

A Scoping Review of Sleep Disturbances in Children and Adolescents with Abdominal Pain Disorders

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Objective/Purpose/Aim: Sleep disturbances have been implicated as contributors to chronic pain. We undertook this review to assess the current literature regarding sleep disturbances in youth with chronic abdominal pain. We assessed studies evaluating prevalence, pathophysiology, and/or outcomes to identify gaps in knowledge and to determine whether there is an evidential basis for sleep interventions in this population.

Materials and Methods: Utilizing Google Scholar, Pub Med, SCOPUS, and Embase, we searched using the terms “sleep disturbances” AND (“abdominal pain”/exp OR “abdominal pain”) AND ([adolescent]/lim OR [school]/lim). Articles were included if they contained data regarding sleep disturbance prevalence, pathophysiology, or relationships to outcome. After two independent review, 32 manuscripts were included in this review.

Results: Based on their high prevalence (19–75% of abdominal pain cohorts), there is sufficient evidence to recommend routine screening for sleep disturbances in youth with chronic abdominal pain. There is a broad range of negative physiologic and emotional effects of sleep deprivation.

Conclusion: Sleep disturbances are common in youth with chronic abdominal pain. Sleep interventions are appropriate when disturbances are identified though it is not yet known the degree to which these interventions will affect the pain experience and resultant disability. Future studies should focus on evaluation of specific sleep interventions on patient outcomes.

Keywords: sleep, disorders of gut-brain interaction, irritable bowel syndrome, functional dyspepsia

Introduction

Chronic abdominal pain is very common in youth, particularly adolescents.¹ While identifiable disease is present in some of these children and adolescents, the strong majority will not have a well-defined disease accounting for symptoms. Most will meet criteria for an abdominal pain-associated disorder of gut-brain interaction (AP-DGBI).^{2–4} As the name implies, these conditions are believed to arise from an interaction between the gastrointestinal tract and the central and peripheral nervous systems. They are best conceptualized through a biopsychosocial model which recognizes biologic (eg, dysmotility, inflammation, visceral hypersensitivity), psychological (eg, anxiety, depression, coping), and social factors (eg, interactions with family, peers, teachers).⁵ These factors interact with each other, and all can contribute to symptom generation. Sleep is a physiologic function shown to interact with all three of these factors and, as such, may be of importance as a therapeutic target.⁶

There are multiple theoretical factors which provide plausibility for a role for sleep dysfunction to be important in pediatric AP-DGBI: 1. Sleep dysfunction is common in youth, particularly in adolescents, the group with the highest prevalence of AP-DGBIs; 2. Sleep deprivation is associated with a variety of physiologic disturbances across multiple systems relevant to abdominal pain (eg neurologic, inflammatory, cardiac); 3. A bidirectional relationship between sleep

and a number of receptors relevant to gastrointestinal functioning (eg, immunologic, endocannabinoid, nitrous oxide signaling, and the stress hormone axis) has been demonstrated in chronic pain patients; 4. Sleep deprivation has strong associations with negative mood, a well-established factor in AP-DGBIs.^{7–10} A previous systematic review of sleep problems in pediatric DGBI in general (not specifically abdominal pain-related) demonstrated increased sleep disturbances in association with DGBIs.⁶

Despite the existing theoretical basis implicating sleep disturbances as critical in the conceptualization of pediatric AP-DGBI, empirical evidence appears to be lacking. We undertook this review to assess the current literature for sleep disturbances in youth with chronic abdominal pain regarding their prevalence and pathophysiology, as well as their potential role in outcome in order to identify gaps in knowledge and to determine whether there is an evidential basis for sleep intervention in youth with AP-DGBIs.

Methods

Using the search terms: “sleep disturbances” AND (“abdominal pain”/exp OR “abdominal pain”) AND ([adolescent]/lim OR [school]/lim), we queried PubMed, Embase, Scopus, and Google Scholar yielding an initial 138 articles in children and adolescents (ages 6–18 years. All identified studies were included regardless of cohort size. The articles included in this review were published in English between January 2000 through December 2023. After removing duplicates and reviewing abstracts, we identified 52 articles for full review. After reviewing bibliographies from these articles, another 16 articles were added for full review. Articles were included if they contained data regarding sleep disturbance prevalence, pathophysiology, or relationships to outcome. Two authors independently retrieved relevant data from the articles and any discrepancies in retrieved data were resolved. The final number of articles totaled 32. Of these 32 articles, 24 articles reported prevalence, 18 described associations related to pathophysiology, and 3 had outcome data. These articles form the basis for the current review.

Results

Prevalence

A total of 24 articles reported prevalence rates, including 13 studies assessing abdominal pain patients within a specialty clinic setting and 11 studies assessing patients within a general medical clinic or subjects from a community sample. These studies are summarized in Table 1.^{11–34} Prevalence rates varied from 19 to 75% (all but one ≥ 40%) om abdominal

Table 1 Summary of Studies Reporting Prevalence Rates for Youth with Abdominal Pain- Associated Disorders of Gut-Brain Interaction

First Author	Country	Population	Age Range	Total Population Size	Diagnostic Method for Sleep	Prevalence
Gustafsson ¹¹	Finland	Community sample	10–15 years	1,351	Health Behavior of School-Aged Children questionnaire	Excessive daytime sleepiness: 13% (ages 10 and 12 years), 24% at 15 years (associated with AP)
Haim ¹²	Israel	Gastroenterology clinic recurrent AP patients	10–17 years	25 (plus 15 controls)	Actigraphy; sleep habit questionnaire; sleep log	Good sleep quality by report in 25% of AP vs 87% of controls; no actigraphic differences
Huang ¹³	Australia	General practice clinic	3–16 years	164	Self- developed questionnaire	Sleep disturbance in 21% of AP vs 7% of controls
Huntley ¹⁴	United States	Functional AP patients	8–15 years	67 (plus 80 controls)	Child Sleep Questionnaire (CSQ)	Behavioral sleep disorders in 71%, excessive daytime somnolence in 33%
Jansen ¹⁵	United States	Functional Gastrointestinal disorders	7–12 years	67	Child Sleep habits Questionnaire (CSHQ); Sleep Self-Report (SSR); daily diaries	Sleep disturbance in 61%

(Continued)

Table 1 (Continued).

First Author	Country	Population	Age Range	Total Population Size	Diagnostic Method for Sleep	Prevalence
Kovacic ¹⁶	United States	Functional AP patients	11–18 years	112	Interview- >30 minutes to fall asleep and/or repeated nighttime awakenings	Frequent sleep disturbance in 73% of those with nausea and 48% of those without nausea
Luntamo ¹⁷	Finland	Community sample	8 years	1030–1038	Child Depression Inventory Scale	Sleep problems in 30% of girls, 13% of boys
Luntamo ¹⁸	Finland	Community sample	13–18 years	2,215	Specific sleep questions	Sleep problems in 27.2% (frequent co-occurrence with AP)
Manhart ¹⁹	Germany	AP and Inflammatory Bowel Disease (IBD) patients	14–25 years	23 AP (plus 48 controls)	Pittsburgh Sleep Quality Index (PSQI), Sleep Disturbance Scale for Children (SDSC), Nightmare Effect Questionnaire (NEQ)	Sleep disturbance in 22.8%; poor sleep quality in 58.5%
Murphy ²⁰	United States	Functional AP patients	11–17 years	278	PROMIS Sleep Disturbance Short Form	Sleep disturbance in 45%
Noor ²¹	Indonesia	Community sample	High School	294	Sleep disturbance scale for Children (SDSC)	Sleep disturbance in 53.1% (not associated with AP)
Pace ²²	Italy	AP patients	13 years	67	Rome II Modular Questionnaire	Sleep disturbance in 19% of IBS patients
Paiva ²³	Portugal	Community sample	12–19 years	3,476	Health Behavior In School-Aged Children (HBSC)	Sleep problems in 37.2%; sleep deprivation in 18.9% (not associated with AP)
Schurman ²⁴	United States	Functional AP patients	8–17 years	283	Sleep disturbance scale for Children (SDSC)	Sleep disturbance in 45%
Schwille ²⁵	Germany	Community sample	11–17 years	7,697	German Health Interview and Examination Survey for Children and Adolescents (KiGGS)	Sleep disturbance in 31% of children and 49.2% of adolescents with AP
Tarbell ²⁶	United States	Nausea patients (AP in 93.7%)	7–18 years	63	PROMIS, Parent-Proxy Pediatric Sleep Disturbance- Short Form	Sleep disturbance in 71.4% of those with nausea
Zhou ²⁷	China	Community sample	12–18 years	1,362	Pittsburgh Sleep Quality Index (PSQI)	Poor sleep in 34.3% (associated with IBS)
Bedree ²⁸	United States	DGBI patients	8–17 years	118	PROMIS, Pediatric Sleep Disturbance- Short Form	Mild sleep disturbance in 8%, moderate in 42%, severe in 22%
Thompson ²⁹	United States	AP-DGBI	8–18 years	226	Sleep disturbance scale for Children (SDSC)	DIMS in 40%, DOES in 14%, SWTD in 10%
Kim ³⁰	South Korea	Functional AP patients	12–18 years	66	Pittsburgh Sleep Quality Index Korean (PSQI-K)	Elevated PSQI-K in 57.6%
Kumagai ³¹	Japan	General Population	10–15 years	2,060	Single sleep question	Not enough sleep in 18% of FD/IBS
Pollard ³²	United States	IBS and FAP	5–17 years	39	Adolescent Sleep-Wake Scale	Scores decreased in 65% from Spring to Summer
Song ³³	Korea	Middle and high school students	Grades 7–11	820	Length of sleep question	<6 hours sleep in 22.7% of IBS group
Yamamoto ³⁴	Japan	Junior and high school students	Grades 7–12	98,411	Sleep questions	In IBS group, <5 hours sleep in 18%, difficulty initiating sleep in 17%, difficulty maintaining sleep in 12%

Abbreviations: AP, Abdominal Pain; DGBI, disorder of gut brain interaction; IBS, Irritable bowel syndrome; FD, functional dyspepsia; FAP, functional abdominal pain; DIMS, disorder of initiation and maintenance of sleep; DOES, disorder of excessive daytime sleepiness; SWTD, sleep-wake transition disorder.

pain-specific study groups and from 13 to 53% for subjects reporting abdominal pain in community samples. In the largest abdominal pain cohorts (>200 subjects), prevalence rates for sleep disturbances were 40–45%.

Sleep disturbances are common in youth with AP-DGBI, with the most common disorders being related to initiation and maintenance of sleep. Sleep disturbances are increased in AP-DGBI over the general population or controls in most but not all studies. When assessing prevalence, there is significant variability in defining sleep disturbances with a general lack of objective measures. The only study that included an objective measure (actigraphy) did not find a difference between abdominal pain patients and controls.¹²

Nine studies compared sleep disturbance prevalence between females and males.^{11,17,18,20,23,24,27,29,30} Three studies demonstrated increased prevalence in females (one of which employed a validated sleep-specific measure), one demonstrated increased prevalence in males, and six demonstrated no difference between sexes (4 of which employed a validated sleep-specific measure).

Pathophysiology

A total of 8 studies assessed associations between sleep disturbances and pain prevalence, pain frequency, and/or intensity with all demonstrating positive relationships.^{15,17,18,20,28,33–35} One of these demonstrated a temporal relationship between sleep disturbances and pain with increased sleep being protective and decreased sleep having a triggering effect on pain.³⁵ Four studies evaluated relationships between sleep disturbances and other gastrointestinal symptoms with associations being demonstrated for nausea (2 studies), heartburn, and diarrhea.^{15,26,28,36}

The most common associations evaluated were for psychologic disturbances, quality-of-life, and functional disability. Eight studies assessed psychologic disturbances, primarily anxiety and depression, and positive associations were demonstrated in each study.^{11,13,18,28,29,32,36,37} One study reported decreased quality-of-life in subjects with sleep disturbances and two reported increased functional disability.^{20,23,24}

Two studies demonstrated possible mechanisms for sleep disturbances.^{21,38} One study found an association between sleep disturbances and screen time and lack of extra-curricular activities.²¹ The other found improvement in sleep disturbances with percutaneous electrical nerve field stimulation (PENFS), though it is not clear whether sleep improved due to improved pain or a more direct effect of PENFS on the brain.³⁸

Outcomes

There has been a paucity of studies assessing the effect of sleep disturbances on outcomes or the effect of interventions on sleep in this patient population with only three such studies identified. In one retrospective study, poor sleep predicted worse outcome in a multi-disciplinary abdominal pain clinic.³⁹ In another study assessing buspirone for patients with abdominal pain, buspirone improved sleep but was not superior to placebo in relief of pain.⁴⁰ In the third study, PENFS resulted in improved sleep, anxiety, pain, mechanical sensitivity, and functional disability.³⁸

Discussion

Sleep disturbances are common in youth with AP-DGBIs and appear to be more common than in the general pediatric population. These findings are consistent with, and build upon, a previous systematic review of sleep problems in pediatric DGBIs in general.⁶ The current review includes 15 manuscripts not included in the previous review. Sleep disturbances appear to be even more frequent in patients with chronic abdominal pain in association with other gastrointestinal symptoms including nausea, heartburn, and diarrhea.^{15,26,28,36} Importantly, sleep disturbance is associated with increased pain severity, pain interference, and functional disability as well as lower quality-of-life.^{15,20,23,24,28,33} Sleep disturbance is linked to functional disability through physical symptoms.²⁴ While associations do not assign cause-and-effect, it is likely that pain interferes with sleep and there is empiric evidence for poor sleep enhancing pain.⁴¹ In a momentary assessment study, increased sleep was shown to be protective and decreased sleep to have a triggering effect on pain.³⁵ This finding is similar to what has been reported in adults with IBS where poor sleep predicts higher next day pain.⁴¹ These studies provide evidence for screening youth with chronic abdominal pain for sleep disturbances and intervening when sleep problems are identified.

While subjective sleep measures (ie, survey data) demonstrate increased prevalence of sleep disturbances in youth with AP-DGBI, there is a need for more studies utilizing objective sleep measures. The gold standard for objective sleep measurement is polysomnography, however, this is generally performed in a sleep lab with assessment generally over one night. Actigraphy represents the “gold standard” for naturalistic and longitudinal studies as it is performed in the patient’s usual sleep environment and can be repeated daily if needed. Actigraphy has been validated against polysomnography.⁴² We only identified one study utilizing actigraphy and within this study, increased sleep disturbance was subjectively reported by abdominal pain patients while there were no actigraphic differences in comparison to controls.¹² Mixed findings have also been reported in the broader pediatric pain literature when assessing subjective and objective sleep measures.⁴³

In general, inadequate sleep duration is common in children and particularly in adolescents where reported prevalence rates vary from 62 to 75%.⁴⁴ Particularly in adolescents, sleep deprivation is associated with decreased cognitive function and mood disorders.^{45,46} Likewise, sleep disturbances appear to be associated with psychological dysfunction, particularly anxiety and depression, in youth with AP-DGBI. Again, these associations are likely bidirectional with anxiety or depression resulting in sleep disturbances and sleep loss, in turn, worsening anxiety and depression. These interactions are likely to have clinical importance as psychological dysfunction has been highly implicated in AP-DGBIs and psychological function has been shown to mediate the relationship between pain and sleep.^{38,47,48} In a retrospective study, sleep dysfunction, difficulty relaxing, depression, and older age (ie, teens vs children) were the best predictors of a poorer clinical response in an AP-DGBI population.³⁹ While the interaction between sleep and psychosocial factors have been well studied in general and are among the most studied in patients with chronic abdominal pain, there is a paucity of studies regarding biologic pathways in patients with AP-DGBIs. This is an important area of inquiry as identification of specific pathways may expand our possible points of intervention or provide biomarkers to indicate when sleep deprivation is causing direct biologic dysfunction. A single study of PENFS may provide some insight.³⁸ PENFS has been shown to modulate amygdala function and vagal function, and likely affects numerous other pathways. PENFS resulted in decreased pain, decreased gastrointestinal mechanical sensitivity, and improved sleep.³⁸ It is unclear whether improved sleep was due to decreased pain or a more direct effect, but both began to improve early in the treatment course.

There is a paucity of outcome studies. A single retrospective study demonstrated the ability of poor sleep to predict poorer outcomes, and, among those who did achieve clinical resolution, slower improvement.³⁹ We were not able to identify any studies assessing specific sleep interventions in patients with AP-DGBIs. There is a need for assessing the effects of sleep interventions, alone or in combination with other treatments, on pain frequency and severity, quality-of-life, and functional disability. In addition, given the association between sleep disturbances and mood, there is a need to assess the effect of psychological interventions on sleep and the subsequent impact on pain.

In conclusion, based on high prevalence, there is sufficient evidence to recommend routine screening for sleep disturbance in adolescents with AP-DGBI. There remains a need for more studies utilizing objective sleep measures. Given the broad range of negative physiologic and emotional effects of sleep deprivation, sleep interventions are appropriate when disturbances are identified though it is not yet known the degree to which these interventions will affect the pain experience and resultant disability. Future studies should focus on evaluation of specific sleep interventions on patient outcomes, either alone or as one of multiple interventions, targeting the various relevant components of the biopsychosocial model.

Disclosure

The authors report no conflicts of interest in this work.

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