Total Sleep Time (CV)	0.21 (0.10)	0.20 (0.10)	0.17 (0.07)	1.50	-0.01	n.c.	n.c.	n.c.

Note. BPD = borderline personality disorder. HC = healthy comparison. CC = clinical comparison. * $p < .05$, *** $p < .01$, *** $p < .001$. n.c. = not calculated. H = Kruskal Wallis ANOVA test statistic. Group comparisons = Dunn-Bonferroni pairwise comparison, with Bonferroni adjusted p values.

Table 4

Mean (SD) Actigraphy Sleep Parameters and Inter-Group Comparisons –Weekend (Friday-Saturday Nights) Data Only

Sleep Parameter	BPD (n = 37)	HC (n = 35)	CC (n = 17)	H	η^2_H	BPD vs. HC	BPD vs. CC	CC vs. HC
Bedtime (time ± min)	12:49AM (121.88)	12:45AM (78.34)	12:36AM (86.46)	0.20	-0.02	n.c.	n.c.	n.c.
Rise time (time ± min)	10:02AM (95.87)	9:07AM (75.17)	9:24AM (86.49)	8.27*	0.07	-17.52*	-8.30	9.22
Time in Bed (min)	552.69 (105.63)	502.30 (61.67)	528.20 (77.38)	7.05*	0.06	-15.95*	-4.67	11.29
Total Sleep Time (min)	493.51 (110.85)	448.58 (76.12)	443.90 (68.05)	5.23	0.04	n.c.	n.c.	n.c.
Sleep Onset Latency (min)	8.95 (10.37)	8.81 (14.81)	4.00 (3.33)	4.06	0.02	n.c.	n.c.	n.c.
Sleep Efficiency (%)	89.55% (10.41%)	89.50% (10.79%)	84.21% (6.42%)	10.98**	0.10	-4.08	-20.63*	24.71**
Wake After Sleep Onset (min)	46.84 (50.41)	40.84 (44.8)	75.82 (35.36)	12.74**	0.12	-5.45	-21.42*	26.87**
Variability								
Bedtime (SD-mins)	104.66 (73.06)	68.16 (41.50)	66.36 (29.83)	5.38	0.04	n.c.	n.c.	n.c.
Rise time (SD-mins)	91.92 (71.41)	50.49 (30.66)	65.21 (32.71)	7.95*	0.07	-17.04*	-7.45	9.59
Time in Bed (CV)	0.19 (0.17)	0.16 (0.13)	0.15 (0.07)	0.42	-0.02	n.c.	n.c.	n.c.
Total Sleep Time (CV)	0.20 (0.16)	0.18 (0.13)	0.16 (0.07)	0.06	-0.02	n.c.	n.c.	n.c.

Note. BPD = borderline personality disorder. HC = healthy comparison. CC = clinical comparison. * $p < .05$, *** $p < .01$, *** $p < .001$. n.c. = not calculated. H = Kruskal Wallis ANOVA test statistic. Group comparisons = Dunn-Bonferroni pairwise comparison, with Bonferroni adjusted p values.

Table 5

Mean (SD) Actigraphy Sleep Parameters and Inter-Group Comparisons – Weeknight (Sunday-Thursday) Data Only

Sleep Parameter	BPD (n = 37)	HC (n = 35)	CC (n = 17)	H	η^2_H	BPD vs. HC	BPD vs. CC	CC vs. HC
Bedtime (time ± min)	11:51PM (94.99)	12:14AM (61.74)	12:07AM (79.67)	2.31	0.00	n.c.	n.c.	n.c.
Rise time (time ± min)	8:58AM (100.28)	8:02AM (69.98)	8:46AM (76.06)	7.99*	0.07	-16.97*	-3.44	13.53
Time in Bed (min)	547.25 (88.59)	468.40 (49.38)	521.39 (46.14)	21.86***	0.22	-27.08***	-1.73	25.35**
Total Sleep Time (min)	492.68 (100.18)	426.30 (73.22)	426.12 (39.45)	11.51**	0.11	-17.49*	-22.01*	4.52
Sleep Onset Latency (min)	6.95 (7.41)	5.01 (5.41)	5.94 (3.79)	3.31	0.01	n.c.	n.c.	n.c.
Sleep Efficiency (%)	90.00% (10.44%)	90.57% (10.81%)	82.43% (5.85%)	19.67***	0.20	-5.05	-28.00**	33.06***
Wake After Sleep Onset (min)	44.24 (48.50)	34.57 (39.008)	79.59 (30.55)	22.86***	0.23	-8.60	-27.82**	36.41***
Variability								
Bedtime (SD-mins)	81.63 (50.04)	57.74 (43.67)	68.74 (33.94)	8.82*	0.08	-18.00*	-4.51	13.49
Rise time (SD-mins)	80.98 (43.99)	54.77 (29.52)	78.69 (39.30)	8.02*	0.07	-15.89*	-0.55	16.44
Time in Bed (CV)	0.19 (0.10)	0.17 (0.10)	0.18 (0.09)	1.62	0.00	n.c.	n.c.	n.c.
Total Sleep Time (CV)	0.21 (0.11)	0.2 (0.11)	0.17 (0.08)	1.26	-0.01	n.c.	n.c.	n.c.

Note. BPD = borderline personality disorder. HC = healthy comparison. CC = clinical comparison. * $p < .05$, *** $p < .01$, *** $p < .001$. n.c. = not calculated. H = Kruskal Wallis ANOVA test statistic. Group comparisons = Dunn-Bonferroni pairwise comparison, with Bonferroni adjusted p values.

Table 6

Mean (SD) Actigraphy and Self-Report Sleep Parameters in Young People with BPD Features with and without Co-occurring Depression

	Combined Days		Weekdays		Weekends	
	Depression	No Depression	Depression	No Depression	Depression	No Depression
Subjective						
Insomnia Severity Index	15.37 (6.59)	12.93 (6.81)				
Pittsburgh Sleep Quality Index	10.87 (4.15)	9.03 (3.46)				
Munich Chronotype Questionnaire	6:01AM (112.14)	5:13AM (54.35)				
Epworth Sleepiness Scale	7.58 (5.03)	7.00 (2.16)				
Actigraphy						
Bedtime (time ± min)	12:22AM (97.01)	11:41PM (61.79)	11:58PM (103.94)	11:33PM (65.95)	1:13AM (124.75)	11:44PM (89.15)
Rise time (time ± min)	9:09AM (94.19)	9:51AM (68.77)	8:47AM (103.20)	9:29AM (89.65)	9:53AM (104.77)	10:24AM (65.36)
Time in Bed (min)	526.38 (68.56)	609.42 (80.02)	528.99 (84.18)	596.54 (84.99)	520.06 (93.54)	640.79 (86.79)
Total Sleep Time (min)	467.27 (83.71)	560.62 (81.82)	470.24 (97.51)	553.28 (84.17)	460.35 (97.31)	583.02 (97.95)
Sleep Onset Latency (min)	7.67 (6.70)	7.73 (8.99)	7.35 (7.88)	5.89 (6.22)	8.14 (8.04)	11.15 (15.37)
Sleep Efficiency (%)	89.02% (11.36%)	91.90% (4.39%)	89.04% (11.92%)	92.60% (3.95%)	89.11% (11.73%)	90.90% (5.71%)
Wake After Sleep Onset (min)	47.31 (53.96)	39.26 (16.73)	47.49 (55.95)	35.45 (15.78)	47.29 (57.61)	45.63 (23.92)
Actigraphy Variability						
Bedtime (SD-mins)	99.66 (57.25)	99.73 (52.46)	79.89 (45.76)	86.32 (62.73)	102.53 (76.77)	110.4 (65.38)
Rise time (SD-mins)	98.25 (44.01)	99.83 (44.98)	81.27 (38.53)	80.18 (58.73)	93.72 (79.68)	87.06 (44.96)
Time in Bed (CV)	0.21 (0.12)	0.17 (0.07)	0.20 (0.10)	0.17 (0.10)	0.20 (0.19)	0.16 (0.12)

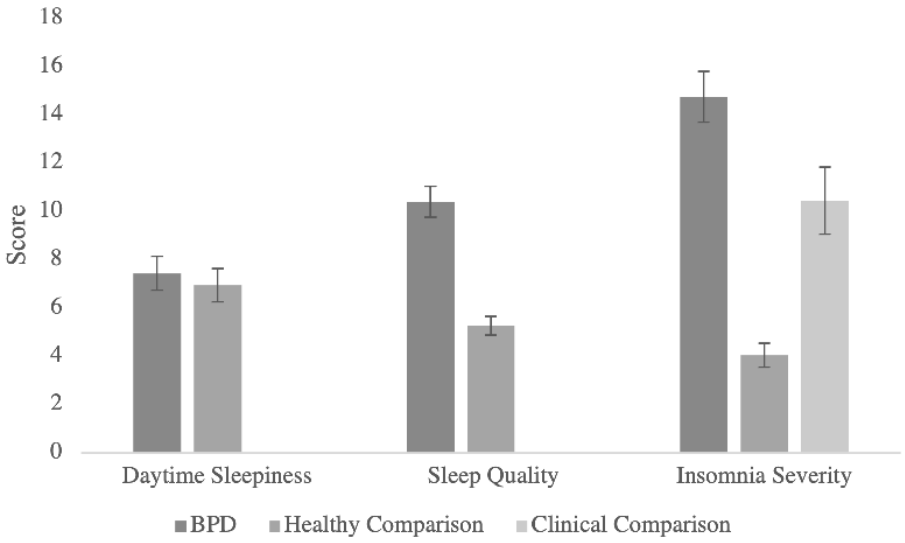
Total Sleep Time (CV)	0.23 (0.11)	0.18 (0.08)	0.22 (0.11)	0.18 (0.11)	0.20 (0.18)	0.18 (0.12)

Table 7

Mean (SD) Actigraphy and Self-Report Sleep Parameters in Adolescents (15-17 years, N = 12) and Young Adults (18-25 years, N = 28) with BPD Features

	Combined Days		Weekdays		Weekends	
	Adolescents	Young Adults	Adolescents	Young Adults	Adolescents	Young Adults
Subjective						
Insomnia Severity Index	15.58 (5.90)	14.4 (7.01)				
Pittsburgh Sleep Quality Index	11.00 (4.11)	10.15 (4.04)				
Munich Chronotype Questionnaire	5:19AM (87.58)	6:05AM (108.61)				
Epworth Sleepiness Scale	8.48 (4.59)	6.99 (4.42)				
Actigraphy						
Bedtime (time ± min)	11:45PM (44.34)	12:22AM (102.17)	11:25PM (46.21)	12:03AM (108.19)	12:24AM (90.02)	12:59AM (133.24)
Rise time (time ± min)	9:17AM (65.63)	9:22AM (98.64)	8:59 (80.23)	8:58 (109.12)	10:02AM (69.71)	10:01AM (106.26)
Time in Bed (min)	572.59 (80.04)	538.77 (79.31)	574.49 (92.97)	535.72 (85.9)	578.41 (105.61)	541.8 (105.79)
Total Sleep Time (min)	522.7 (105.21)	479.72 (85.11)	520.56 (122.53)	480.88 (89.23)	537.91 (113.64)	474.72 (106.27)
Sleep Onset Latency (min)	5.41 (6.12)	8.64 (7.59)	6.40 (9.13)	7.19 (6.75)	3.08 (2.64)	11.44 (11.43)
Sleep Efficiency (%)	91.01% (11.85%)	89.28% (9.30%)	90.27% (14.18%)	89.88% (8.75%)	92.82% (7.65%)	88.23% (11.22%)
Wake After Sleep Onset (min)	41.01 (46.77)	46.88 (47.56)	44.05 (57.64)	44.32 (45.37)	33.75 (31.59)	52.38 (56.15)
Actigraphy Variability						
Bedtime (SD-mins)	95.07 (46.21)	101.63 (59.43)	83.91 (49.09)	80.66 (51.37)	89.2 (58.84)	111.19 (78.43)
Rise time (SD-mins)	96.09 (33.94)	99.78 (47.74)	77.76 (45.98)	82.34 (43.97)	91.22 (70.28)	92.22 (73.26)

Time in Bed (CV)	0.20 (0.09)	0.20 (0.11)	0.18 (0.05)	0.19 (0.11)	0.19 (0.22)	0.19 (0.15)
Total Sleep Time (CV)	0.22 (0.10)	0.21 (0.11)	0.20 (0.09)	0.21 (0.11)	0.20 (0.21)	0.19 (0.15)



jsr_13463_f1.png