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SCIENTIFIC INVESTIGATIONS

Elevated risk of depression among adolescents presenting with sleep disorders

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Study Objectives: Depression is prevalent among patients with sleep disorders, and studies show associations between suicidal ideation and insufficient sleep. Using retrospective clinic records, we examined positive depression screening rates among adolescent sleep clinic patients relative to other subspecialty clinic patients. We also examined relationships between sleep diagnoses and positive depression screening rate in adolescent sleep clinic patients.

Methods: Data were analyzed from patients ages 12–18 (n = 12,520) who were screened for depression using the Patient Health Questionnaire-2 (PHQ-2). Those who screened positive were administered the PHQ-9. Logistic regression was used to examine effects of age, sex, race, ethnicity, and clinic on likelihood of a positive depression screen. Within sleep clinic patients (n = 308), demographic factors, sleep disorder diagnosis, and body mass index percentile were examined using logistic and linear regression.

Results: Among all patients screened, older age and female sex predicted positive depression screens. Sleep clinic patients were more likely to screen positive than patients in 9 other clinics [odds ratios 2.03–6.83]. Results were similar even when the PHQ-9 sleep item was excluded [odds ratios 2.18–6.41]. Within sleep clinic patients, sleep disorder diagnosis (eg, insomnia, obstructive sleep apnea) was predictive of a positive depression screen ($\chi^2(1) = 10.88$, $P = .004$): insomnia patients were most likely to be experiencing depression.

Conclusions: Adolescent sleep clinic patients are at increased risk for depressive symptoms. Among insomnia patients, risk was independent of age, sex, and obesity, suggesting a unique relationship between insomnia and affective distress, as has been found in adults. Assessing adolescents for sleep disorders should be prioritized, given the strong association with depression.

Keywords: sleep disorders, depression, suicidal ideation, adolescence, insomnia

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BRIEF SUMMARY

Current Knowledge/Study Rationale: Sleep disturbance and depression are common in adolescents and often co-occur. Furthermore, insufficient sleep is related to increased risk of suicidal ideation. Sleep is a modifiable behavior, and treatment of sleep disorders is associated with amelioration of depressive symptoms.

Study Impact: This study demonstrates that adolescent patients with sleep disorders were at greater risk for depressive symptoms and suicidal ideation than patients in other subspecialty clinics. This risk was greatest in patients with a diagnosis of insomnia, regardless of age, sex, and obesity. These findings highlight the need to screen for depression in adolescents with sleep disturbance and emphasize the importance of assessing for sleep problems in other pediatric clinics.

INTRODUCTION

Depression is highly prevalent during mid- to late adolescence, affecting 4% to 5% of all adolescents.[1] Nearly one-fifth of adolescents will experience a depressive episode by the time they turn 18 years old,[2] and the majority of those individuals will have a second depressive episode within the following 5 years.[3–6]

Diagnostic criteria for depression includes depressed mood, anhedonia, or both for 2 weeks or more; along with significant change in appetite/weight, insomnia, or hypersomnia, psychomotor slowing, fatigue, feelings of worthlessness or guilt, concentration difficulties, or suicidal ideation.[7] Sleep difficulties are highly comorbid among patients experiencing depression, as up to 90% of adult patients with major depressive disorder endorse sleep disturbances.[8] In addition, several symptoms of depression overlap with symptoms of sleep disruption, including fatigue, loss of energy, irritability, and difficulty concentrating.[7]

Adolescents are also highly prone to sleep disturbances: over one-third of adolescents endorse occasional sleep problems.[9] In the context of depression among adolescents, a meta-analysis revealed that subjective reports of sleep disruption were significantly greater in adolescents with major depressive disorder, compared to controls.[3] These findings are also supported by studies that measure sleep objectively, as adolescents with major depressive disorder have longer sleep onset latency, more awakenings, and lower sleep efficiency than nonclinical controls.[3] Finally, as in adults, adolescents with sleep disorders (eg, insomnia) are at increased risk for the onset of an initial depressive episode and suicide attempts.[10] A meta-analysis of 11 studies of children and adolescents with obstructive sleep

apnea (OSA) showed that there is a higher rate of depressive symptoms in youth with OSA, compared to controls.[11] This analysis revealed that treatment of OSA via adenotonsillectomy results in a significant reduction of depressive symptoms, compared to presurgery levels, suggesting that resolving sleep disorders has the potential to ameliorate depressive symptoms.

Children with chronic medical conditions are also more vulnerable to mental health problems.[12] For example, a meta-analysis of children, adolescents, and young adults with life-limiting conditions revealed a pooled depression prevalence estimate of 14.3%. However, prevalence rates varied by diagnostic group: HIV had the highest pooled depression prevalence estimate at 24.2%, whereas neurological conditions had the lowest prevalence at 7.0%.[12] In another study of medically ill children seen by a variety of subspecialty clinics (eg, allergy, rheumatology, transplant services, asthma and pulmonary, gastroenterology, hepatology, genetic and metabolic diseases, endocrinology, cardiology, nephrology), 15% of the sample screened positive for depression based on the Children's Depression Inventory.[13]

Despite high depression prevalence rates, adolescents rarely seek psychiatric care on their own, and most adolescents do not receive treatment until young adulthood.[14] As such, screening adolescents for depression is an important initial step in identifying children at risk. Earlier identification creates the opportunity for adolescents to establish a diagnosis and initiate treatment far sooner than if left undiagnosed. Reliable screening measures that are sensitive enough to detect depression have become a mainstay in many pediatric hospital and ambulatory settings.[15] The presentation of child or adolescent depression may differ from the typical presentation of adult depression and is more variable. In addition, youth with depression frequently have comorbid psychiatric disorders, making depression even more challenging to diagnose in this age group.[6] Both the Patient Health Questionnaire-2 (PHQ-2) and Patient Health Questionnaire-9 (PHQ-9) have been identified as effective screening tools to identify depression[16,17] and show promise for bringing children at risk for depression to the attention of pediatricians in the primary care setting.[16–18]

Given these associations between sleep disturbance and symptoms of depression, we hypothesized that adolescent patients presenting to a pediatric sleep clinic would have the highest risk of screening positive for depression, relative to patients presenting to other outpatient subspecialty clinics. We further examined known risk factors for depression, including demographics,[19,20] body mass index (BMI) percentile,[21,22] and sleep disorder diagnosis[11,23] within this sleep clinic patient sample. We predicted that, as in adults, adolescent patients diagnosed with primary insomnia would have the highest rate of positive depression screens.

METHODS

Patients

Study procedures were approved by the Institutional Review Board at University of California, San Diego (IRB no. 180457). There were 2 phases of implementation of depression screening. Initially, a pilot screening program was implemented in select clinics in May, 2016, including the sleep clinic. The program was later expanded to all specialty outpatient clinics in August, 2017. As part of this hospital-wide depression-screening initiative, all patients age 12 and older were initially screened for depression using the PHQ-2. If they obtained a score ≥ 3, they were subsequently screened using the PHQ-9. Data were retrospectively collected from patients age 12–18 years who presented for clinical encounters from August, 2017, to March, 2018, at specialty outpatient clinics in a tertiary children's hospital. Demographic variables for age, sex, race, and ethnicity were obtained for all patients. To maintain consistency across clinics, patients who were screened prior to August, 2017, as part of the pilot screening program were not included in this sample. Information was not available to determine whether patients were seen in more than 1 clinic during the study period.

Sleep disorder diagnosis and BMI percentile were obtained for patients who were screened as part of a sleep clinic–related encounter. Sleep clinic patients were grouped based on their primary diagnosis: insomnia, OSA, or other (eg, narcolepsy, hypersomnolence, isolated delayed sleep phase, periodic limb movement disorder, snoring, recurrent isolated sleep paralysis, chronic fatigue). For follow-up analyses investigating risk factors for depression within the sleep clinic sample, data from patients who participated in the pilot screening program were included. These data were retrospectively collected from patients age 12–21 years who presented for sleep clinic encounters from May, 2016, to March, 2018.

Measures

Patient Health Questionnaire-2

The PHQ-2 is a brief self-report screener for depression that is commonly used in both adult and adolescent primary care settings. This questionnaire consists of 2 items that assess the frequency of depressed mood and anhedonia over the previous 2 weeks. Each item is scored from 0 ("not at all") to 3 ("nearly every day"), with total scores ranging from 0 to 6.[24] Using a cutoff score of 3, the PHQ-2 has a sensitivity of 73.7% and specificity of 75.2% for detecting depression in youth,[16] making its utility comparable to that of longer depression questionnaires.[24,25]

Patient Health Questionnaire-9

The PHQ-9 includes both items of the PHQ-2, along with 7 additional questions that mirror the diagnostic criteria for depression.[7] Scores from the PHQ-9 can be used to provide a dichotomous measure of depression (ie, probable major depression diagnosis) or a continuous measure of depression severity. The PHQ-9 also includes a question to probe suicidal ideation. With regard to predicting a diagnosis of major depressive disorder, the PHQ-9 has a sensitivity of 89.5%, and a specificity of 77.5% in adolescents, making it an appropriate tool to screen for depression in this age group.[17,18]

It is important to acknowledge that the PHQ-9 includes 1 question that screens for sleep disturbance ("Trouble falling or

staying asleep, or sleeping too much?"). Because this item could potentially inflate scores for patients with sleep disorders, we also examined the odds of a positive depression screen with this item removed. In addition, we examined whether the presence of suicidal ideation, a surrogate marker for severe depression, differed in patients in the sleep clinic compared to patients from all other subspecialty clinics.

Depression grouping variable

For logistic regression analyses, patients were grouped as either experiencing depression or control as follows: Patients who scored ≤ 2 points on the PHQ-2 were classified as controls (ie, negative depression screen); patients who scored ≥ 3 points on the PHQ-2 and ≥ 10 points on the PHQ-9 were classified as experiencing depression (ie, positive depression screen). For analyses without the sleep item, patients who scored ≥ 8 points on the Patient Health Questionnaire without sleep item (PHQ-WS) were classified as experiencing depression. A score ≥ 1 on the PHQ-9 suicide item was considered a positive screen for suicidal ideation.

Statistical methods

All analyses were performed using SPSS version 25 (IBM Corp, Armonk, NY). Logistic regression was used to examine the independent effects of age, sex, race, ethnicity, and hospital subspecialty clinic on the likelihood of a positive depression screen (ie, PHQ-9 score ≥ 10) vs a negative depression screen (ie, PHQ-2 score ≤ 2). Within sleep clinic patients, logistic regression was performed using the same predictors (age, sex, race, ethnicity), as well as BMI percentile and sleep disorder diagnosis (ie, insomnia, OSA, other). Linear regression was then performed to examine these relationships in the subset of patients who completed the PHQ-9. Group differences in covariates were examined using independent samples *t* tests for continuous variables, and separate chi-square analyses were conducted to evaluate differences in categorical variables. Odds ratio (OR) was used to indicate the strength of these associations; OR > 1 signified a predictor's association with higher odds of screening positive for depression. Results were considered statistically significant at $P < .05$.

RESULTS

Across-clinic analyses

Across the 11 specialty clinics, 12,520 patients were screened using the PHQ-2. Patients ranged in age from 12 to 18 years, and consisted of 52.4% females. Eight hundred ninety patients (7.1%) screened positive on the PHQ-2 (score ≥ 3), and 588 patients (4.7%) subsequently screened positive on the PHQ-9 (score ≥ 10). Out of the total sample, 272 patients (2.2%) endorsed experiencing suicidal ideation in the previous 2 weeks. See **Table 1** for a full list of sample characteristics and **Figure 1** for rate of positive depression screen across all subspecialty clinics.

Logistic regression analyses revealed that age and sex were significant predictors of a positive PHQ-9 screen (see **Table 2**). Females had greater odds of experiencing depression (OR = 2.49, $P < .001$), and the risk of a positive screen increased with age, with OR = 1.22, $P < .001$ per 1 year increase.

Compared to other clinics, unadjusted analyses showed that patients in the sleep clinic had significantly greater odds of a positive PHQ-9 screen than all other clinics, with the exception of the child abuse pediatrics clinic (24%; OR = 0.37, $P = .002$). Age- and sex-adjusted analyses (see **Table 3**) indicated that sleep clinic patients were more than twice as likely to screen positive on the PHQ-9 than patients in the cardiology, endocrinology, gastroenterology, hematology, nephrology, neurology, pulmonary, rehabilitative medicine, and rheumatology clinics (OR range = 2.03–6.83, $P \leq .011$); no patients from the metabolic clinic screened positive on the PHQ-9, precluding statistical analysis of this comparison. Further, after controlling for age and sex, the comparison between sleep clinic patients

Table 1—Demographic characteristics of clinic samples.

	n	Sex [n (% Female)]	Race [n (% White)]	Ethnicity [n (% Hispanic)]	Age in Years [M (SD)]
All clinics	12520	6565 (52.4)	5128 (41.0)	5879 (47.0)	15.1 (1.9)
Cardiology	125	60 (48)	86 (68.8)	52 (41.6)	15.5 (1.76)
Child abuse pediatrics	98	91 (92.9)	26 (26.5)	50 (51)	15.2 (1.79)
Endocrinology	4806	2652 (55.2)	2017 (42)	2269 (47.2)	15 (1.9)
Gastroenterology	1331	654 (49.1)	481 (36.1)	673 (50.6)	15.2 (1.86)
Hematology	303	150 (49.5)	104 (34.3)	152 (50.2)	15.3 (1.99)
Metabolic	24	13 (54.2)	13 (54.2)	7 (29.2)	14 (1.59)
Nephrology	1013	408 (40.3)	368 (36.3)	508 (50.1)	15.2 (1.93)
Neurology	2826	1421 (50.3)	1130 (40)	1310 (46.4)	15.1 (1.88)
Pulmonary	675	333 (49.3)	334 (49.5)	281 (41.6)	14.9 (1.88)
Rehabilitative medicine	340	151 (44.4)	155 (45.6)	137 (40.3)	15.1 (1.89)
Rheumatology	766	552 (72.1)	329 (43)	338 (44.1)	15.2 (1.85)
Sleep	213	80 (37.6)	85 (39.9)	102 (47.9)	15.2 (1.92)

M = mean, SD = standard deviation.

Figure 1—Rates of positive depression screens (Patient Health Questionnaire-9 ≥ 10) and positive suicide screens across clinics.

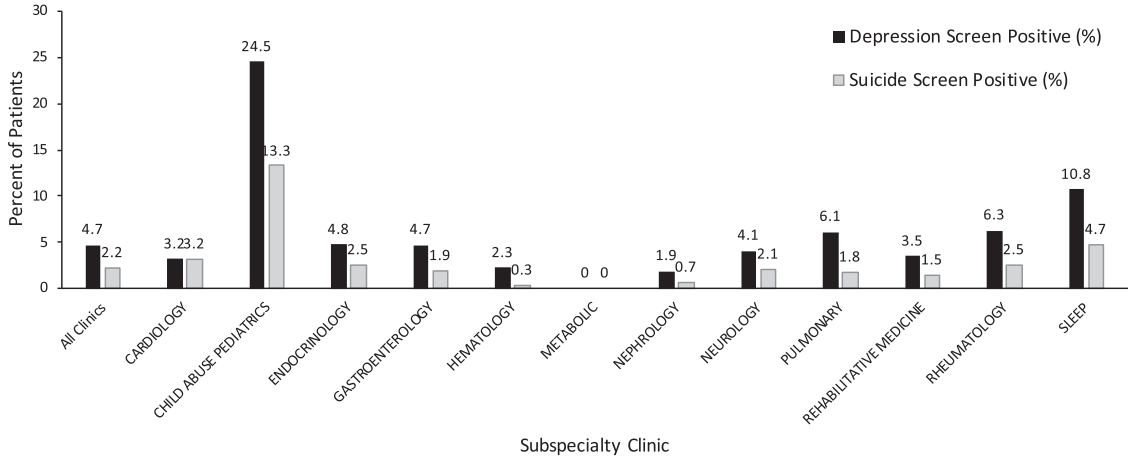

Table 2—Demographic predictors of positive depression screen (ie, PHQ-9 Score ≥ 10) and positive suicide screen across all clinics.

Variable	OR	*P*
Depression		
Age	1.22 [1.161, 1.272]	< .001
Sex (ref: Male)	2.49 [2.068, 3.006]	< .001
Race	0.97 [0.809, 1.155]	.708
Ethnicity	0.87 [0.729, 1.039]	.124
Suicidal Ideation		
Age	1.09 [1.022, 1.163]	.008
Sex (ref: Male)	3.155 [2.366, 4.206]	< .001
Race	0.828 [0.641, 1.068]	.147
Ethnicity	1.024 [0.794, 1.321]	.855

OR = odds ratio, ref = reference group for logistic regression odds ratio.

and child abuse pediatrics clinic patients no longer differed significantly (OR = 0.55, $P = .078$).

Without the sleep item, results were similar. Unadjusted analyses showed that sleep clinic patients were significantly more likely to screen positive on the PHQ-WS than all other clinics except child abuse pediatrics (25%; OR = 0.42, $P = .007$). Adjusted analyses (see **Table 3**) also showed that sleep clinic patients were significantly more likely to screen positive on the PHQ-WS than patients in nine other clinics (OR range = 2.18–6.41, $P \leq .006$), after accounting for age and sex. Again, the rate of positive PHQ-WS screen no longer differed significantly in sleep clinic patients compared to patients in the child abuse pediatrics clinic (OR = 0.60; $P = .121$) after adjusting for age and sex.

Age and sex were also predictive of endorsement of the suicidal ideation item on the PHQ-9 (see **Table 2**). Odds of suicidal ideation increased 1.09 times ($P = .008$) with each 1-year increase in age, and females were more than 3 times as likely as males to report experiencing suicidal ideation in the previous 2 weeks ($P < .001$). Compared to 7 other clinics (endocrinology, gastroenterology, hematology, nephrology, neurology, pulmonary, rehabilitative medicine), the unadjusted odds of suicidal ideation endorsement were significantly higher in sleep clinic patients (OR range = 1.95–14.87, $P \leq .047$). Unadjusted odds of suicidal ideation for patients in the cardiology (OR = 1.48, $P = .48$) and rheumatology clinics (OR = 1.93, $P = .098$) did not differ from that of patients in the sleep clinic. Patients in the sleep clinic had significantly lower unadjusted odds of suicidal ideation (OR = 0.31, $P = .009$) compared to patients in the child abuse pediatrics clinic. Controlling for age and sex (see **Table 3**), sleep clinic patients were significantly more likely to endorse suicidal ideation than patients in the endocrinology, gastroenterology, hematology, nephrology, neurology, pulmonary, rehabilitative medicine, and rheumatology clinics (OR range = 2.3–17.49, $P \leq .023$), and this rate did not significantly differ from that of patients in the child abuse pediatrics clinic (OR = 0.53, $P = .15$) or cardiology clinic (OR = 1.69, $P = .386$).

Sleep clinic analyses

Demographic characteristics of the sleep clinic patients are presented in **Table 4**. Sleep clinic patients screened positive for

Table 3—Results of adjusted logistic regressions for predicting positive depression/suicide screens in the sleep clinic compared to each subspecialty clinic.

	Positive Depression Screen[a]		Positive Depression Screen, Without Sleep Item[b]		Positive Suicide Screen[c]	
	OR	*P*	OR	*P*	OR	*P*
Cardiology	4.21	.010	4.68	.006	1.69	.386
Child abuse pediatrics	0.56	.078	0.60	.121	0.53	.150
Endocrinology	2.88	< .001	2.91	< .001	2.36	.012
Gastroenterology	2.87	< .001	2.97	< .001	2.94	.005
Hematology	6.27	< .001	5.90	< .001	17.49	.007
Metabolic	–	–	–	–	–	–
Nephrology	6.83	< .001	6.41	< .001	7.38	< .001
Neurology	3.25	< .001	3.30	< .001	2.70	.005
Pulmonary	2.03	.011	2.18	.004	3.06	.012
Rehabilitative medicine	3.65	< .001	3.72	< .001	3.57	.023
Rheumatology	2.50	< .001	2.59	< .001	2.71	.013

Results from the metabolic clinic are not presented because there were no patients who screened positive for depression or suicidal ideation. [a]Patient Health Questionnaire (PHQ)-9 Score ≥ 10. [b]PHQ without sleep item (PHQ-WS) score ≥ 8. [c]Score ≥ 1 on the PHQ-9 suicide item. OR = odds ratio.

Table 4—Sleep clinic demographics by depression screening group.

Variable	All Sleep Patients[a] (n = 308)	Negative Depression Screen (PHQ-2 ≤ 2; n = 259)	Positive Depression Screen (PHQ-9 ≥ 10; n = 33)
Sex [n (% female)]*	135 (43.8)	107 (41.3)	20 (60.6)
Race [n (% White)]	121 (39.3)	99 (38.2)	14 (42.4)
Ethnicity [n (% Hispanic)]	154 (50.0)	133 (51.4)	14 (42.4)
BMI percentile [M (SD)]	81.1 (27.11)	80.6 (27.07)	83.6 (28.81)
Age [M (SD)]	15.6 (2.06)	15.6 (2.09)	15.9 (1.84)
Insomnia primary diagnosis [n (%)]*	44 (14.3)	30 (11.6)	13 (39.4)
OSA primary diagnosis [n (%)]	184 (59.7)	156 (60.2)	14 (42.4)
Other sleep disorder diagnosis [n (%)]	80 (26.0)	73 (28.2)	6 (18.2)

*P < .05. [a]Patients who screened positive on the Patient Health Questionnaire (PHQ)-2 (score > 2) but negative on the PHQ-9 (score < 10) are included in the sample reported under All Sleep Patients. These patients were not included in either the Negative or Positive Depression Screen groups. M = mean, SD = standard deviation.

depression on the PHQ-9 at a rate of 10.8% (insomnia: 29.5%; OSA: 7.6%; other sleep disorders: 7.5%). Logistic regression analyses revealed that the likelihood of a positive PHQ-9 screen was dependent on the sleep disorder diagnosis (ie, insomnia, OSA, other; $\chi^2(1) = 10.881$, $P = .004$; see **Table 5**). Specifically, patients diagnosed with insomnia had an increased likelihood of a positive PHQ-9 depression screen compared to patients presenting with OSA symptoms (OR = 4.73, $P = .002$) and compared to patients with other sleep disorder diagnoses (OR = 5.02, $P = .006$). Further, patients with a primary diagnosis of insomnia reported significantly more depressive symptoms than patients with OSA ($b = 4.79$, $P = .013$; see **Table S1** in the supplemental material). Patients with OSA did not differ from patients with other sleep disorder diagnoses ($b = 3.43$, $P = .160$) in their report of depressive symptoms. Nearly 5% of sleep clinic patients endorsed the suicidal ideation item on the PHQ-9. There was no statistically significant difference in rate of suicidality across diagnoses; 5 patients with insomnia (11%), 6 patients with OSA (3%), and 3 patients with other sleep diagnoses (4%) reported suicidal ideation.

With respect to demographic effects, females were twice as likely as males to screen positive for depression (OR = 2.02, $P = .084$). No demographic factors, however, were significant predictors of continuous PHQ-9 scores for sleep clinic patients.

DISCUSSION

The identification of risk factors associated with depression and suicidal ideation in adolescence is critical to early diagnosis and treatment. The findings from our study provide strong evidence that adolescents presenting with symptoms of sleep disturbance

Table 5—Results of adjusted logistic regression for predicting depression (ie, PHQ-9 ≥ 10) in sleep clinic patients.

Variable	Wald	df	OR [95% CI]	*P*
Age	1.015	1, 271	1.11 [0.90, 1.37]	.314
Sex	2.977	1, 271	2.02 [0.91, 4.50]	.084
Race	.141	1, 271	1.18 [0.49, 2.84]	.708
Ethnicity	.488	1, 271	1.36 [0.58, 3.21]	.485
BMI percentile	2.499	1, 271	1.02 [1.0, 1.04]	.114
Sleep disorder diagnosis	10.881	2, 270		.004
Other (ref: OSA)	.012	1, 271	.94 [0.34, 2.66]	.912
Insomnia (ref: OSA)	9.257	1, 271	4.73 [1.74, 12.88]	.002
Insomnia (ref: Other)	11.987	1, 271	5.02 [1.58, 15.95]	.006

CI = confidence interval, df = degrees of freedom, OSA = obstructive sleep apnea, PHQ, Patient Health Questionnaire, ref = reference group for pairwise comparison.

are at increased risk for both depressive symptoms and suicidal ideation. In this large sample of adolescents, sleep clinic patients reported clinically significant levels of depressive symptoms at more than twice the rate of patients in other subspecialty clinics (cardiology, endocrinology, gastroenterology, hematology, nephrology, neurology, pulmonary, rehabilitative medicine, and rheumatology). Surprisingly, the rate of positive depression screens in patients across many comparison specialty clinics was consistent with or lower than the general population prevalence rate of 4% to 5%,[1] compared to the 14% to 15% prevalence rate observed in studies of medically ill children.[12,13] In contrast, the rate of positive depression screens in the sleep clinic was more than twice as high as the rate of depression found in the general adolescent population.[1] This discrepancy may be explained by the hospital's broad implementation of the depression screener in outpatient specialty clinics, which captured a much larger number of patients, many of whom may have had milder forms of illness, rather than a life-limiting condition.

Additionally, sleep clinic patients were at significantly greater risk of reporting suicidal ideation than patients in nearly all other subspecialty clinics; these patients reported suicidal ideation in the previous 2 weeks at a rate of nearly 5%. Thus, patients with a sleep disorder may be at greater risk for suicidal ideation and symptoms of depression, and screening all patients for these issues should be an important goal of pediatric sleep clinics. Similarly, adolescents who report sleep disturbances in other pediatric clinics (eg, those who may have milder cases of insomnia) should be screened for depression.

Among adolescents presenting in the sleep clinic, patients with a primary diagnosis of insomnia were at the greatest risk of screening positive for depression, compared to patients with OSA and other sleep disorders (eg, narcolepsy, delayed sleep phase syndrome, hypersomnolence). Although sample sizes varied considerably across groups (ie, fewer insomnia patients), this effect was independent of the demographic variables of age and BMI percentile. This finding may suggest a unique relationship between primary insomnia and affective distress. There is an inherent overlap between sleep problems and depression, such that sleep disturbance is related to increased risk of depression and is also considered a secondary symptom of depression. The evidence to date suggests that this relationship is bidirectional,[26] although more research is needed to draw definitive conclusions about cause and effect relationships between sleep disturbance and depression. Sleep problems have been found to be unidirectionally predictive of depression in children,[27,28] although these studies were limited by a broad definition of childhood sleep problems. Sivertsen and colleagues have shown previously that adolescents with short sleep duration (< 6 hours) and insomnia are at the greatest risk of developing depression.[29] Furthermore, longitudinal studies suggest that insomnia in adolescence precedes and may even contribute to the onset of depression.[30,31] Short sleep duration is also related to greater risk of depression in adults.[32] One potential mechanism is that corticolimbic circuitry is altered by insufficient sleep and hyperarousal, consequently affecting emotion regulation and reward processing.[33] Sleep disturbance may also reinforce ruminative thinking, perpetuating further sleep disturbance, which over time could develop into depression.[3] In addition, sleep disturbance and short total sleep duration are independently associated with suicidal thoughts and plan, even after controlling for the presence of depression.[34,35] Considering these observations and the findings from our study, examining sleep habits of adolescents in the primary care setting and probing for possible sleep disorders, particularly insomnia, should be a priority for providers working with adolescent patients.

Screening for both depression and sleep disturbance may also serve to connect adolescents with appropriate services and may mitigate risk for depression and suicide. For example, cognitive behavioral therapy (CBT) is an effective method of treatment for both depression and insomnia, and a number of studies in adults have demonstrated that CBT for insomnia is effective at simultaneously improving symptoms of comorbid depression[36] and suicide ideation.[37] There have been a handful of clinical trials examining the use of youth-adapted CBT for insomnia to treat comorbid insomnia and depression[38–40] that show promise with regard to feasibility and acceptability in adolescents; however, more randomized controlled trials are needed in this area.[41] Importantly, in order to identify and adequately treat patients diagnosed with insomnia and depression, efforts should be made to

increase the availability of appropriate mental health professionals for adolescents in sleep clinic settings, as well as primary care and other specialty clinic settings.

These findings also have implications for establishing public policies to help reduce risk of chronic sleep disturbance and sleep loss during adolescence. One example of a modifiable systemic factor that contributes to insufficient sleep in adolescents is early school start times. Recent data has suggested that most adolescents in the United States are sleep-deprived and not getting the recommended amount of sleep.[42,43] The American Academy of Pediatrics has recognized this as a significant public health issue and recommends that middle schools and high schools start class at 8:30 AM or later, to better align the school schedule with the natural delay in sleep-wake cycles that occurs with puberty.[44] Adequate sleep has also been described as protective against suicidality in adolescents: with every 1-hour increase in sleep duration, the risk of suicidal ideation decreases by 11%, and individuals who get 8–9 hours of sleep tend to have the lowest risk.[35] Additionally, delaying school start time is associated with reduction in depressed mood.[45] Given our study's observed positive association between sleep disorders, depression, and suicidal ideation, and other research demonstrating that insufficient sleep in adolescence relates to other adverse outcomes such as obesity, car crashes, and poor academic performance,[46] implementation of public policies that promote adequate sleep among adolescents is critically needed.

This study is limited by several factors, including its retrospective design and use of screening measures as an indicator of depression. While the PHQ-2 and PHQ-9 are brief, understandable tools that are freely available and useful to health care providers, they cannot replace the gold-standard diagnostic interview for depression. All patients who screened positive for depression were subsequently referred to mental health services to establish a diagnosis and obtain treatment. However, due to logistical constraints, it was not feasible to obtain a prompt psychiatric assessment and diagnosis for each patient. Additionally, as part of clinical care, patients who agreed to be assessed by psychiatry may have been referred to community providers to increase access to services. Thus, diagnostic information was not available for the purposes of this study.

Additionally, the PHQ-2 was used as the initial screening tool, and those who screened negative were not given the opportunity to complete the more extensive PHQ-9. While the specificity of these 2 measures is comparable, the PHQ-9 has a higher sensitivity for detecting depression; therefore, some adolescents who screened negative on the PHQ-2 may have been missed. Another limitation is that we did not include patients who screened positive on the PHQ-2 but negative on the PHQ-9 in our PHQ-2 logistic regression analyses; this was deliberate in order to reduce the chance of having false negatives in the control group. Additionally, although duplicate visits were minimized to the greatest extent possible, it is possible that individual patients could have presented to more than 1 subspecialty clinic. Unfortunately, due to the retrospective nature of the data, no information was available to determine whether patients were seen in more than 1 clinic.

Because sleep disturbance is a primary symptom of depression, one might expect that individuals presenting to a sleep clinic would be more likely screen positive for depression. Indeed, 1 of the 9 questions of the PHQ-9 specifically probes for sleep disturbance, which could potentially elevate PHQ-9 scores in the sleep clinic sample. We excluded this item to examine depression scores without the influence of sleep problems, and the results remained the same, suggesting that our findings are independent of increased sleep disturbance. We also specifically addressed the isolated incidence of suicidal ideation in our sample as a surrogate marker for mood disturbance independent of the sleep disturbance question. We found that independently patients with sleep disturbance were also more likely to endorse suicidal ideation. Within our sleep clinic sample, there was a small number of patients with a primary diagnosis of insomnia, relative to patients with OSA or other sleep disorders. Thus, we may have been limited by a small sample size and reduced statistical power to detect differences in demographic risk factors within these patients. It is notable that the odds of a positive depression screen in the insomnia group were still large enough to reach statistical significance even compared to many more patients in the other diagnostic groups; however, given the small cell size of the insomnia group, this finding should be replicated with larger samples. Although polysomnography data was available for a portion of sleep clinic patients, there were few differences between those classified as experiencing depression and control patients (see **Table S2** in supplemental material). It is possible that in addition to a small sample size, these data were limited by the clinical nature of the sleep study and may not reflect the sleep quality typical for many of these patients at home, particularly those with insomnia. Although the findings of our study could be strengthened using multicenter study designs to improve generalizability, the findings do nonetheless suggest that adolescents seen in sleep clinics may be at a higher risk for positive depression screening.

CONCLUSIONS

Moving forward, using a larger sample size of sleep clinic patients, particularly children with insomnia, coupled with a variety of objective sleep measures (eg, polysomnography, actigraphy) may help to elucidate particular aspects of sleep quality that are specifically related to depression in adolescents (eg, sleep efficiency, number of awakenings, sleep latency). In addition, risk of depression/suicidality should be investigated in patients who report insomnia but are not evaluated in a sleep clinic. It is possible that only the most severe insomnia patients are referred to specialized sleep clinics, and the risk of depression/suicidality may not be as evident in milder insomnia cases seen by other clinics. Longitudinal studies are also needed to examine treatment of sleep disorders as a method to simultaneously prevent or treat depression among adolescents; this research will help to establish the extent to which sleep disturbance is causative of adolescent depression. For example, a well-designed randomized controlled trial of CBT for insomnia in adolescents with insomnia and depression could

strengthen the evidence of the association between these disorders, particularly if the trial demonstrated reversibility of depression symptoms through insomnia treatment. Such research may point to mechanisms that underlie the temporal relationship between sleep disturbance and the risk for future depression and suicidality, and inform strategies for prevention and intervention for adolescents.

ABBREVIATIONS

BMI, body mass index
CBT, cognitive behavioral therapy
OR, odds ratio
OSA, obstructive sleep apnea
PHQ-2, Patient Health Questionnaire-2
PHQ-9, Patient Health Questionnaire-9
PHQ-WS, Patient Health Questionnaire without sleep item

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