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THE RELATIONSHIP BETWEEN SLEEP DISTURBANCE, AND DISEASE ACTIVITY IN PEDIATRIC PATIENTS WITH INFLAMMATORY BOWEL DISEASE

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Abstract

Objective: The aim of this prospective cross sectional study was to assess the prevalence of sleep disturbance in children with inflammatory bowel disease (IBD), including the relationships between sleep, inflammatory markers, and disease activity of pediatric patients with IBD.

Methods: Pediatric IBD patients and parents were enrolled in the study. Patients completed the Pittsburgh Sleep Quality Index (PSQI), the Pediatric Daytime Sleepiness Scale (PDSS), and the Adolescent Sleep Wake Scale (ASWS) surveys. Parents completed the Child Sleep Habits Questionnaire (CSHQ). Disease activity for Crohn's disease (CD) was determined by the Pediatric Crohn's Disease Activity Index (PCDAI) and the Pediatric Ulcerative Colitis Activity Index (PUCAI) was used to define disease activity in UC/indeterminate colitis patients.

Results: Fifty-three pediatric patients with IBD (38 CD, 12 UC and 3 Indeterminate colitis) participated in the study. The significant correlations between the CSHQ and PCDAI ($p=0.002$) and the PSQI and PUCAI ($p=0.04$) were found. Youth with UC and indeterminate colitis significantly reported more sleep disturbance than patients with CD, ($p=0.03$, 0.05 , and 0.04 ; PSQI, PDSS, ASWS, respectively). Patients self reported significantly more sleep disturbance than was observed by parents ($p<0.0001$). This study showed the significant correlations between CSHQ score compared to ESR and albumin ($p=0.001$ and 0.03 , respectively).

Conclusion: Results suggest that increased disease activity is associated with adverse effects on sleep quality. Based on the results of this study, pediatric IBD patients should be screened for sleep disturbance.

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Introduction

Pediatric inflammatory bowel disease (IBD) is an immune-mediated chronic inflammatory disease of the intestinal tract, including Crohn's disease (CD) and ulcerative colitis (UC). The pathogenesis of IBD is most commonly a waxing and waning disease with symptomatic periods alternating with asymptomatic periods. The specific trigger(s) for flare-ups of IBD are not defined. Therefore, the primary goal is to achieve and maintain remission while also improving the quality of life.

IBD has been associated with environmental factors (1). In this regard, accruing evidence indicates that sleep disturbance may serve as a potential environmental trigger, which in turn may affect disease course and flare-ups in IBD (2–7, 24).

Sleep disturbance has been reported to impose adverse effects on characteristics of the inflammatory response (8). In animal models of dextran sodium sulfate-induced colitis, introduction of acute or chronic sleep disturbance exacerbates colonic inflammation (9). Inflammatory cytokines such as tumor necrosis factor (TNF- α), interleukin-1 (IL-1) and IL-6 have been shown to act as mediators on the effect on sleep (10). Pediatric studies describe relationships between sleep disturbance and chronic diseases such as juvenile rheumatoid arthritis (11), chronic kidney disease (12), migraines (13) and type I diabetes mellitus (14). Sleep disturbance, therefore, might be an important factor that affects the course of chronic inflammatory disorders.

The current study had three primary aims: 1) to assess the prevalence of sleep disturbance and characterize the nature of sleep quality in children with IBD, 2) to examine the relationship of sleep disturbance to IBD disease activity and inflammatory markers, and 3) to compare reports of sleep quality as reported by parents and adolescents.

Methods

This study was cross-sectional with questionnaire surveys designed to evaluate sleep disturbance in pediatric IBD patients from December 2015 to July 2017 (total 19 months).

Participants

Pediatric patients less than 18 years and diagnosed with IBD were recruited as well as their parent/guardian. Non-English speaking participants or patients who were diagnosed with any chronic medical conditions other than IBD were excluded. Patients older than ten years completed self-report questionnaires.

Procedure

All research procedures were reviewed and approved by the affiliated university Institutional Review Board. Participants were recruited in the clinic setting by investigators (C.J. and N.V.). Informed consent was obtained from the parent or guardian of the subject and assent was obtained from subjects 10 years of age and older prior to enrollment in the study. Sleep and quality of life questionnaires were distributed to parents/patients for completion. The

following information was collected by review of the medical record: patient demographics, IBD classification, IBD phenotype based on the Paris classification, (15) and results of the history and physical examination conducted by pediatric gastroenterologists. Chart reviews also collected additional IBD-related information (e.g., duration, laboratory test results, medication history, etc.).

Sleep Measures

1. The Child Sleep Habits Questionnaire (CSHQ) is a 45-item parent-report measure to identify both behaviorally based and medically based sleep problems in children (16). The CSHQ yields both a total score and eight subscale scores that reflect key sleep domains, including bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night waking, parasomnias, sleep disordered breathing and daytime sleepiness. Items are rated on a 3-point scale: “usually” if the sleep behavior occurred 5 to 7 times/week; “sometimes” for 2 to 4 times/week; and “rarely” for 0 to one time/week. A cut-off total CSHQ score of 41 yielded a sensitivity of 80% and specificity of 72% to identify both behaviorally based and medically-based sleep problems in school-aged children (16). Additionally, the sleep questionnaire was used to elicit causes of sleep disturbance that awaken (and/or delay sleep onset) IBD patients as well as the use of sleeping medications. Parents completed the CSHQ for all patients. So patients aged less than 10 years old completed the CSHQ only by parent.
2. The Pittsburgh Sleep Quality Index (PSQI) is a self-report measure used to assess the quality and patterns of sleep in adolescents/adults (17). It differentiates “poor” from “good” sleep quality by measuring seven areas: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medications and daytime dysfunction over the last month. Items are rated on a 4-point scale: not during the past month (0), less than once a week (1), once or twice a week (2) and three or more times a week (3), yielding a potential score ranging from 0–21. A total component score of 5 or greater is indicative of poor sleep quality with a diagnostic sensitivity of 89.6% and specificity of 86.5% (17). All patients over the age of 10 years completed the PSQI.
3. The Pediatric Daytime Sleepiness Scale (PDSS) is a 32-item self-report questionnaire assessing daily sleep patterns, school achievement, mood, sleepiness, quality of life and extracurricular activities in a Likert-scale format (eg, never=0, seldom=1, sometimes=2, frequently=3, always=4). Higher scores indicated greater levels of sleepiness (18). All patients over the age of 10 years completed the PDSS.
4. The Adolescent Sleep Wake scale (ASWS) is a 28-item self-report instrument that assesses sleep quality in 12- to 18-year-old adolescents (19). ASWS uses a 6-point scale (“always,” “frequently-if not always,” “quite often,” “sometimes,” “once in a while” and “never”), which is measured along five behavioral dimensions: going to bed, falling asleep, maintaining sleep, reinitiating sleep and

returning to wakefulness. The higher scores indicate better sleep quality. All patients over the age of 10 years completed the ASWS.

Since one of the aims of the study was to compare reports of sleep quality between parents and adolescents, it was useful to obtain multiple assessments. The CSHQ is most useful for parental impressions of child sleep quality, while the PSQI, ASWS, and PDSS were useful to obtain self-reported sleep quality by adolescents. The subscales of the ASWS focus on falling asleep and maintaining sleep, while the PSQI measures a broader range of subscales such as the use of sleeping medications and daytime dysfunction.

Assessment of Disease Activity

Participants were diagnosed with IBD by pediatric gastroenterologists. The pediatric gastroenterologists recorded the disease activity based on the Pediatric Crohn's disease activity index (PCDAI) in the CD group (20), which is a weighted score based on symptoms reported by patients, laboratory values and physical examination findings. Patients were defined to have inactive, mild, or severe disease based on their PCDAI score (0–10 = inactive, 11–30 = mild, 31 = moderate/severe). Disease activity in UC patients was determined by the Pediatric Ulcerative Colitis Activity Index (PUCAI), which is based on patient reported symptoms (21). The PUCAI was used as a primary outcome measure to reflect disease activity in pediatric UC and indeterminate colitis. Total sum scores of PUCAI were divided into groups of remission (< 10), mild disease (10–29), moderate (30–64) and severe (> 65). Additionally, we reviewed routine laboratory tests collected as part of the clinic visit, which included Erythrocyte Sedimentation Rate (ESR) and C-Reactive Protein (CRP).

Statistical analysis

The t-test was used to compare the mean values of two samples when both sample sizes were 30 or larger. For sample sizes that were less than 30, normality was assessed using the Shapiro test. If the normality test failed, the Mann-Whitney U test (Wilcoxon test) was used to analyze nonparametric data. In addition, results were validated using a permutation test. For the numeric variables, we compared the mean values using unpaired t-test between two groups of patients. Fisher's exact test was used to compare distributional differences among different levels of categorical variables. Spearman's correlation coefficients were used to evaluate the association between scores using different questionnaires. Scores using different instruments were rescaled to 0–100 for direct comparisons. A paired t-test or Wilcoxon signed rank test was used to compare their mean values. Significance level of 0.05 was used to determine the significance of results.

Results

Sample Characteristics (Table, Supplemental Digital Content)

The mean age at the time of enrollment was 13.88 ± 3.43 (range 3.83–18) years old, with 45 participants over the age of 10 years. The mean weight of patients with CD was significantly lower than patients with UC. Furthermore, the mean BMI of patients with CD was

significantly lower than patients with UC. Patients with IBD were classified according to the Paris classification. Six from 38 patients (15.8%) with CD had growth delay and 32 from 38 patients (84.2%) with CD had no growth delay. Growth-delayed patients with CD (mean PSQI=5.58) had significantly higher sleep disturbance based on the PSQI score than non-growth delayed CD patients (mean PSQI=1.33), $p=0.01$). We found no other significant differences between the Paris classification (age, location, behavior and extent), and sleep questionnaire scores.

Characterization of Sleep in Pediatric IBD (Table 1)

Abnormal sleep quality was reported in 67.9% and 60% of IBD patients according to the CSHQ and PSQI scores, respectively. Interestingly, 17 of the total 32 patients with inactive IBD (53.12%) had a CSHQ score of 41 or greater, which indicates poor sleep quality. Even 13 of the 29 adolescents with inactive IBD (44.8%) who completed the PSQI recorded a score of 5 or greater, which also indicates poor sleep quality.

Patients with UC had significantly more sleep disturbance than patients with CD, according to all adolescent sleep questionnaires; however, there were no significant differences between the parental sleep questionnaire (CSHQ) scores reported by CD and UC patients (Table 1). We found no significant differences between CD and UC patients in nocturnal symptoms including: nocturnal bowel movement(s), nocturnal abdominal pain or feeling too cold/hot.

As for subscales of PSQI scores, the UC group reported significantly higher subscales scores than the CD group in terms of subjective sleep quality, sleep latency, sleep duration, and habitual sleep efficiency (Table 1). Patients with UC also had significantly worse subscales of ASWS scores than CD patients in term of going to bed, and falling asleep (Table 1).

Relationship of sleep to IBD disease activity and inflammatory markers (Table 2)

Child Sleep Habits Questionnaire (CSHQ)

A comparison of CSHQ scores with characteristics of the IBD group such as age, sex, ethnicity, surgery and steroid use found no significant correlations. However, patients with other symptoms of disease activity such as nocturnal abdominal pain and nocturnal bowel movement(s) had significantly higher CSHQ scores when compared to patients without these nocturnal symptoms ($p=0.004$ and 0.001 , respectively). In addition, this study showed a significant correlation between the CSHQ score and laboratory markers of increased IBD activity such as elevated ESR and decreased albumin (Table 2). Furthermore, we found a significant correlation between the PCDAI and CSHQ scores according to Table 2. In addition, CD patients with higher PCDAI scores (CSHQ=1.76), had significantly more sleep disturbance based on the CSHQ score than CD patients in remission, (CSHQ=1.29, $p=0.002$); however, there were no significant differences of CSHQ scores between higher PUCAI scores and remission in the UC group (1.53 and 1.43, $p=0.51$, respectively).

The data in Table 2 demonstrates that other markers of disease activity including abnormalities in hemoglobin, platelet count and ESR significantly correlated with CSHQ scores in the CD group. As for the UC group, the only significant laboratory value that correlated with the CSHQ score was the CRP.

Subscales of the CSHQ score also showed the significant correlations between bedtime resistance, sleep onset delay, sleep anxiety, night waking, parasomnias and PCDAI (Table 3). As for UC group, there were significant correlations between sleep duration, night waking and PUCAI (Table 3).

Pittsburgh Sleep Quality Index (PSQI)

We found no significant correlations/differences among the PSQI score and characteristics or laboratory tests of the IBD group. However, IBD patients with nocturnal abdominal pain, nocturnal bowel movement(s), or feeling too cold/hot, had a significantly higher PSQI score compared to patients without those symptoms ($p=0.02$, 0.001 and 0.04 , respectively). The higher PUCAI scores significantly correlated with the PSQI score (Table 2). Patients with active colitis based on the PUCAI (mean PSQI = 11.12), had a significantly higher PSQI score than patients in remission (mean PSQI = 6.0, $p = 0.03$), however there was no significant difference of PSQI scores between higher PCDAI scores and remission in the CD group.

Subscales of the PSQI score also showed the significant correlations between sleep disturbance and PCDAI (Table 3). As for the UC group, subjective sleep quality significantly correlated with the PUCAI score (Table 3).

Pediatric Daytime Sleepiness Scale (PDSS)

We found no significant correlations between PDSS scores and characteristics, laboratory tests, and nocturnal abdominal pain or nocturnal bowel movement(s). Finally, no correlation between disease activity based on PCDAI and PUCAI and PDSS scores were detected.

Adolescent Sleep Wake scale (ASWS)

Age at the time of diagnosis of IBD was inversely correlated with the ASWS score, (Spearman coefficient = -0.26 , $p = 0.03$), meaning that patients diagnosed with IBD at a younger age had better sleep quality according to the ASWS score. This study showed no other significant correlations between the ASWS and characteristics or laboratory tests. Furthermore, there were no significant correlations between symptoms including nocturnal abdominal pain or nocturnal bowel movement(s), nor disease activity based on PCDAI and PUCAI scores and the ASWS.

Differences between parental and adolescent sleep questionnaire scores

After rescaling all parental (CSHQ) and adolescent questionnaires (PSQI, PDSS, ASWS) to 0–100, adolescents reported significantly more sleep disturbance than parents, according to the PSQI, PDSS and ASWS (24.27 for CSHQ and 28.70, 44.42 and 60.33 PSQI, PDSS, ASWS, respectively; all $p<0.0001$).

Discussion

Sleep disturbance and disease activity of IBD have not been extensively studied in pediatric patients. Pirinen *et al* demonstrated that parents of adolescents with IBD reported more sleep problems than the parents of control subjects. In contrast, adolescents with IBD did not report more sleep problems than control adolescents (3). However, the present study showed adolescents with IBD reported significantly more sleep disturbance than parents reported. This observation is similar to differences in parents' perception of their child's symptoms and patient reported symptoms seen in other conditions such as parents' underestimation of gastroesophageal reflux disease symptoms in adolescents (22).

Sleep disturbance in adults with IBD has been published. Graff *et al* reported poorer sleep quality in 82% of adults with IBD who had active disease compared to a group with inactive disease (4). Pirinen *et al* also studied the correlation between sleep disturbance and disease activity of pediatric IBD based on a numeric visual analog scale (3). That study (3) found that adolescents with severe IBD symptoms had more sleep disturbance associated with somnolence than adolescents with mild IBD symptoms, which was similar to findings in the present study using the PCDAI and PUCAI as indicators of disease severity. Similarly, Benhayon *et al* also reported that sleep disturbance was worse in pediatric IBD with moderate/severe disease activity when compared to patients in remission (6). However, that study only included depressed youth with CD and found sleep disturbance in depressed youth with CD (n = 96) was significantly greater than a healthy group (n = 19) (6). Interestingly, that report found that the mean PSQI scores were similar in depressed youth with CD whether their disease was active or inactive (6). In contrast, the present study found the active disease had significantly worse sleep disturbance than inactive disease in both the CD and UC groups.

In adults, elevated C-Reactive Protein (CRP) was shown to be associated with poorer quality of sleep, even in IBD without nocturnal symptoms (23). Benhayon *et al* showed that ESR and CRP seem to have a strong relationship with sleep disturbance (6). A recently published study (24) showed there were no significant correlations of subjective sleep (the Insomnia Severity Index) with ESR or CRP in children and adolescent with IBD. Furthermore, a statistically significant linear correlation was found between ESR and the percentage of stage 4 sleep of objective sleep EEG recordings ($p=0.013$). ESR and albumin correlated with sleep disturbance, but not CRP in this present study. We speculate that ESR might be one of laboratory tests that correlate with sleep disturbance in IBD patients since ESR remains elevated for a longer period of time in inflammatory processes than CRP.

One adult study (2) revealed adults with inactive IBD (n = 80) had more significant sleep disturbance than healthy controls (n = 15). This present study revealed that subjects with inactive IBD (53.12% and 44.8%) had abnormal CSHQ and PSQI scores respectively, which indicates poor sleep quality. Patients with IBD may have sleep disturbance because of nocturnal abdominal pain, nocturnal bowel movement, or the presence of ostomies that require night-time care. This present study showed patients who had abdominal pain and bowel movement(s) in the night-time had higher sleep disturbance than patients who did not have nocturnal symptoms. However, in our small sample of those having ostomies, this

relationship was not observed. Moreover, this present study showed a significant correlation between feeling too cold/hot during the night and a PSQI score that might suggest IBD alters perception of these symptoms. Adverse effects of anti-inflammatory medications such as corticosteroids may also cause sleep disturbance (25–26). However, our study did not show any correlation between corticosteroid use and sleep questionnaire scores, which was similar to Benhayon *et al* 's report (6).

Ranjbaran *et al* found significantly more sleep disturbance in adults with inactive CD than adults with inactive UC (2). In contrast, this present study showed significantly more sleep disturbance in pediatric UC patients than those with CD without significant differences in night-time bowel movement(s) and night-time abdominal pain, suggesting that increased disease severity may affect sleep quality even in the absence of nocturnal abdominal pain or diarrhea. This present study's result was different from Ranjbaran *et al*'s report because their study investigated only adult inactive IBD and our patients with UC had more severe disease activity than patients with CD (Table, Supplemental Digital Content).

This study has several limitations. The cross-sectional design of the study prevents the ability to determine causal relationships. We hypothesized a bi-directional relationship between sleep and the inflammatory process in IBD. Sleep characteristics were based on survey responses, instead of polysomnography, which is a more objective measure of sleep quality. Sleep disturbance in IBD may be caused by other factors, such as psychological stress, pain, anxiety or depression, which were not analyzed in the present study. Disease activity was determined by the clinical scores PCDAI and PUCAI instead of a more objective marker of mucosal inflammation such as fecal calprotectin.

In conclusion, this study found that pediatric IBD patients are more likely to have significant sleep disturbance regardless of whether the disease is in remission or active. Sleep problems may be associated with increased disease activity. If sleep disturbance does indeed contribute to the disease severity of IBD, then treatment targeting sleep disturbance may be an additional approach to manage IBD. We speculate that future studies may be helpful to determine whether recognition and treatment of sleep disturbance in pediatric IBD patients may decrease disease severity. The present study shows that pediatric patients with IBD should be screened for sleep disturbance.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations:

IBD	Inflammatory Bowel Disease
CD	Crohn's disease
UC	ulcerative colitis
CSHQ	Child Sleep Habits Questionnaire
PSQI	Pittsburgh Sleep Quality Index
PDSS	Pediatric Daytime Sleepiness Scale
ASWS	Adolescent Sleep Wake Scale
PCDAI	Pediatric Crohn's Disease Activity Index
PUCAI	Pediatric Ulcerative Colitis Activity Index

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What is Known

- The specific etiology and trigger(s) for flare-ups of IBD are not defined and there is currently no cure for IBD. Therefore, the primary goal is achieving and maintaining remission while also improving the quality of life.
- Sleep disturbance impose adverse effects on host defense mechanisms and the ability to overcome infection by affecting the magnitude and characteristics of the inflammatory response.

What is New

- Sleep disturbance is reported in 67.9% and 60% patients with IBD, according to responses in parent and adolescent questionnaires, respectively.
- Parental questionnaire (CSHQ) severity scores significantly correlated with the PCDAI in Crohn's disease patients while adolescent questionnaire (PSQI) severity scores significantly correlated with PUCAI in ulcerative colitis/indeterminate colitis patients.
- Adolescents reported significantly more sleep disturbance than parents.
- Patients with UC reported more sleep disturbance than patients with CD, and this difference was statistically significant.

Table 1

Characterization of total and subscales of sleep survey scores within pediatric IBD patients

	Total IBD		CD		UC		Difference between CD & UC
Parent Report	Mean	SD	Mean	SD	Mean	SD	p value
Total CSHQ score	49.01	12.22	44.84	17.77	47.73	10.35	0.38
1. Bedtime resistance	7.86	2.72	7.82	2.98	8.00	1.97	0.20
2. Sleep onset delay	1.54	0.69	1.44	0.64	1.80	0.77	0.12
3. Sleep duration	4.13	1.82	3.89	1.87	4.53	1.99	0.37
4. Sleep anxiety	4.66	2.13	4.63	2.34	4.53	1.84	0.92
5. Night waking	3.98	1.78	3.78	1.98	4.26	1.48	0.77
6. Parasomnias	7.94	3.77	7.73	4.27	8.00	3.02	0.75
7. Sleep disordered breathing	3.18	1.74	3.23	1.90	2.86	1.50	0.94
8. Daytime sleepiness	13.13	4.59	12.50	5.09	14.33	3.53	0.19
Adolescent Report							
Total PSQI score	6.06	4.25	4.78	3.81	9.15	3.84	0.03
1. Subjective sleep quality	0.88	0.77	0.68	0.69	1.38	0.77	0.002
2. Sleep latency	1.68	1.92	1.37	1.93	2.46	1.76	0.01
3. Sleep duration	0.40	0.65	0.25	0.43	0.76	0.92	0.04
4. Habitual sleep efficiency	0.60	0.93	0.22	0.55	1.53	1.05	0.01
5. Sleep disturbances	1.24	0.77	1.21	0.83	1.30	0.63	0.83
6. Use of sleeping medications	0.40	0.93	0.37	0.94	0.46	0.96	0.91
7. Daytime dysfunction over the last month	0.84	0.97	0.68	0.93	1.23	1.01	0.08
Total PDSS score	14.35	7.67	12.93	8.15	17.84	5.04	0.05
Total ASWS score	96.48	34.95	105.38	32.86	81.46	28.15	0.04
1. Going to bed	16.88	5.77	17.81	6.39	14.62	2.95	0.01
2. Falling asleep	21.53	9.31	23.53	9.06	16.61	8.29	0.01
3. Maintaining sleep	21.20	8.99	22.59	9.00	17.38	9.03	0.11
4. Reinitiating sleep	22.31	11.59	22.65	12.32	21.00	10.85	0.33
5. Returning to wakefulness	14.55	7.72	15.53	7.30	11.84	8.83	0.12

Table 2

Correlations of sleep surveys, laboratory tests, and IBD severity score between total IBD, CD and UC group (p value)

	CSHQ			PSQI			PDSS			ASWS		
	Total	CD	UC	Total	CD	UC	Total	CD	UC	Total	CD	UC
PCDAI	N/A	0.49 (0.002)	N/A	N/A	0.21 (0.24)	N/A	N/A	-0.24 (0.185)	N/A	N/A	-0.16 (0.39)	N/A
PUCAI	N/A	N/A	0.12 (0.68)	N/A	N/A	0.57 (0.04)	N/A	N/A	0.27 (0.36)	N/A	N/A	0.16 (0.61)
Hct	-0.17 (0.22)	-0.27 (0.09)	0.15 (0.60)	0.04 (0.79)	-0.01 (0.96)	-0.09 (0.75)	0.02 (0.92)	-0.02 (0.93)	-0.23 (0.46)	-0.06 (0.67)	0.02 (0.90)	-0.04 (0.90)
Hb	-0.25 (0.08)	-0.38 (0.02)	-0.02 (0.94)	-0.05 (0.73)	-0.12 (0.50)	-0.17 (0.56)	0.03 (0.86)	0.09 (0.63)	-0.36 (0.23)	0.003 (0.98)	0.08 (0.65)	-0.05 (0.86)
WBC	0.03 (0.86)	0.03 (0.88)	-0.17 (0.53)	0.16 (0.30)	0.09 (0.59)	0.36 (0.26)	0.21 (0.16)	0.06 (0.74)	0.38 (0.19)	-0.11 (0.48)	-0.05 (0.78)	0.21 (0.48)
Platelet	0.18 (0.20)	0.33 (0.04)	-0.33 (0.23)	0.03 (0.86)	-0.06 (0.75)	0.41 (0.16)	-0.01 (0.93)	-0.06 (0.72)	0.27 (0.37)	-0.11 (0.49)	-0.16 (0.36)	-0.5 (0.85)
ESR	0.46 (0.001)	0.53 (0.001)	0.01 (0.98)	0.18 (0.22)	0.25 (0.17)	0.08 (0.78)	-0.14 (0.35)	-0.13 (0.47)	0.16 (0.59)	-0.18 (0.25)	-0.20 (0.26)	-0.53 (0.06)
Albumin	-0.30 (0.03)	-0.28 (0.09)	-0.25 (0.37)	-0.17 (0.25)	-0.31 (0.09)	-0.03 (0.92)	0.09 (0.55)	0.10 (0.58)	-0.02 (0.95)	0.02 (0.91)	0.05 (0.76)	0.24 (0.43)
CRP	0.04 (0.77)	0.26 (0.11)	-0.60 (0.03)	-0.05 (0.75)	0.07 (0.68)	0.28 (0.35)	0.06 (0.70)	0.11 (0.55)	0.22 (0.48)	-0.18 (0.23)	-0.29 (0.11)	-0.22 (0.47)

Hct, Hematocrit; Hb, Hemoglobin; WBC, White Blood Cell; ESR, Erythrocyte

Sedimentation Rate; CRP, C-Reactive Protein

Table 3

Correlation between subscales of sleep survey scores and IBD severity score

	PCDAI		PUCAI	
Parent Report	Spearman's correlation coefficients	p value	Spearman's correlation coefficients	p value
Total CSHQ score	0.49	0.002	0.11	0.68
1. Bedtime resistance	0.51	0.001	0.34	0.20
2. Sleep onset delay	0.36	0.02	0.30	0.27
3. Sleep duration	0.22	0.20	0.60	0.01
4. Sleep anxiety	0.59	0.001	0.40	0.13
5. Night waking	0.55	0.001	0.69	0.004
6. Parasomnias	0.46	0.006	0.46	0.82
7. Sleep disordered breathing	0.28	0.10	0.42	0.12
8. Daytime sleepiness	0.27	0.10	-0.07	0.79
Adolescent Report				
Total PSQI score	0.21	0.24	0.57	0.04
1. Subjective sleep quality	0.22	0.22	0.63	0.02
2. Sleep latency	-0.02	0.92	0.07	0.80
3. Sleep duration	0.17	0.34	0.53	0.06
4. Habitual sleep efficiency	0.05	0.77	0.24	0.43
5. Sleep disturbances	0.35	0.04	0.41	0.16
6. Use of sleeping medications	0.26	0.14	0.22	0.48
7. Daytime dysfunction over the last month	0.14	0.44	0.37	0.20
Total PDSS score	-0.24	0.18	0.27	0.36
Total ASWS score	-0.15	0.39	0.15	0.61
1. Going to bed	-0.05	0.76	0.25	0.40
2. Falling asleep	-0.19	0.28	0.11	0.71
3. Maintaining sleep	-0.19	0.28	0.47	0.10
4. Reinitiating sleep	-0.18	0.32	0.50	0.07
5. Returning to wakefulness	-0.12	0.50	-0.22	0.45