



Sleep in infancy and childhood: implications for emotional and behavioral difficulties in adolescence and beyond

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Purpose of review

Extensive scientific efforts have been made in an attempt to identify early markers of behavioral and emotional problems. In this context, sleep has received considerable research attention, as it appears to be closely linked to developmental psychopathology. The present review synthesizes some of the most recent findings regarding the concurrent and longitudinal associations between psychopathology and behavioral manifestations of sleep in childhood and adolescence.

Recent findings

Recent evidence suggests that compromised sleep is associated with both internalizing and externalizing problems in childhood and adolescence. Moreover, sleep problems have been shown to predict the development of various emotional and behavioral problems, including depression, anxiety, attention-deficit hyperactivity disorder, risk-taking and aggression. Yet, inconsistencies are apparent, particularly among findings that are based on objective sleep measurement.

Summary

Taken together, most recent findings suggest that poor sleep in childhood and adolescence constitutes a risk factor for psychopathological symptoms. Accordingly, the importance of early detection and intervention should be a primary goal in clinical settings. In the research domain, the underlying mechanism of these associations should receive future research attention, in an attempt to broaden the understanding of the relationship between sleep and psychopathology.

Keywords

behavior problems, child, development, psychopathology, sleep

INTRODUCTION

During the first years of life, sleep patterns undergo rapid and conspicuous maturational processes. Significant maturational changes occur in sleep architecture [i.e., electroencephalography (EEG)-based sleep stages or spectral density] and in localization of different brain waves during different sleep stages. These changes were the focus of a recent *Current Opinion* review [1^{***}]. The focus of our current review is mainly on the behavioral manifestation of sleep, including sleep schedule, sleep duration, sleep continuity and fragmentation in infants, children and adolescents and how these aspects of sleep are related to developmental psychopathology.

The most noticeable sleep-related process in early childhood is the consolidation of sleep during the nocturnal hours and the reduction in the number of episodes and duration of daytime sleep. Sleep consolidation during the night is a rapid process

occurring most dramatically during the first 6 months [2,3]. In spite of the rapid sleep consolidation process during early childhood, many infants and children continue to suffer from fragmented sleep manifested by multiple and prolonged night wakings [4,5]. Another important developmental change is the reduction in total sleep time throughout childhood and adolescence [6–9]. The reduction in sleep duration is mostly driven by the delay in sleep onset time. This delay appears to be

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KEY POINTS

- Poor sleep quality and insufficient sleep are very prevalent problems in child development and they are closely linked to behavioral and emotional problems in children.
- Although the links between sleep and psychopathology appear to be bidirectional, the more established causal direction is that inadequate sleep may lead (or exacerbate) to compromised emotional and behavioral regulation, and thus increase the risk for psychopathology.
- Brief and effective intervention for childhood sleep problems has been developed and established. Considering the ongoing stress associated with sleep problems in early childhood and the risk for later psychopathology, early sleep problems should be identified and treated.
- Future research should focus on using both objective and subjective sleep measures in assessing sleep and its links to psychopathology; using longitudinal designs to assess the long-term impact of sleep problems and interventions aimed at resolving these problems and further identifying mediators and moderators for the associations between sleep and psychopathology.

accelerated in early adolescence and is linked to the growing prevalence of delayed sleep-phase syndrome, which is characterized by inability to fall asleep at appropriate hours, extremely late sleep onset time, difficulty waking up in the mornings (for regular school or work activities) and the associated daytime sleepiness [10]. Furthermore, research suggests that children's sleep duration is gradually decreasing over decades, such that 100 years ago children slept an average of over an hour more than children sleep today [11]. This could be attributed mainly to the rapid technological evolution introducing, electricity, artificial light and modern social media, as well as other social activities competing with sleep time. It has been estimated that close to 25% of children (ages 6–11 years) and 39% of adolescents (ages 12–17 years) in the United States suffer from insufficient sleep and its adverse correlates [12].

SLEEP AND PSYCHOPATHOLOGY IN CHILDREN AND ADOLESCENTS

Childhood psychopathology is considered a major risk factor for psychopathology in adolescence and adulthood [13–22]. Adolescence has been defined as a vulnerable period for the onset of psychopathology, and brain and hormonal changes occurring during this period have been implicated in this

growing vulnerability [23–26]. Therefore, it is crucial to identify, and if possible to treat, every risk factor that increases the vulnerability of the child or the adolescent to psychopathology. Sleep is one of the key factors that have been associated with developmental psychopathology [25,27,28^{***}, 29–32,33^{***},34,35]. The following sections will present the most recent findings regarding the associations between sleep and internalizing and externalizing problems.

SLEEP AND INTERNALIZING DISORDERS

During the last decade, there has been a growing interest in the relationships between childhood sleep problems and internalizing disorders, with many studies demonstrating that these disorders are strongly associated [27,36–40]. Most of these studies have focused on the links between sleep disturbances and depression, but other internalizing disorders and symptoms, such as anxiety [41–43], loneliness [44,45], suicidal ideation and completion [46–48], have also been the focus of research. More recent publications of cross-sectional and longitudinal studies have extended these findings and have provided substantial support for strong bidirectional links between sleep and internalizing disorders, particularly when the assessment of sleep is based on subjective measures [1^{**},28^{**}, 33^{**},49–51,52^{**},53,54].

Recent large-scale cross-sectional studies have reported associations between different facets of children's sleep, such as sleep quality, quantity and timing and between internalizing symptoms. Poor reported sleep quality (i.e., insomnia symptoms) and eveningness circadian chronotype were significantly associated with depressive symptoms in two different cross-sectional studies of the Australian adolescents [55^{*},56]. In a large survey of 10 220 adolescents, those with insomnia and who slept less than 6 h at night had an increased risk to suffer from depressive symptoms [50]. Further on, in a large cohort study of 11 788 adolescents from 11 different European countries, shorter sleep duration was associated with emotional and peer-related problems, as well as with anxiety and suicidal ideation [33^{**}]. Suicidal ideation was also strongly associated with reported sleep problems in a nonclinical sample of the Croatian adolescents [57], and in a clinical sample of adolescents admitted to a psychiatric inpatient unit [58].

Studies comparing sleep problems in children at risk for psychopathology or clinical samples and controls yielded mixed results [13,59^{*},60]. In a study of children and adolescents at high risk for depression, high-risk adolescents showed poorer sleep

[polysomnography (PSG) measures] in comparison to controls [59[■]]. However, PSG measures were not significantly different between high-risk children and controls. Children at high risk for a bipolar disorder were reported to have an increased risk of a variety of psychiatric disorders, including sleep disorders [13]. Conversely, in a recent study comparing sleep of adolescents with social anxiety disorder to controls, no significant differences were observed in actigraphic or subjective sleep measures [60]. A recent meta-analysis found only modest differences between children and adolescents with major depressive disorder and controls for both sleep microarchitecture (e.g., detailed analysis of EEG frequencies detected by PSG during sleep) and macroarchitecture features [e.g., total sleep time, sleep latency, sleep efficiency, awake time, stage 1, stage 2, stage 3, stage 4, rapid eye movement (REM) latency and REM sleep] [61[■]]. The strongest difference was found in sleep latency, with 31% of adolescents with major depressive disorder showing increased sleep latency. Because 63–99% of depressed youth had similar sleep macroarchitecture to controls, the authors concluded that the differences in sleep could not be considered as specific biological markers for depression. Similar findings of longer sleep latency and lower sleep efficiency in depressed adolescents in comparison with controls were reported in another meta-analysis [52[■]].

A central question, which has been the focus of many recent studies, is whether it would be possible to identify a directional relationship between sleep disorders and internalizing disorders in children. Indeed, recent reviews have concluded that sleep problems probably predict the onset of internalizing disorders [1[■],55[■]]. A recent meta-analysis, based on longitudinal and treatment studies, has demonstrated that sleep disturbances precede the development of depression, but there was no support for a predictive role of depression in the development of sleep disturbance [52[■]]. Longitudinal studies published in the last 2 years further support these findings [32,62[■],63,64[■]]. In addition to depression, recent studies have also focused on the links between sleep problems and self-injury. In one of these studies, difficulties initiating sleep and early morning waking were associated with increased risk of subsequent hospitalization for self-harm. However, these associations could mainly be explained by coexistent symptoms of anxiety and depression [65].

Longitudinal studies following school-aged children into adolescence have also reported significant predictive associations between sleep and internalizing symptoms. In a community-based sample of 1420 children assessed 4–7 times between ages

9 and 16 years, bidirectional predictive relationships were found between reported child sleep problems and higher prevalence of generalized anxiety disorder and depression symptoms [66]. Likewise, Perfect *et al.* [67] found that insomnia symptoms as reported by the child and parental-reported excessive daytime sleepiness were the sleep parameters most consistently predictive of reported depressive and anxiety symptoms.

Only a few studies have recently focused on sleep and internalizing symptoms of preschool children [30,68,69[■],70]. In a study of 5-year old children, poor sleep assessed objectively by EEG [69[■]] and actigraphy [70] was a significant predictor of parental-reported internalizing problems 1 year later.

In summary, accumulating evidence demonstrates strong bidirectional links between disturbed sleep and internalizing disorders in children and adolescents, and suggests that sleep disorders may precede the development of various emotional problems, particularly depression.

SLEEP AND EXTERNALIZING DISORDERS

Externalizing behaviors, such as aggression, conduct problems and risk-taking in children and adolescents, are a serious concern because of their high prevalence rates and associations with adverse outcomes and later psychopathology [71–73]. The links between sleep and externalizing problems have been the focus of several recent investigations.

Considering concurrent links, childhood behavioral problems have been found to be positively correlated with different aspects of poor sleep, including the number of night-wakings [74] and short sleep duration [75–77]. A recent large cohort study indicated that preschool children with shorter night-time sleep duration had higher odds of parent-reported overactivity, anger, aggression, impulsivity, tantrums and annoying behaviors than their peers, even after controlling for many relevant covariates [34]. Similarly, actigraphy-measured sleep duration was recently found to be inversely associated with aggression at age 5 years [78].

The associations between sleep and attention deficit hyperactivity disorder (ADHD) have drawn extensive scientific attention in the past decades. This topic has been addressed in recent years in a number of reviews and meta-analyses [79–82], and therefore only a summary of recent findings is included here.

Reported sleep problems have been significantly associated with ADHD [83,84]. It has been shown that 30% of children with ADHD have reported sleep difficulties [81]. When objective measures of

sleep are considered, the findings are less consistent. One meta-analysis found no consistent significant differences between PSG sleep measures in children with ADHD versus controls, with the exception of periodic limb movements in sleep [79]; whereas, a second meta-analysis reported that children with ADHD have lower sleep efficiencies, more sleep stage shifts and increased apnea–hypopnea index as presented in PSG studies [80]. Recent actigraphic studies have pointed to the associations between ADHD and longer sleep latency, shorter sleep duration and lower sleep efficiency [84,85].

In adolescence, sleep problems have been linked to risk-taking behaviors, such as cigarette smoking, drug abuse, risky driving and delinquency [28^{***},86]. A recent study of healthy adolescents showed that even normative levels of self-reported poor sleep quality were related to more risk-related behavior [87]. Interestingly, the authors suggest that poor sleep is associated with greater arousal to rewards and a potential lack of motivation to engage in cognitive control, which may account for their riskier behavior. With regards to more specific aspects of sleep, short sleep duration in adolescence has recently been associated with several risk-taking behaviors, such as smoking and snuffing [35]. Interestingly, a recent study found longitudinal predictive links between sleep movements at age 4.5 years and ADHD at age 18 years, but failed to find associations between childhood insomnia and elevated ADHD symptomology in adolescence [88^{*}].

Evidence from longitudinal studies suggests that childhood sleep problems are also associated with later externalizing behaviors [76,89–91]. In a recent prospective study, two specific parent-reported sleep difficulties in childhood were found predictive of later externalizing behaviors. First, sleep-movement persistence (from ages 4.5 to 9 years) was associated with externalizing at age 9 years. Second, insomnia, especially persistent insomnia, was associated with externalizing at ages 9 and 18 years [88^{*}]. Similar results were recently found concerning general sleep problems reported by parents at preschool age, which predicted school-aged externalizing problems [68]. Correspondingly, parent-reported and self-reported sleep problems in older children (assessed repeatedly between ages 9 and 16 years) predicted an increase in the prevalence of oppositional defiant disorder, even when adjusting for comorbidity and relevant covariates [66]. In contrast, a recent investigation failed to detect longitudinal links between poor sleep reported in infancy (ages 12 and 18 months) and aggression at age 5 years [78]. Nevertheless, sleep characteristics from as early as the fetal stage have been found to predict the degree of self-regulation (effortful control) both

at 8–9 years and at 14–15 years [92]. Furthermore, it has recently been proposed that measuring individual developmental trajectories in sleep patterns, as opposed to cross-sectional assessment, may be more indicative of later ADHD [93^{*}].

In adolescence, the negative consequences of sleep loss and disruptions seem to include a future tendency toward risk-taking behaviors. A recent review presented ample evidence from prospective studies, suggesting that poorer or shorter sleep predicts more alcohol and drug use, driving while intoxicated, unprotected sexual activity, multiple unintentional injuries and other health-risk behaviors [28^{***}]. Correspondingly, in a recent large cohort study, short sleep duration in adolescence was identified as a marker of delinquency in adulthood, and its effects were partially mediated by sensation-seeking and impulse control [94]. The issue of mediators and moderators of these longitudinal associations has been relatively neglected, yet several investigations have identified relevant factors, such as sex [86], socioeconomic status [95] and maternal characteristics [77,78]. Further research is warranted regarding possible mediation and moderation trajectories in this domain.

UNDERLYING MECHANISMS

Different underlying mechanisms have been proposed to explain the ubiquitous bidirectional and predictive links between sleep and behavioral and emotional problems. For instance, the interpretation that insufficient or poor sleep is the cause (or exacerbating factor) for psychopathology gains support from experimental studies on sleep restriction and extension in children. Overall, these studies lend some support to the claim that insufficient sleep can lead to compromised neurobehavioral functioning, emotion regulation, mood and other outcomes that are related to psychopathology [96^{***},97^{***},98–103].

Recently, Baum *et al.* [96^{***}] showed that following a mild sleep restriction protocol of 6.5 h in bed per night for five consecutive nights adolescents were more irritable, angry, oppositional, tense and prone to emotional outbursts according to parent-reports and self-reports, compared with a healthy sleep duration schedule (10 h sleep opportunity for five consecutive nights). Another recent study, which examined the influence of gradual sleep extension in a group of adolescents with chronic sleep reduction, found a significant decrease in depressive symptom severity at the end of the sleep extension period [97^{***}]. Davis *et al.* [99] found that sleep restriction to 4 h for one night led to riskier pedestrian behavior (e.g., impulsive road behavior)

in a virtual reality setting, in comparison with adequate sleep (8.5 h) in healthy adolescents. Thus, it seems that sleep restriction may compromise safety and well-being and lead to a variety of poor psychological outcomes in youth.

Evidence regarding the negative impact of sleep manipulations on psychopathology-related outcomes underscores the need to identify the processes responsible for this impact. One such mechanism is related to the links between sleep and emotions and emotion regulation that also address the impact of insufficient sleep on brain functions that are related to executive control and emotional information processing [104,105]. Other suggested mechanisms include overlapping genetic features [27,106] and shared family and parenting factors [107] that influence both sleep and psychopathology.

CONCLUSION

Poor (or insufficient) sleep is very common during infancy, childhood and adolescence. It appears to be a risk factor for developing psychopathology or exacerbating it during development. Both poor sleep and childhood psychopathology are precursors of adult adjustment problems and psychopathology. Poor sleep can be identified in early development and effective interventions are available [108]; therefore, the importance of early detection and treatment should be a primary goal for clinicians in the field.

Our review reveals that most studies leading to these conclusions are based on reported measures and on correlational designs. The few studies, which are based on objective measurement of sleep, have reached less conclusive findings regarding the links between sleep problems and internalizing disorders. This issues should be further explored to identify to what extent these links are mainly in the subjective domain (e.g., negative bias in depression or shared-method variance) and to what extent the objective sleep measures fail to document some meaningful aspects of reported sleep. Notwithstanding methodological issues, bidirectional links have been identified between sleep and psychopathology. Longitudinal studies suggest that sleep is a more reliable predictor of psychopathology than the opposite prediction.

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Conflicts of interest

The authors have no conflict of interest.

REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

1. Tesler N, Gerstenberg M, Huber R. Developmental changes in sleep and ■ their relationships to psychiatric illnesses. *Curr Opin Psychiatry* 2013; 26:572–579.

This highly relevant review, published recently in *Current Opinion*, discusses the bidirectional relationships between altered sleep (with a special emphasis on sleep architecture), brain development and psychiatric disorders and symptoms in children and adolescents.

2. Henderson JM, France KG, Owens JL, Blampied NM. Sleeping through the night: the consolidation of self-regulated sleep across the first year of life. *Pediatrics* 2010; 126:e1081–e1087.
3. Henderson JMT, France KG, Blampied NM. The consolidation of infants' nocturnal sleep across the first year of life. *Sleep Med Rev* 2011; 15:211–220.
4. Wang G, Xu G, Liu Z, *et al.* Sleep patterns and sleep disturbances among Chinese school-aged children: prevalence and associated factors. *Sleep Med* 2013; 14:45–52.
5. Hysing M, Harvey AG, Torgersen L, *et al.* Trajectories and predictors of nocturnal awakenings and sleep duration in infants. *J Dev Behav Pediatr* 2014; 35:309–316.
6. Williams JA, Zimmerman FJ, Bell JF. Norms and trends of sleep time among US children and adolescents. *JAMA Pediatr* 2013; 167:55–60.
7. Maslowsky J, Ozer EJ. Developmental trends in sleep duration in adolescence and young adulthood: evidence from a national United States sample. *J Adolesc Health* 2014; 54:691–697.
8. Pesonen AK, Martikainen S, Heinonen K, *et al.* Continuity and change in poor sleep from childhood to early adolescence. *Sleep* 2014; 37:289–297.
9. Price AMH, Brown JE, Bittman M, *et al.* Children's sleep patterns from 0 to 9 years: Australian population longitudinal study. *Arch Dis Child* 2014; 99:119–125.
10. Sivertsen B, Pallesen S, Stormark KM, *et al.* Delayed sleep phase syndrome in adolescents: prevalence and correlates in a large population based study. *BMC Public Health* 2013; 13:1163.
11. Matricciani L, Olds T, Petkov J. In search of lost sleep: secular trends in the sleep time of school-aged children and adolescents. *Sleep Med Rev* 2012; 16:203–211.
12. Smaldone A, Honig JC, Byrne MW. Sleepless in America: inadequate sleep and relationships to health and well being of our nation's children. *Pediatrics* 2007; 119 (Suppl 1):S29–S37.
13. Duffy A, Horrocks J, Doucette S, *et al.* The developmental trajectory of bipolar disorder. *Br J Psychiatry* 2014; 204:122–128.
14. Broeren S, Muris P, Diamantopoulou S, Baker JR. The course of childhood anxiety symptoms: developmental trajectories and child-related factors in normal children. *J Abnorm Child Psychol* 2013; 41:81–95.
15. Hakulinen C, Jokela M, Hintsanen M, *et al.* Childhood family factors predict developmental trajectories of hostility and anger: a prospective study from childhood into middle adulthood. *Psychol Med* 2013; 43:2417–2426.
16. Heron J, Barker ED, Joinson C, *et al.* Childhood conduct disorder trajectories, prior risk factors and cannabis use at age 16: birth cohort study. *Addiction* 2013; 108:2129–2138.
17. Klimes-Dougan B, Desjardins CD, James MG, *et al.* The development of thought problems: a longitudinal family risk study of offspring of bipolar, unipolar, and well parents. *Dev Psychopathol* 2013; 25:1079–1091.
18. McCarty CA, Wymbs BT, Mason WA, *et al.* Early adolescent growth in depression and conduct problem symptoms as predictors of later substance use impairment. *J Abnorm Child Psychol* 2013; 41:1041–1051.
19. Mezulis A, Salk RH, Hyde JS, *et al.* Affective, biological, and cognitive predictors of depressive symptom trajectories in adolescence. *J Abnorm Child Psychol* 2014; 42:539–550.
20. Pingault JB, Cote SM, Galera C, *et al.* Childhood trajectories of inattention, hyperactivity and oppositional behaviors and prediction of substance abuse/dependence: a 15-year longitudinal population-based study. *Mol Psychiatry* 2013; 18:806–812.
21. Pingault JB, Cote SM, Lacourse E, *et al.* Childhood hyperactivity, physical aggression and criminality: a 19-year prospective population-based study. *PLoS One* 2013; 8:e62594.
22. Steiger AE, Allemand M, Robins RW, Fend HA. Low and decreasing self-esteem during adolescence predict adult depression two decades later. *J Pers Soc Psychol* 2014; 106:325–338.
23. Walker EF. Adolescent neurodevelopment and psychopathology. *Curr Dir Psychol* 2002; 11:24–28.
24. Spear LP. The adolescent brain and age-related behavioral manifestations. *Neurosci Biobehav Rev* 2000; 24:417–463.
25. Dahl RE, Lewin DS. Pathways to adolescent health: sleep regulation and behavior. *J Adolesc Health* 2002; 31:175–184.

26. Graber JA. Pubertal timing and the development of psychopathology in adolescence and beyond. *Horm Behav* 2013; 64:262–269.
27. Gregory AM, Sadeh A. Sleep, emotional and behavioral difficulties in children and adolescents. *Sleep Med Rev* 2012; 16:129–136.
28. Shochat T, Cohen-Zion M, Tzischinsky O. Functional consequences of inadequate sleep in adolescents: a systematic review. *Sleep Med Rev* 2014; 18:75–87.
- An excellent review of the literature on the consequences of inadequate sleep in adolescents, including psychopathology and other health issues.
29. Sadeh A. Consequences of sleep loss or sleep disruption in children. *Sleep Med Clin* 2007; 2:513–520.
30. Magee CA, Gordon R, Caputi P. Distinct developmental trends in sleep duration during early childhood. *Pediatrics* 2014; 133:e1561–e1567.
31. Orzech KM, Acebo C, Seifer R, et al. Sleep patterns are associated with common illness in adolescents. *J Sleep Res* 2014; 23:133–142.
32. Roberts RE, Duong HT. The prospective association between sleep deprivation and depression among adolescents. *Sleep* 2014; 37:239–244.
33. Sarchiapone M, Mandelli L, Carli V, et al. Hours of sleep in adolescents and its association with anxiety, emotional concerns, and suicidal ideation. *Sleep Med* 2014; 15:248–254.
- This very large cross-sectional study included 11 788 students from 11 different European countries and demonstrated that the variables most strongly associated with reduced sleep hours were emotional and peer-related problems, suicidal ideation and older age
34. Scharf RJ, Demmer RT, Silver EJ, Stein RE. Nighttime sleep duration and externalizing behaviors of preschool children. *J Dev Behav Pediatr* 2013; 34:384–391.
35. Stea TH, Knutsen T, Torstveit MK. Association between short time in bed, health-risk behaviors and poor academic achievement among Norwegian adolescents. *Sleep Med* 2014; 15:666–671.
36. Goetz RR, Wolk SI, Coplan JD, et al. Premorbid polysomnographic signs in depressed adolescents: a reanalysis of EEG sleep after longitudinal follow-up in adulthood. *Biol Psychiatry* 2001; 49:930–942.
37. Gregory AM, Rijdsdijk FV, Lau JY, et al. The direction of longitudinal associations between sleep problems and depression symptoms: a study of twins aged 8 and 10 years. *Sleep* 2009; 32:189–199.
38. Johnson EO, Roth T, Breslau N. The association of insomnia with anxiety disorders and depression: exploration of the direction of risk. *J Psychiatr Res* 2006; 40:700–708.
39. Fredriksen K, Rhodes J, Reddy R, Way N. Sleepless in Chicago: tracking the effects of adolescent sleep loss during the middle school years. *Child Dev* 2004; 75:84–95.
40. Roane BM, Taylor DJ. Adolescent insomnia as a risk factor for early adult depression and substance abuse. *Sleep* 2008; 31:1351–1356.
41. Alfano CA, Ginsburg GS, Kingery JN. Sleep-related problems among children and adolescents with anxiety disorders. *J Am Acad Child Adolesc Psychiatry* 2007; 46:224–232.
42. Storch EA, Murphy TK, Lack CW, et al. Sleep-related problems in pediatric obsessive-compulsive disorder. *J Anxiety Disord* 2008; 22:877–885.
43. Gregory AM, Caspi A, Eley TC, et al. Prospective longitudinal associations between persistent sleep problems in childhood and anxiety and depression disorders in adulthood. *J Abnorm Child Psychol* 2005; 33:157–163.
44. Xu Z, Su H, Zou Y, et al. Sleep quality of Chinese adolescents: distribution and its associated factors. *J Paediatr Child Health* 2012; 48:138–145.
45. Harris RA, Qualter P, Robinson SJ. Loneliness trajectories from middle childhood to preadolescence: impact on perceived health and sleep disturbance. *J Adolesc* 2013; 36:1295–1304.
46. Pigeon WR, Pinquart M, Conner K. Meta-analysis of sleep disturbance and suicidal thoughts and behaviors. *J Clin Psychiatry* 2012; 73:e1160–e1167.
47. Goldstein TR, Bridge JA, Brent DA. Sleep disturbance preceding completed suicide in adolescents. *J Consult Clin Psychol* 2008; 76:84–91.
48. Lee YJ, Cho SJ, Cho IH, Kim SJ. Insufficient sleep and suicidality in adolescents. *Sleep* 2012; 35:455–460.
49. Do YK, Shin E, Bautista MA, Foo K. The associations between self-reported sleep duration and adolescent health outcomes: what is the role of time spent on Internet use? *Sleep Med* 2013; 14:195–200.
50. Sivertsen B, Harvey AG, Lundervold AJ, Hysing M. Sleep problems and depression in adolescence: results from a large population-based study of Norwegian adolescents aged 16–18 years. *Eur Child Adolesc Psychiatry* 2013. [Epub ahead of print]
51. Tham SW, Holley AL, Zhou C, et al. Longitudinal course and risk factors for fatigue in adolescents: the mediating role of sleep disturbances. *J Pediatr Psychol* 2013; 38:1070–1080.
52. Lovato N, Gradisar M. A meta-analysis and model of the relationship between sleep and depression in adolescents: recommendations for future research and clinical practice. *Sleep Med Rev* 2014. [In press]
- An important meta-analysis, based on 23 studies, provides strong evidence from longitudinal and treatment studies that sleep disturbances in adolescents precede the development of depression.
53. Peterman JS, Carper MM, Kendall PC. Anxiety disorders and comorbid sleep problems in school-aged youth: review and future research directions. *Child Psychiatry Hum Dev* 2014. [In press]
54. Asarnow LD, McGlinchey E, Harvey AG. The effects of bedtime and sleep duration on academic and emotional outcomes in a nationally representative sample of adolescents. *J Adolesc Health* 2014; 54:350–356.
55. Alvaro PK, Roberts RM, Harris JK. A systematic review assessing bidirectionality between sleep disturbances, anxiety, and depression. *Sleep* 2013; 36:1059–1068.
- A cross-sectional study of adolescents that revealed significant associations between insomnia, chronotype and depressive symptoms. Among the subtypes of anxiety, only generalized anxiety disorder was significantly linked to insomnia.
56. Short MA, Gradisar M, Lack LC, Wright HR. The impact of sleep on adolescent depressed mood, alertness and academic performance. *J Adolesc* 2013; 36:1025–1033.
57. Franic T, Kralj Z, Marcinko D, et al. Suicidal ideations and sleep-related problems in early adolescence. *Early Interv Psychiatry* 2014; 8:155–162.
58. Kaplan SG, Ali SK, Simpson B, et al. Associations between sleep disturbance and suicidal ideation in adolescents admitted to an inpatient psychiatric unit. *Int J Adolesc Med Health* 2013. [In press]
59. Bat-Pitault F, Da Fonseca D, Cortese S, et al. The sleep macroarchitecture of children at risk for depression recruited in sleep centers. *Eur Psychiatry* 2013; 28:168–173.
- This study found significant differences in objective sleep measures (assessed by PSG) between adolescents at risk for depression (by virtue of having a mother with a history of depression) and controls, but found no differences between children at risk and healthy controls.
60. Mesa F, Beidel DC, Bunnell BE. An examination of psychopathology and daily impairment in adolescents with social anxiety disorder. *PLoS One* 2014; 9:e93668.
61. Augustinavicius JL, Zanjani A, Zakzakis KK, Shapiro CM. Polysomnographic features of early-onset depression: a meta-analysis. *J Affect Disord* 2014; 158:11–18.
- An important meta-analysis examining the relationships between sleep as assessed with PSG and depression in children and adolescents. The study provides support for only modest differences on sleep macroarchitecture and microarchitecture between children and adolescents with major depressive disorder and controls.
62. El-Sheikh M, Bub KL, Kelly RJ, Buckhalt JA. Children's sleep and adjustment: a residualized change analysis. *Dev Psychol* 2013; 49:1591–1601.
- A very impressive three-wave longitudinal study of children from diverse economic and ethnic backgrounds examining the predictive links between children's sleep and anxiety and depressive symptoms
63. Roberts RE, Duong HT. Depression and insomnia among adolescents: a prospective perspective. *J Affect Disord* 2013; 148:66–71.
64. Matamura M, Tochigi M, Usami S, et al. Associations between sleep habits and mental health status and suicidality in a longitudinal survey of monozygotic twin adolescents. *J Sleep Res* 2014; 23:290–294.
- A longitudinal study of 314 monozygotic twins reporting significant associations between later bedtime and shorter sleep duration and emotional distress (i.e., anxiety and depressive symptoms, suicidal thoughts and reported self-harm behaviors), while controlling for genetic and shared environmental factors.
65. Junker A, Bjørngaard JH, Gunnell D, Bjerkeset O. Sleep problems and hospitalization for self-harm: a 15-year follow-up of 9000 Norwegian adolescents. *The Young-HUNT study. Sleep* 2014; 37:579–585.
66. Shanahan L, Copeland WE, Angold A, et al. Sleep problems predict and are predicted by generalized anxiety/depression and oppositional defiant disorder. *J Am Acad Child Adolesc Psychiatry* 2014; 53:550–558.
67. Perfect MM, Levine-Donnerstein D, Archbold K, et al. The contribution of sleep problems to academic and psychosocial functioning. *Psychol Schools* 2014; 51:273–295.
68. Simola P, Luukkonen K, Pitkaranta A, et al. Psychosocial and somatic outcomes of sleep problems in children: a 4-year follow-up study. *Child Care Health Dev* 2014; 40:60–67.
69. Hatzinger M, Brand S, Perren S, et al. In preschool children, sleep objectively assessed via sleep-EEGs remains stable over 12 months and is related to psychological functioning, but not to cortisol secretion. *J Psychiatr Res* 2013; 47:1809–1814.
- A unique longitudinal study examining sleep of preschool children with EEG. The findings revealed that sleep remained stable over a 12-month period and that poor objective sleep significantly predicted more internalizing problems as reported by the parents.
70. Hatzinger M, Brand S, Perren S, et al. In preschool children, sleep objectively assessed via actigraphy remains stable over 12 months and is related to psychological functioning, but not to cortisol secretion. *J Psychiatr Res* 2014; 55:22–28.
71. Witkiewitz K, King K, McMahon RJ, et al. Evidence for a multidimensional latent structural model of externalizing disorders. *J Abnorm Child Psychol* 2013; 41:223–237.
72. Kessler RC, Avenevoli S, Costello EJ, et al. Prevalence, persistence, and sociodemographic correlates of DSM-IV disorders in the National Comorbidity Survey Replication Adolescent Supplement. *Arch Gen Psychiatry* 2012; 69:372–380.
73. Loth AK, Drabick DA, Leibenluft E, Hulvershorn LA. Do childhood externalizing disorders predict adult depression? a meta-analysis. *J Abnorm Child Psychol* 2014. [In press]

74. Reid GJ, Hong RY, Wade TJ. The relation between common sleep problems and emotional and behavioral problems among 2- and 3-year-olds in the context of known risk factors for psychopathology. *J Sleep Res* 2009; 18:49–59.
75. Velten-Schurian K, Hautzinger M, Poets CF, Schlarb AA. Association between sleep patterns and daytime functioning in children with insomnia: the contribution of parent-reported frequency of night waking and wake time after sleep onset. *Sleep Med* 2010; 11:281–288.
76. Gregory AM, Van der Ende J, Willis TA, Verhulst FC. Parent-reported sleep problems during development and self-reported anxiety/depression, attention problems, and aggressive behavior later in life. *Arch Pediatr Adolesc Med* 2008; 162:330–335.
77. Goodnight JA, Bates JE, Staples AD, *et al.* Temperamental resistance to control increases the association between sleep problems and externalizing behavior development. *J Fam Psychol* 2007; 21:39–48.
78. Sheridan A, Murray L, Cooper PJ, *et al.* A longitudinal study of child sleep in high and low risk families: relationship to early maternal settling strategies and child psychological functioning. *Sleep Med* 2013; 14:266–273.
79. Sadeh A, Pergamin L, Bar-Haim Y. Sleep in children with attention-deficit hyperactivity disorder: a meta-analysis of polysomnographic studies. *Sleep Med Rev* 2006; 10:381–398.
80. Cortese S, Faraone SV, Konofal E, Lecendreux M. Sleep in children with attention-deficit/hyperactivity disorder: meta-analysis of subjective and objective studies. *J Am Acad Child Adolesc Psychiatry* 2009; 48:894–908.
81. Yoon SY, Jain U, Shapiro C. Sleep in attention-deficit/hyperactivity disorder in children and adults: past, present, and future. *Sleep Med Rev* 2012; 16:371–388.
82. Sedky K, Bennett DS, Carvalho KS. Attention deficit hyperactivity disorder and sleep disordered breathing in pediatric populations: a meta-analysis. *Sleep Med Rev* 2014; 18:349–356.
83. Gomes AA, Parchao C, Almeida A, *et al.* Sleep-wake patterns reported by parents in hyperactive children diagnosed according to ICD-10, as compared to paired controls. *Child Psychiatry Hum Dev* 2013. [In press]
84. Moreau V, Rouleau N, Morin CM. Sleep in children with attention deficit hyperactivity disorder: actigraphic and parental reports. *Behav Sleep Med* 2014; 12:69–83.
85. Moreau V, Rouleau N, Morin CM. Sleep, attention, and executive functioning in children with attention-deficit/hyperactivity disorder. *Arch Clin Neuropsychol* 2013; 28:692–699.
86. Wong MM, Brower KJ, Zucker RA. Childhood sleep problems, early onset of substance use and behavioral problems in adolescence. *Sleep Med* 2009; 10:787–796.
87. Telzer EH, Fuligni AJ, Lieberman MD, Galvan A. The effects of poor quality sleep on brain function and risk taking in adolescence. *Neuroimage* 2013; 71:275–283.
88. Armstrong JM, Ruttelle PL, Klein MH, *et al.* Associations of child insomnia, sleep movement, and their persistence with mental health symptoms in childhood and adolescence. *Sleep* 2014; 37:901–909.
- A valuable investigation of the concurrent and longitudinal associations between insomnia and sleep-related movement at ages 4.5 and 9 years and mental health symptoms at ages 9 and 18 years.
89. Quach J, Hiscock H, Canterford L, Wake M. Outcomes of child sleep problems over the school-transition period: Australian population longitudinal study. *Pediatrics* 2009; 123:1287–1292.
90. Gregory AM, Eley TC, O'Connor TG, Plomin R. Etiologies of associations between childhood sleep and behavioral problems in a large twin sample. *J Am Acad Child Adolesc Psychiatry* 2004; 43:744–751.
91. Kamphuis J, Meerlo P, Koolhaas JM, Lancel M. Poor sleep as a potential causal factor in aggression and violence. *Sleep Med* 2012; 13:327–334.
92. Van den Bergh BR, Mulder EJ. Fetal sleep organization: a biological precursor of self-regulation in childhood and adolescence? *Biol Psychol* 2012; 89:584–590.
93. Scott N, Blair PS, Emond AM, *et al.* Sleep patterns in children with ADHD: a population-based cohort study from birth to 11 years. *J Sleep Res* 2013; 22:121–128.
- This interesting study indicates that individual age-specific shifts in sleep duration may serve as more useful predictors of ADHD compared with absolute sleep duration at any specific stage.
94. Peach HD, Gaultney JF. Sleep, impulse control and sensation-seeking predict delinquent behavior in adolescents, emerging adults, and adults. *J Adolesc Health* 2013; 53:293–299.
95. El-Sheikh M, Kelly RJ, Buckhalt JA, Benjamin Hinnant J. Children's sleep and adjustment over time: the role of socioeconomic context. *Child Dev* 2010; 81:870–883.
96. Baum KT, Desai A, Field J, *et al.* Sleep restriction worsens mood and emotion regulation in adolescents. *J Child Psychol Psychiatry* 2014; 55:180–190.
- This is an important experimental study on the negative effects of sleep restriction for 6.5 h in bed per night for five consecutive nights on mood and emotion regulation in adolescents.
97. Dewald-Kaufmann JF, Oort FJ, Meijer AM. The effects of sleep extension and sleep hygiene advice on sleep and depressive symptoms in adolescents: a randomized controlled trial. *J Child Psychol Psychiatry* 2014; 55:273–283.
- This interesting study examined the effect of a gradual sleep extension manipulation combined with sleep hygiene on adolescents with chronic sleep reduction, and found that adolescents are able to cooperate with the manipulation and that it may lead to a reduction in depressive symptoms.
98. Sadeh A, Gruber R, Raviv A. The effects of sleep restriction and extension on adolescents' pedestrian safety: what a difference an hour makes. *Child Dev* 2003; 74:444–455.
99. Davis AL, Avis KT, Schwebel DC. The effects of acute sleep restriction on adolescents' pedestrian safety in a virtual environment. *J Adolesc Health* 2013; 53:785–790.
100. Fallone G, Acebo C, Seifer R, Carskadon MA. Experimental restriction of sleep opportunity in children: effects on teacher ratings. *Sleep* 2005; 28:1561–1567.
101. Berger RH, Miller AL, Seifer R, *et al.* Acute sleep restriction effects on emotion responses in 30- to 36-month-old children. *J Sleep Res* 2012; 21:235–246.
102. Molfese DL, Ivanenko A, Key AF, *et al.* A one-hour sleep restriction impacts brain processing in young children across tasks: evidence from event-related potentials. *Dev Neuropsychol* 2013; 38:317–336.
103. Gruber R, Cassoff J, Frenette S, *et al.* Impact of sleep extension and restriction on children's emotional lability and impulsivity. *Pediatrics* 2012; 130:e1155–e1161.
104. Kahn M, Sheppes G, Sadeh A. Sleep and emotions: bidirectional links and underlying mechanisms. *Int J Psychophysiol* 2013; 89:218–228.
105. Walker MP, van der Helm E. Overnight therapy? The role of sleep in emotional brain processing. *Psychol Bull* 2009; 135:731–748.
106. Barclay NL, Gregory AM. Quantitative genetic research on sleep: a review of normal sleep, sleep disturbances and associated emotional, behavioural, and health-related difficulties. *Sleep Med Rev* 2013; 17:29–40.
107. Sadeh A, Tikotzky L, Scher A. Parenting and infant sleep. *Sleep Med Rev* 2010; 19:103–110.
108. Mindell JA, Kuhn B, Lewin DS, *et al.* Behavioral treatment of bedtime problems and night wakings in infants and young children: an American Academy of Sleep Medicine review. *Sleep* 2006; 29:1263–1276.