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SCIENTIFIC INVESTIGATIONS

Sleep disturbances in children with functional gastrointestinal disorders: demographic and clinical characteristics

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Study Objectives: Research indicates a deleterious effect of sleep disturbances on pain and illness-related functioning across pediatric populations. Sleep problems in youth with functional gastrointestinal disorders (FGIDs) are understudied, despite studies in adult FGIDs indicating sleep disruptions increase pain and symptom severity. This study sought to better characterize sleep problems in school-age children with FGIDs and to assess relationships with demographic characteristics and gastrointestinal symptoms.

Methods: Sixty-seven children with FGIDs (pediatric Rome IV criteria) and 59 parents completed questionnaires assessing sleep problems, and children completed a 2-week pain/stooling diary. Sleep problems in this sample were compared with published normative samples, and children above and below the clinical cutoff were compared on demographics and FGID symptoms.

Results: Of the sample, 61% were above the clinical cutoff for sleep disturbances, with significantly greater bedtime resistance, sleep onset delay, sleep duration, and daytime sleepiness than the comparison group. Children above the clinical cutoff reported greater mean abdominal pain severity and pain interference. Relative to White participants, Black/African-American participants were more likely to be above the clinical cutoff and indicated more frequent night wakening and symptoms of sleep-disordered breathing, but lower maximum and overall mean abdominal pain severity.

Conclusions: Sleep problems in children with FGIDs are common and related to greater day-to-day abdominal pain severity and pain interference. Results suggest sleep–pain relationships may differ across racial/ethnic groups. Assessing sleep in children with FGIDs is important, and further research is needed to assess underlying mechanisms and evaluate sleep as a potential treatment target in this population.

Keywords: sleep problems, FGID, school-age children, abdominal pain

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BRIEF SUMMARY

Current Knowledge/Study Rationale: Sleep problems are common and exacerbate pain and symptoms in adults with functional gastrointestinal disorders, but little is known about this in youth. Existing sleep research in pediatric functional gastrointestinal disorders is limited by retrospective assessment and broad age ranges, and rarely examines the relationship to gastrointestinal symptoms, necessitating more methodologically sound research in this population.

Study Impact: This study better characterizes sleep disturbances in pediatric functional gastrointestinal disorders and demonstrates their relationship with gastrointestinal symptoms. Clinically elevated sleep problems were common in children with functional gastrointestinal disorders, and subjective sleep problems were related to greater pain severity and activity interference, suggesting sleep as a target for screening and intervention.

INTRODUCTION

Abdominal pain is the most common type of recurrent/chronic pediatric pain and is reported by up to 10–20% of children, constituting 5% or more of pediatrician visits in the United States.[1] Because most children and adolescents do not have an underlying organic cause explaining their abdominal pain, a significant percentage are diagnosed with a functional gastrointestinal (GI) disorder (FGID), such as irritable bowel syndrome, functional abdominal pain, or functional dyspepsia.[2] Children with FGIDs experience significant declines in health-related quality of life, often equivalent to those with organic GI disorders such as inflammatory bowel disease, as well as greater school absenteeism and health care costs.[3,4] Improving understanding of the multiple causal and perpetuating factors of pain in youth with FGIDs is an important focus of research to tailor assessment and optimize intervention in this population.

In adults with FGIDs, inadequate sleep, delayed sleep onset, and poor sleep quality are common and contribute to increased abdominal pain and GI symptom severity concurrently and next-day.[5–9] At younger ages, most youth with chronic pain complain about sleep disturbances, including short sleep duration, poor quality sleep, and frequent night awakenings.[10] In turn, sleep disruption is related to lower health-related quality of life, greater functional disability, and more limited social functioning.[10] Even in a nonclinical, community-based sample, daytime sleepiness increases risk for GI symptoms.[11] Despite established research supporting the sleep–pain relationship in both adults with irritable bowel syndrome and pediatric chronic

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pain populations, it is unclear if the same occurs for children with FGIDs.

Existing research examining sleep in youth with FGIDs is limited by single-informant report of sleep disturbances (ie, child- or parent-only) or samples with a wide age range of youth, despite distinct developmental differences in sleep–wake regulation.[12] No studies to date have examined relationships among sleep characteristics and daily reports of abdominal pain, other specific FGID symptoms, or pain interference in children with FGIDs. Further, any assessment of GI-related pain or functional disability is limited to retrospective report.[12,13]

To address these gaps in the literature, the aims of this study were to (1) characterize the prevalence and nature of sleep disturbances in school-age children with FGIDs using a measure with clinical cutoff scores and (2) examine how sleep problems relate to demographic characteristics and FGID symptoms measured via a prospective 2-week daily diary including child-reported abdominal pain-severity pain interference. We hypothesized that caregivers and children would report clinically significant sleep disturbances at rates higher than published normative samples, with rates of sleep disturbances predicted to be consistent with clinical samples of adults with FGIDs[6] and older children/adolescents with functional abdominal pain.[13,14] Second, we hypothesized that children with clinically significant sleep disturbances would report higher average abdominal pain severity and pain interference relative to those without clinically significant sleep disturbances.

METHODS

Participants

Sixty-seven children ages 7–12 years and 59 parents were recruited as part of 2 National Institutes of Health–funded studies, one examining factors affecting treatment response to peppermint oil in children with functional abdominal pain and the other a multisite study examining moderators of treatment response to either a low fermentable carbohydrate (FODMAP) diet or a parent-focused cognitive behavioral therapy phone intervention. The difference in sample size between parents and children was a function of the parent-report sleep questionnaire being added to study procedures shortly after the child-report sleep questionnaire. Due to the study design, no healthy controls were recruited in either study. In both studies, FGID status was determined using pediatric Rome IV criteria.[15,16] Sleep and pain/stooling assessments were completed prior to any diet or therapy intervention. Exclusion criteria included children with previous bowel surgery, documented GI disorders (eg, Crohn disease), those currently receiving cognitive-behavioral therapy, comorbid serious chronic medical conditions (eg, diabetes, cystic fibrosis), weight and/or height greater than 2 standard deviations from the mean for age, significant developmental/psychiatric disorders (eg, autism), or a non–English-speaking family.

Procedure

Children were recruited from the Texas Children's Hospital Pediatric Gastroenterology, Hepatology, and Nutrition Service and Texas Children's Hospital Pediatric Associates (primary care pediatrics). Potential participants were identified from billing records documenting *International Classification of Diseases*, *Tenth Revision* (ICD-10), codes for irritable bowel syndrome, functional abdominal pain, or abdominal pain. A research coordinator contacted identified families by letter to offer study information and then by phone for additional screening using a modified pediatric Rome IV questionnaire (https://theromefoundation.org/rome-iv/rome-iv-questionnaire/).[17]

Consenting and assenting parents and children completed a 2-week pain/stooling diary using the REDCap (Research Electronic Data Capture) data-management system.[18] Families completed the 2-week diary and questionnaires using REDCap online surveys, with correspondence in reporting interval for the prospective pain/stooling diary and retrospective sleep data. All study protocols were approved by the Baylor College of Medicine Institutional Review Board. Parents provided consent and the children provided assent.

Measures

Child Sleep Habits Questionnaire

The Child Sleep Habits Questionnaire (CSHQ) is a 38-item retrospective parent-report questionnaire assessing child sleep and sleep-related behaviors over the past week. Sleep problems are rated on a 3-point Likert scale (ie, 1 = "rarely or never," 2 = "sometimes," and 3 = "usually"), with higher scores representing greater sleep problems.[19] The CSHQ yields a total sleep problem score and subscales including bedtime resistance, sleep anxiety, sleep onset delay, parasomnias, daytime sleepiness, night awakenings, and sleep-disordered breathing (SDB). A total score equal to or greater than 41 indicates clinically significant sleep problems.[18,19] CSHQ scores differentiated a clinical sample of children with sleep disorders from children in a community sample and are significantly correlated with child-reported sleep problems.[19] Cronbach's α for the CSHQ in the current study was α = 0.83.

Sleep Self-Report

The Sleep Self-Report (SSR) is a 26-item retrospective child report of sleep behaviors and problems (ie, difficulty going to bed, difficulty waking, and daytime sleepiness) over the past week.[20] Items are rated on a 3-point Likert scale (ie, 1 = "rarely or never," 2 = "sometimes," and 3 = "usually"). Items are summed to represent a total sleep problems score, with higher scores representing greater sleep problems.[20] This total score has demonstrated good convergent validity with sleep-related daytime functioning.[21] Cronbach's α for the SSR in the current study was α = 0.82.

Pain and stool diary

Participants completed 3 daily ratings of pain and stooling using a validated daily diary.[22,23] Children provided information about abdominal pain occurring during morning (midnight to noon), afternoon (noon to 5 PM), and evening hours (5 PM to midnight). For each interval, abdominal pain severity was rated on a

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10-point Likert scale, with 0 = "no pain" and 10 = "the worst." A mean pain-severity rating was computed by calculating the mean of these 3 daily ratings (morning, afternoon, evening) for all nonzero ratings (ie, all ratings except those indicating no pain). Pain frequency was defined as number of days in which pain was rated as 1 or greater, and pain-related interference was assessed by asking whether pain interfered with activities (1 = "not at all," 2 = "a little," 3 = "a lot," or 4 = "could not participate because of the pain") during each respective interval. The mean of pain interference was computed across the 3 intervals (ie, morning, afternoon, evening) each day. Children also reported frequency, timing, and form of bowel movements each day using the Bristol Stool Form Scale.[22] Proportions of constipated stools (ie, rated 1–2 on the Bristol Stool Form Scale), normal stools (ie, rated 3–5 on the Bristol Stool Form Scale) and diarrheal stools (ie, rated 6–7 on the Bristol Stool Form Scale) were calculated. The total number of days in which no bowel movements occurred also was calculated. Consistent with our prior studies, participants with at least 10 days of complete diary data were retained for analyses.[24–26]

Demographics

A demographic questionnaire was used to obtain information regarding child demographics (age, sex, body mass index, race, ethnicity, and insurance).

Data analyses

Analyses were conducted using IBM SPSS version 26 software (IBM Corporation, Armonk, NY). Variables were first examined for outliers and deviation from assumptions of normality. Item-level missing data were addressed by imputing means of subscale scores or the total score as appropriate. Demographic variables were compared for those above and below the cutoff score for clinically significant sleep problems on the CSHQ. Pearson's bivariate correlations were conducted between the SSR total score and FGID symptoms from the pain/stooling diary. Next, SSR and CSHQ total and subscale scores were compared between the whole sample and 2 separate published comparison groups[19,27] utilizing 1-sample *t* tests. Given the diversity of the sample, demographics also were compared by specific racial (eg, Black/African American vs White) and ethnic (ie, Hispanic vs non-Hispanic) groups.[28] Group comparisons were conducted via either Fisher's exact test (for categorical comparisons with cells of $n \leq 5$), chi-square tests, or 1-way analyses of variance. However, group comparisons with non–normally distributed variables were conducted using the 2-sample Mann-Whitney *U* test. Because Cohen's *d* tends to be a positively biased parameter of effect size in smaller samples,[29] 95% confidence intervals were reported as an estimate of effect size. Finally, descriptive analyses examined GI symptom data from the 2-week pain/stooling diary for the whole sample, by racial/ethnic groups, and for those with a CSHQ score above/below the clinical cutoff. Means also were compared for children above and below the CSHQ clinical cutoff using univariate analyses with race/ethnicity entered as a covariate. Data are presented as mean ± standard deviation unless otherwise noted.

RESULTS

Demographic data for the sample (mean age = 10.3 years; 63% female) are provided in **Table 1**. Because of the relatively high proportion of Black/African-American participants in this sample, we explored demographic differences between Black/African-American participants (50.7%) and White participants (40.3%). Participants in other racial groups were not compared directly due to low frequency (ie, n = 5 participants identified as American Indian/Alaskan Native, Asian, or >1 race). The 2 racial groups were equivalent on all other demographic variables including age, sex, body mass index, asthma diagnosis, and insurance status.

Demographic data were examined separately for children with (n = 36) and without (n = 23) clinically significant sleep problems per the CSHQ (**Table 1**). Age, sex, body mass index, ethnicity, and insurance status were equivalent between the 2 groups. Children with clinically significant sleep problems were more likely to identify as Black/African American (37.9%) than children without clinically significant sleep problems (13.8%, $\chi^2 = 5.54$, $P = .019$).

Sleep characteristics

Table 2 presents comparisons between the current sample and community-based comparison groups on the SSR and CSHQ. The SSR scores (child report) from the current sample (36.9 ± 7.3) were significantly higher than scores from the published comparison group (31.6 ± 5.3; $t = 5.92$, $P < .001$) of 619 Dutch elementary school–aged children (mean age = 9.9 ± 1.7; 46.0% female).[27] Additionally, the SSR total was correlated positively with pain interference ($r = .29$, $P = .026$), proportion of diarrheal bowel movements ($r = .29$, $P = .017$), and feeling tired any time during the day ($r = .29$, $P = .019$). Due to its relevance to the FGID population, 1 item on the SSR was examined separately; 25.4% of children (17 out of 67) reported pain waking them up at least 3–7 nights per week. The SSR total was also correlated positively with the CSHQ total ($r = .59$, $P = .003$).

CSHQ scores (parent report) from the current sample (45.0 ± 8.1) were significantly higher than the published comparison group (38.8 ± 5.6; $t = 5.85$, $P < .001$) of 469 US school-aged children (mean age = 7.6 ± 1.5; 48.8% female).[19] Sixty-one percent (n = 59) of the sample scored above the CSHQ clinical cutoff score. Additionally, participants in the current sample reported significantly greater bedtime resistance (7.7 ± 2.2), sleep onset delay (1.6 ± 0.7), sleep duration (3.8 ± 1.2), and daytime sleepiness (13.8 ± 4.0) than the comparison group.

Racial group differences regarding sleep and FGID symptoms

Regarding racial group differences (**Table 3**), total parent-reported sleep problems were greater in Black/African-American participants (n = 30, 46.4 ± 8.1) than in White participants (n = 24, 42.1 ± 6.8), with greater symptoms of SDB and night wakening in Black/African-American participants. Groups did not differ significantly on any of the remaining CSHQ subscales or total child-reported sleep problems. Further, non-Hispanic/Latino

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Table 1—Demographics and group comparisons by CSHQ clinical cutoff (parent report).

	Full Sample	CSHQ Below Clinical Cutoff (n = 23)	CSHQ Above Clinical Cutoff (n = 36)	F/χ^2	*P*
Age, mean ± SD, y	10.3 ± 1.6	10.5 ± 1.6	10.0 ± 1.6	1.44	.236
Female, n (%)	42 (62.7)	14 (23.7)	25 (42.4)	0.46	.497
Body mass index, mean ± SD, kg/m^2	22.3 ± 5.6	21.1 ± 6.0	23.6 ± 5.6	2.65	.109
Race, n (%)	—	—	—	6.77*	.039*
American Indian or Alaskan Native	2 (3.4)	0 (0.0)	2 (3.4)	—	—
Asian	2 (3.4)	1 (1.7)	1 (1.7)	—	—
Black/African American	30 (51.7)	8 (13.8)	22 (37.9)	—	—
White	24 (41.3)	14 (24.1)	10 (17.2)	—	—
Black vs White	—	—	—	5.54*	.019*
Ethnicity: Hispanic or Latino, n (%)	31 (46.3)	11 (18.6)	17 (28.8)	0.00	.964
Insurance, n (%)	—	—	—	2.28	.582
Medicaid	7 (10.4)	3 (5.1)	3 (5.1)	—	—
CHIP	17 (25.4)	4 (6.8)	12 (20.3)	—	—
PPO/HMO/managed care	41 (61.2)	15 (25.4)	20 (33.9)	—	—
Asthma, n (%)	6 (9.0)	1 (1.7)	4 (6.8)	0.83	.639

*P < .05. CHIP = Children's Health Insurance Program, CSHQ = Children's Sleep Habits Questionnaire, HMO = Health Maintenance Organization, PPO = Preferred Provider Organization, SD = standard deviation.

Table 2—Parent-reported sleep characteristics comparing the FGID sample and normative groups.

	Current Sample (n = 59)	CSHQ Comparison Sample	SSR Comparison Sample	*t*	*P*	95% CI	
						Lower	Upper
CSHQ							
Total	45.0 ± 8.1	38.8 ± 5.6	—	5.85***	<.001	4.1	8.3
Bedtime resistance	7.7 ± 2.2	7.1 ± 1.9	—	2.29*	.026	0.1	1.2
Sleep onset delay	1.6 ± 0.7	1.3 ± 0.5	—	3.45**	.001	0.1	0.5
Sleep duration	3.8 ± 1.2	3.4 ± 0.9	—	2.68**	.010	0.1	0.7
Sleep anxiety	5.1 ± 1.8	4.9 ± 1.5	—	0.94	.352	−0.2	0.7
Night wakings	3.5 ± 0.7	3.5 ± 0.9	—	0.16	.871	−0.2	0.2
Parasomnias	8.4 ± 1.6	8.1 ± 1.3	—	1.29	.202	−0.1	0.7
Sleep-disordered breathing	3.5 ± 1.0	3.2 ± 0.6	—	1.86	.068	−0.0	0.5
Daytime sleepiness	13.8 ± 4.0	9.6 ± 2.8	—	8.01***	<.001	3.1	5.2
SSR total	36.9 ± 7.3	—	31.6 ± 5.3	5.92***	<.001	3.5	7.0

Values are means ± SDs unless otherwise indicated. *P < .05; **P < .01; ***P < .001. CI = confidence interval, CSHQ = Children's Sleep Habits Questionnaire, FGID = functional gastrointestinal disorder, SSR = Sleep Self-Report.

participants did not differ significantly from Hispanic/Latino participants on any parent- or child-reported sleep variables.

Given the demographics of the current sample, pain/stooling diary data were compared by race/ethnicity in order to better characterize FGID symptoms in these groups (**Table 3**). Mean abdominal pain severity was significantly higher among White participants (3.8 ± 1.1) than Black/African-American participants (3.0 ± 1.1). Similarly, White participants reported greater maximum pain severity across the 2 weeks (6.0 ± 1.7) than Black/African-American participants (4.8 ± 2.2). Number of days without a bowel movement was greater among Black/African-American participants (6.0 ± 3.4) than White participants (3.5 ± 2.9). No group differences between Hispanic/Latinos and non-Hispanic/Latinos were found for diary variables.

Clinical sleep problems and FGID symptoms

Finally, FGID symptoms from the diary were compared between children below and above the CSHQ clinical cutoff, controlling for group differences in race/ethnicity. Mean pain severity was significantly higher among children with clinically significant sleep problems (3.5 ± 1.2) than children without such problems (3.1 ± 0.9). Further, mean pain interference was significantly greater among children with clinically significant sleep problems (0.7 ± 0.4) than those without such problems (0.4 ± 0.3). Other FGID symptom variables did not differ

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Table 3—Comparison of Black/African-American and White participants on sleep problems and FGID symptoms.

	White (n = 24)	Black (n = 30)	F/Mann-Whitney *U*	*P*	95% CI	
					Lower	Upper
Parent-reported sleep						
CSHQ						
Total	42.1 ± 6.8	46.4 ± 8.1	234.5*	.029	−8.5	−0.2
Bedtime resistance	7.0 ± 1.5	7.8 ± 2.2	277.0	.092	−1.8	0.2
Sleep onset delay	1.5 ± 0.7	1.6 ± 0.7	347.0	.633	−0.4	0.3
Sleep duration	3.5 ± 0.9	4.2 ± 1.4	281.5	.082	−1.3	−0.0
Sleep anxiety	4.8 ± 1.05	4.9 ± 1.8	322.0	.341	−0.8	0.7
Night wakings	3.3 ± 0.6	3.8 ± 0.8	239.0*	.017	−0.9	−0.1
Parasomnias	8.5 ± 1.7	8.3 ± 1.4	346.5	.807	−0.7	1.1
Sleep-disordered breathing	3.2 ± 0.7	3.8 ± 1.2	231.5**	.005	−1.1	−0.1
Daytime sleepiness	12.6 ± 4.0	14.5 ± 3.6	3.54	.065	−3.9	0.1
Child-reported sleep						
SSR total	34.6 ± 7.5	37.4 ± 6.8	357.5	.138	−5.7	1.6
Pain/stooling diary						
Abdominal pain severity (1–10)	3.8 ± 1.1	3.0 ± 1.1	6.40*	.014	0.2	1.4
Maximum abdominal pain severity (1–10)	6.0 ± 1.7	4.8 ± 2.2	5.21*	.026	0.2	2.3
Pain interference rating (1–4)	0.7 ± 0.5	0.5 ± 0.4	306.5	.180	−0.1	0.5
Morning pain severity (1–10)	3.5 ± 1.3	3.0 ± 1.3	2.73	.104	−0.1	1.3
Afternoon pain severity (1–10)	3.9 ± 1.8	3.0 ± 1.2	3.41	.072	−0.1	1.7
Evening pain severity (1–10)	3.6 ± 1.8	3.2 ± 1.5	0.80	.377	−0.5	1.4
Pain frequency (days)	6.7 ± 4.4	5.1 ± 3.8	355.5	.132	−0.5	3.7
Proportion of constipation BMs	0.4 ± 0.4	0.4 ± 0.3	435.0	.725	−0.1	0.2
Proportion of normal BMs	0.5 ± 0.3	0.6 ± 0.3	443.5	.821	−0.2	0.2
Proportion of diarrhea BMs	0.1 ± 0.1	0.1 ± 0.2	454.5	.937	−0.1	0.1
Number of days without BMs	3.5 ± 2.9	6.0 ± 3.4	266.5**	.005	−4.2	−0.8
Tired any time throughout day	1.9 ± 1.8	2.1 ± 2.0	439.5	.777	−1.2	0.8

Values are means ± SDs unless otherwise indicated. *P < .05; **P < .01. BM = bowel movement, CI = confidence interval, CSHQ = Children's Sleep Habits Questionnaire, FGID = functional gastrointestinal disorder, SSR = Sleep Self-Report.

significantly between those above and below the clinical cutoff for sleep problems (**Table 4**).

DISCUSSION

To our knowledge, this is the first study to examine sleep characteristics in exclusively school-age children with FGIDs that also includes daily abdominal pain ratings from a prospective diary. Consistent with our hypothesis, sleep problems were clinically elevated. In fact, 61% of the sample was above the clinical cutoff on the CSHQ, a value shown to identify sleep problems in children with diagnosed clinical sleep disorders,[19] underscoring the extent/severity of sleep disruption in our participants. Further, child report of sleep problems via SSR also was higher in comparison to a Dutch normative sample of school-age children.[27] Sleep problems in our FGID sample appear comparable to school-age children with juvenile rheumatoid arthritis,[30–32] sickle cell disease,[33] and in a mixed sample of children with persistent pain conditions.[34] These findings underscore the importance of assessing and attending to sleep disturbance in pediatric patients with FGIDs.

The limited available evidence suggests that youth with FGIDs report greater sleep problems when compared with healthy controls,[13,14] which, in turn, relate to greater functional disability.[12] The current study extends previous research by focusing on school-age children and expanding on the exact nature of sleep problems, specifically indicating greater bedtime resistance, delayed sleep onset, and greater daytime sleepiness, indicating poor sleep quality despite longer sleep duration. Because our findings suggest that those with both parent- and child-reported sleep problems experience greater pain severity and pain-related interference in daily activities, children who present with an FGID in a health care setting (eg, pediatrician's office, GI clinic) may benefit from screening for sleep problems to identify those at risk for greater impairment and who warrant further, targeted intervention.

The racial composition of our sample allowed us to compare sleep problems between Black/African-American and White participants. Although Black/African-American children did

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Table 4—Child-reported FGID symptoms for children below vs above CSHQ clinical cutoff controlling for race/ethnicity.

	Full Sample	CSHQ Below Clinical Cutoff (n = 23)	CSHQ Above Clinical Cutoff (n = 36)	*F*	*P*	95% CI	
						Lower	Upper
Abdominal pain severity (1–10)	3.4 ± 1.2	3.1 ± 0.9	3.5 ± 1.2	4.35*	.043	−1.3	−0.0
Maximum abdominal pain severity (1–10)	5.3 ± 2.0	5.3 ± 1.9	5.2 ± 2.1	0.25	.620	−1.5	0.9
Pain interference rating (1–4)	0.6 ± 0.5	0.4 ± 0.3	0.7 ± 0.4	9.71**	.003	−0.6	−0.1
Morning pain severity (1–10)	3.3 ± 1.3	2.8 ± 1.1	3.4 ± 1.4	3.94	.053	−1.5	0.0
Afternoon pain severity (1–10)	3.4 ± 1.5	3.2 ± 1.7	3.5 ± 1.3	1.81	.187	−1.7	0.3
Evening pain severity (1–10)	3.3 ± 1.6	2.9 ± 1.4	3.7 ± 1.7	3.61	.065	−2.1	0.1
Number of days with pain	5.7 ± 4.1	5.9 ± 4.5	5.0 ± 3.6	0.23	.637	−1.8	2.9
Proportion of constipated BMs	0.4 ± 0.3	0.3 ± 0.3	0.4 ± 0.4	2.49	.121	−0.4	0.0
Proportion of normal BMs	0.6 ± 0.3	0.7 ± 0.4	0.5 ± 0.3	3.47	.069	−0.0	0.4
Proportion of diarrhea BMs	0.1 ± 0.2	0.1 ± 0.1	0.1 ± 0.2	1.03	.315	−0.2	0.1
Number of days without BMs	4.6 ± 3.4	3.6 ± 3.3	5.7 ± 3.4	1.64	.206	−2.9	0.7
Tired any time throughout day	2.0 ± 2.0	1.7 ± 1.9	2.2 ± 1.9	2.31	.434	−1.6	0.7

Values are means ± SDs unless otherwise indicated. *P < .05, **P < .01. BM = bowel movement, CI = confidence interval, CSHQ = Children's Sleep Habits Questionnaire, FGID = functional gastrointestinal disorder.

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not report greater daytime sleepiness, they did report more frequent night wakening and greater symptoms of SDB. This latter finding is consistent with research indicating higher risk of SDB among Black/African-American youth, even when accounting separately for effects of obesity and respiratory problems.[35] SDB has a well-known deleterious effect on neurocognitive and behavioral functioning[36] that could contribute to worsening pain, functional impairment, and GI symptoms. However, Black/African-American children in the current sample did not have a higher body mass index and reported significantly less overall abdominal pain and lower maximum abdominal pain severity than White children. One possible interpretation is that the specific nature of sleep problems relates differently to symptoms across various racial/ethnic groups. Additionally, cultural differences in reporting cannot be ruled out.[37]

While this study addresses gaps in existing literature, there are limitations that warrant mention. The small sample size affects power for the detection of group differences, and multiple comparisons increase the risk of false positives. Therefore, results should be interpreted with caution, and additional research with a larger sample is needed. Further, data were not available regarding the contribution of other relevant health-related variables (eg, diet and activity level) or more precise cultural and economic indices (eg, socioeconomic status, neighborhood environment), which should be examined as potential contributory factors in future research. For instance, in the current study, Black/African-American children indicated significantly greater days without stooling, which could be attributed to cultural differences in dietary practices. The absence of a local control group does not allow comparison with a concurrent control group, or how this sample relates to other minority pediatric populations, and this will be an important area for future study. Additionally, the Dutch sample utilized a translated version of the SSR, and comparison with this sample may be influenced by cultural differences; that said, importantly, this sample offers the only available published normative comparison for SSR data. While sleep problems were evaluated by multi-informant and validated measures of sleep, inclusion of objective sleep parameters (eg, actigraphy) would help to further qualify/quantify self-reported sleep data. A bidirectional relationship between sleep and pain has been proposed, whereby sleep problems contribute to adverse psychosocial and physiological outcomes that worsen pain and thereby increase sleep problems.[38] Greater understanding about the temporal sleep–pain relationship in FGIDs, perhaps from ecological momentary assessment data, would inform directionality the pain–sleep relationship and identify which factors have the greatest influence and should be targeted in interventions. Ultimately, future research should explore how children with FGIDs would respond to evidence-based treatment targeting sleep problems and the potential impact of such intervention on pain and GI symptoms, and potential impact on nightly bedtime routines would be of particular interest.

The racial composition of our sample represents a notable strength of this study, in addition to other study strengths such as the utilization of Rome IV criteria and concurrent assessment of sleep and prospective pain/stooling diary data. These findings provide preliminary information about potential relationships between FGIDs and sleep problems in a racially and ethnically diverse sample of children, but literature examining sleep problems both in pediatric populations and in minority samples is still in its infancy. Clearly, more research is needed to increase understanding of the role of sleep problems in the complex, multifactorial processes contributing to pediatric health disparities and to extend this research to youth with FGIDs who constitute a substantial proportion of the chronic pain population.[1]

In summary, the current study extends the literature by focusing on school-age children utilizing a measure with a clinical cutoff to better characterize the severity of sleep problems in

children with FGIDs. Given that clinically significant sleep problems were common by both parent and child report, and associated with greater pain and pain interference, these findings call for additional research exploring underlying mechanisms and clinical interventions to address sleep problems in children presenting with FGIDs.

ABBREVIATIONS

CSHQ, Children's Sleep Habits Questionnaire
FGID, functional gastrointestinal disorder
GI, gastrointestinal
SDB, sleep-disordered breathing
SSR, Sleep Self-Report

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