SLEEP AND MENTAL HEALTH PROBLEMS IN CHILDREN AND ADOLESCENTS

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Key points:

- There are complex and bi-directional associations between sleep and mental health.
- In the last decade, there has been an increase in longitudinal studies focusing on sleep and mental health.
- Further research should focus on sleep and mental health in early childhood.
- There is a need to further investigate the mechanisms underlying the associations between sleep and different aspects of mental health.

Summary: Previous reviews have described the links between sleep and mental health extensively. In this narrative review, we focus on literature published during the last decade investigating the links between sleep and mental health difficulties in childhood and adolescence. More specifically, we focus on the mental health disorders listed in the most recent edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5). We also discuss possible mechanisms underlying these associations. The review ends with a discussion of possible future lines of enquiry.

Introduction

Sleep disturbances are often observed in children and adolescents.[1] For example, a recent study found that sleep-related difficulties were reported by parents in 22.6% of children and 20.0% of adolescents.[2] Similarly, many youth develop mental disorders in childhood and adolescence.[3] Childhood and adolescence are key periods in which to investigate mental health, as more than half of mental disorders start during these stages of life, and many persist throughout adulthood.[4] The worldwide prevalence of presenting with any mental disorder at some point during childhood or adolescence was estimated by one meta-analysis to be around 13%.[3]

Not only are sleep difficulties and mental health problems common but they go hand-in-hand. Although traditionally, sleep problems have been considered a secondary symptom of psychiatric conditions,[5] it is now clear that they warrant independent consideration and that there is a complex and bi-directional association between sleep and mental health.[6] Furthermore, there is increasing literature suggesting that sleep disturbances occur prior to the development of mental disorders.[7]

Previous reviews have described the links between sleep and mental health extensively.[8,9] With this in mind, this review focuses predominantly on research studies on this topic published during the last decade. Here, we focus largely on symptoms of mental disorders listed in the most recent edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5).[10] More specifically, we focus on sleep in relation to neurodevelopmental disorders (i.e. autism spectrum disorder [ASD] and attention deficit hyperactivitiy disorder [ADHD]), Schizophrenia spectrum and other psychotic disorders, Bipolar disorders, Depressive disorders, Anxiety disorders, and Disruptive, impulse-control, and conduct disorders, as these are among the most common and/or pervasive mental disorders experienced by young people. Next, we discuss possible mechanisms underlying these associations. Finally, we flag possible lines of future enquiry.

Sleep and mental health in childhood and adolescence

Sleep and neurodevelopmental disorders

Sleep disturbances are extremely prevalent in children with neurodevelopmental disorders.[11] In children with ASD, sleep problems are very common.[12] According to a review, some examples of sleep problems in these children include prolonged sleep latency, decreased sleep efficiency, reduced total sleep time, increased waking after sleep-onset, bedtime resistance, and daytime sleepiness.[13] Importantly, the temporal nature of the association between sleep problems and ASD is unclear because longitudinal studies are lacking, and the existing findings are contradictory. Some authors suggest that sleep problems do not precede autistic behavior but rather co-occur with autistic traits in early childhood,[14] while other research supports that sleep problems in early childhood (e.g. reduced total sleep duration) associate with ASD by age 11 years.[15]

There is growing evidence that ADHD is associated with poor sleep across the lifespan, including during childhood and adolescence.[16] Recent cross-sectional studies have described a wide range of sleep problems in children and adolescents with ADHD. Common sleep complaints reported by parents with children with ADHD include insomnia, excessive daytime sleepiness, and variability in sleep schedule,[17] in addition to greater sleep onset delay, sleep anxiety, night awakenings, and daytime sleepiness,[18] or problems falling asleep and parasomnias.[19] Parent-reported sleep problems in pre-schoolers with ADHD include delayed bedtime, increased sleep onset latency, and absence of naps.[20] Other cross-sectional studies have used objective sleep measures to investigate the sleep patterns in children and adolescent with ADHD. For example, in a meta-analysis investigating the use of actigraphy in children with ADHD, the results showed altered sleep onset latency and sleep efficiency in ADHD, while there was no evidence for differences in terms of sleep duration or wakefulness periods.[21] In pre-schoolers, those with ADHD as compared to age-matched typically developing pre-

school children, show increased motor activity during sleep and night-to-night variability for sleep duration,[22] while in toddlers early signs of ADHD are associated with irregular sleep patterns.[23] In adolescents, having ADHD is associated with shorter actigraphy-measured sleep duration.[24]

In recent years, there has been increased interest in longitudinal studies to investigate the prospective associations between sleep and ADHD. While most of these longitudinal studies have investigated whether sleep problems precede subsequent ADHD, there is also some evidence to suggest that ADHD precedes sleep problems. For example, one study found that children with ADHD report poorer sleep quality in young adulthood, but only if their ADHD persists into adulthood.[25] The converse (i.e. sleep problems precede ADHD) has also attracted research attention and existing evidence supports the idea that sleep problems in early childhood precedes ADHD. For example, parent-reported short sleep duration in early childhood is associated with ADHD in middle childhood.[26] Furthermore, shorter sleep duration and sleep disturbances in early childhood predate the typical age of clinical ADHD diagnosis,[27] and have been associated with inattention and hyperactivity at 5 years.[28] These prospective associations continue into adolescence, with recent evidence suggesting that several sleep problems in early childhood, including insomnia and frequent snoring,[29] as well as difficulty going to sleep, nightmares and restless sleep,[30] predict ADHD in adolescence.

Sleep and schizophrenia spectrum and other psychotic disorders

Psychotic disorders and schizophrenia are usually first diagnosed between 15-35 years old.[31] Therefore, this section will focus on psychotic symptoms which are more likely to be present in pediatric populations.

Cross-sectionally, there is evidence supporting the associations between psychotic experiences and sleep problems in pediatric populations. So far, there is scarce research

focusing on children but existing research higlights that psychotic experiences in children asociate with mother-reported nightmares, but not with actigraphic sleep measures.[32] Most of the cross-sectional research on the topic has been conducted in adolescence, and the existing research indicates that adolescents at ultra-high-risk for psychosis (UHR) display increased sleep onset latency and greater sleep disturbances,[33] in addition to greater wakefulness after sleep onset.[34] At the population level, existing evidence indicates that insomnia and excessive daytime sleepiness associate with psychotic experiences in adolescents,[35] and that adolescents with long and short sleep duration are at higher risk of experiencing psychotic symptoms.[36]

Longitudinally, existing studies show that parent-reported nightmares across childhood are linked to self-reported psychotic experiences in early[37] and late adolescence.[38] Furthermore, parent-reported behavioural sleep problems in early childhood precede self-reported psychotic experiences in early adolescence.[39] Longitudinal studies using actigraphy show that several objective measures of sleep predict the longitudinal course of psychotic symptoms over 12 months in adolescents with UHR,[40] and that circadian disruptions also predict the severity of psychotic symptoms at 1-year follow-up among adolescents with UHR.[41]

Sleep and bipolar disorder

Sleep disturbance is a core symptom of bipolar disorder (BD).[42] The diagnostic criteria indicate that during manic episodes there may be a reduced need for sleep and during episodes of depression, insomnia or hypersomnia can be frequently experienced.[10] However, research on sleep disturbances in youth with BD is still scarce, partly due to controversy around the diagnosis of BD in children and adolescents.

Existing cross-sectional studies indicate that several sleep disturbances are associated with BD in children and adolescents.[43] Furthermore, greater sleep disturbances have been reported in unaffected child and adolescent offspring of bipoplar parents as compared to

controls.[44] When considering different symptoms of BD, longer time in bed and higher prevalence of nocturnal enuresis appear during depressive compared to manic episodes, while unrestful sleep is more common during manic episodes.[45] When comparing BD type I and BD not otherwise specified, there are no differences in the frequency of sleep symptoms.[46]

Longitudinal evidence suggests that sleep disturbances may predict BD. For example, sleep impairments were associated with mania and depression severity across a 2-year follow-up in adolescence.[47] When considering different aspects of sleep, one study found that greater number of awakenings and longer time awake during the weekend predicted greater depression symptoms in adolescents with BD.[48] Furthermore, trouble falling asleep and early morning awakenings were also associated with subsequent BD.[49]

Sleep and depressive disorders

Sleep difficulties are among the core symptoms for the diagnostic criteria for depression,[50] and of all the mental disorders associated with insomnia, the link with depression is most robust.[51] This is not only true for adults, but increasing evidence supports the central role of sleep in childhood and adolescent depression. For example, insomnia is the most common residual symptom among depressed youth.[52]

Cross-sectionally, short sleep as compared to that of appropriate duration, has been associated with increased depressive symptoms in adolescents.[53] Shorter sleep duration and time in bed, as well as longer sleep latency and wake after sleep onset have also been reported in depressed adolescents, and particularly in boys.[54] Furthermore, one study found that participants with fewest depressive symptoms presented moderate sleep timing, shorter sleep-onset latencies and fewer arousals as compared to those with more depressive symptoms.[55]

During the last decade, the number of longitudinal studies on sleep and depression in children and adolescents has increased dramatically. Some of these studies have considered the

bi-directional association between sleep and depression in adolescence. For example, one study reported that sleep deprivation predicted both symptoms of depression and DSM-IV major depression at follow-up, while major depression, but not depression symptoms predicted sleep deprivation.[56] Another study reported that insomnia increased subsequent risk for major depression and major depression increased the risk for subsequent insomnia.[57] Previous longitudinal research also suggests that between 9 and 16 years, sleep problems predict later depression symptoms, and in turn, depression predicts sleep problems.[58] Finally, in a recent study, maternal-reported short sleep duration and frequent night waking at 1.5 years predicted maternal-reported depressive symptoms at 8 years, and in turn maternal-reported depressive symptoms at 1.5 years predicted the onset of later maternal-reported short sleep duration.[59]

Some other longitudinal studies have focused on sleep problems as a precursor of depression. For example, cumulative sleep deprivation was found to increase depression at follow-up in females, but not males, during adolescence.[60] Further, sleep duration <8h and >=9h on weekdays; and <8h and >=12h on weekends have all been associated with depressive symptoms in adolescents over two years.[61] Further, greater sleep disturbances (as compared to other mental disorders) were stronger predictors of depression in early adolescence at 1-year follow-up.[62] Finally, sleep apnoea has received recent attention, with evidence suggesting that childhood apnoea is a risk for subsequent depressive disorders.[63]

Sleep and anxiety disorders

Sleep problems are common in children and adolescents with anxiety disorders with one study reporting that more than 80% of youth with anxiety disorders experience at least one sleep-related problem, and 55% experience three or more.[64]

Cross-sectionally, recent research conducted in children indicates that generalized anxiety disorder symptoms (GAD) are associated with increased parental-reported sleep

concerns in school-aged children.[65] Furthermore, late bedtime and short sleep duration are associated with children's anxious behavior.[66] In adolescence, reduced hours of sleep have been associated with anxiety symptoms,[67] and adolescents with obstructive sleep apnoea report more severe anxiety symptoms.[68]

Longitudinally, the bi-directional associations between sleep and anxiety in young populations have been examined. Existing research supports the role of sleep problems as risk factors for anxiety symptoms in adolescence, with less evidence for the reverse. For example, a recent study found that poor sleep, especially during early and mid-adolescence precedes anxiety symptoms,[69] but not the other way around. Furthermore, reduced sleep quantity increases risk for anxiety, but anxiety does not increase risk for decreased sleep duration among adolescents.[70] Other research suggests that the bi-directionality may vary by subtypes of sleep problems and anxiety symptoms. For example, short sleep duration predicted symptoms of panic disorder, GAD and school phobia; and was predicted by GAD in adolescents.[71]

A further longitudinal study found that a range of sleep variables at age 15 predicted the severity and the diagnoses of anxiety at age 17, 21 and 24 years.[72] It has also been reported that sleep problems at 2 years are significantly associated with anxiety at 8 years,[73] and infants with persistent severe sleep problems during the first postnatal year have an increased risk for anxiety at age 10.[74]

Sleep and composites of internalizing problems in childhood and adolescence

When investigating anxiety and depression in young people, many studies refer to internalizig problems, which include items about both anxiety and depression.

Most recent studies on the topic have investigated longitudinal associations. Some have investigated the potential bi-directionality of these associations, but results are inconsistent. For example, one study reported that sleep problems predicted changes in internalizing problems

over time in young adolescents, but not the other way around.[75] In addition, another study conducted in school-aged children found that sleep problems preceded later internalizing difficulties but not vice versa.[76] However, a further study found that mother-reported sleep problems at 6 years were predictive of self-reported internalizing problems at 11.5 yeras, and at 6 years, teacher-reported and mother-rated internalizing problems were related to sleep problems at 11.5 years.[77] A study of toddlers also found reciprocal associations between trouble getting to sleep and internalizing problems.[78]

Other longitudinal studies have focused on the role of sleep as a precursor of internalizing problems across childhood and adolescence. For example, in early childhood, shorter sleep and poorer sleep quality in infancy was related to internalizing symptoms in toddlers.[79] Further, later bedtimes and less total sleep in infancy were associated with internalizing issues in toddlers,[80] and short sleep duration and frequent nocturnal awakenings in children at 18 months related to internalizing problems at 5 years.[81] In adolescents, persistent sleeping difficulties in females aged 12/13 years predicted internalizing problems at 14/15 years.[82]

Sleep and disruptive, impulse-control, and conduct disorders

Cross-sectionally, existing evidence suggests that children with conduct disorder report more sleep problems than control children.[83] Furthermore, shorter nighttime sleep duration in preschool children has been associated with higher overactivity, anger, aggression, impulsivity, and tantrums based on parental report.[84] Associations have been also reported between obstructive sleep apnoea and conduct disorder in children.[85]

There is also longitudinal evidence to support bi-directional associations between sleep problems and disruptive behaviour during childhood, with greater sleep problems associated with later disruptive behavior and vice versa.[86] Other longitudinal studies have reported that

childhood conduct problems are linked to subsequent sleep problems in adolescence.[87] Furthermore, the reverse has been investigated and existing research suggests that longer sleep duration and higher sleep efficiency are linked to fewer externalizing symptoms at 1-year follow up in children.[88] Finally, early-life sleep disordered breathing symptoms appear to have strong, persistent effects on subsequent disruptive behavior in childhood.[89]

Potential underlying mechanisms in the associations between sleep and mental health

It is increasingly well-established that sleep is linked to mental health, but an understanding of the mechanisms underlying associations lags behind. A greater understanding of the mechanisms will enable us to design more targeted interventions in mental health. Current research points to biological, psychological, and social mechanisms, and suggests the presence of sequential, parallel, and interacting underlying risk factors.[90] Here, we present just a few of the mechanisms which have received the greatest research attention, including (i) the family environment; (ii) genetic factors; and (iii) brain mechanisms..

Family enviroment

A young person's sleep must be considered within the family context.[91] Parenting practices are among the many familial factors that could be linked to poor sleep and mental health problems in youth. For example, adverse parenting styles (e.g., low positivity and high negativity) have been found to be associated with low sleep quality, negative mood, daytime sleepiness, and anxiety/depression symptoms among adolescents,[92] while positive parenting behaviors seem to promote good sleep behaviors and consequently reduce risk for problematic behaviors among adolescents.[93]

Family stress (e.g. family conflict) also has an impact upon sleep development and mental disorders in young people. Overall, the existing evidence suggests that family stress has

been associated with both insomnia and internalizing symptoms in adolescents.[90] For example, one study reported that stressful family events were associated with depressive symptoms in adolescents, and that this relationship was strongest among those with lower sleep quality. Therefore, parenting practices and family stress are both contributors to the relationship between sleep and mental health problems in pediatric population.

Genetic factors

There is evidence from twin studies supporting the existence of strong overlap between genetic influences on symptoms of sleep and mental disorders. For example, recent reviews highlight a role for genetic factors in the associations between sleep variables and other factors, including anxiety, depression, psychotic-like experiens or externalizing behaviours, among others.[94,95]

Furthermore, recent evidence from genome-wide association studies support genetic overlap between sleep-related phenotypes and BD, depression, and schizophrenia.[96] However, other studies indicate that insomnia has the strongest genetic correlations with depression, anxiety and ADHD, while the genetic correlations between insomnia with schizophrenia and BD are lower.[97] Further, recent research using polygenic risk scores suggests that greater genetic susceptibility to ADHD, major depressive disorder, and anxiety disorders may contribute to greater sleep problems among children.[98]

Brain mechanisms

Among the potential brain mechanisms, the prefrontal cortex plays a critical role in the regulation of sleep[99] and the regulation of the affective systems.[100] A recent study reported that longer sleep duration in adolescents correlated with higher volume of the orbitofrontal and prefrontal cortex.[101] Other studies indicate that the medial prefrontal cortex correlates with bedtime and wake-up times in adolescents,[102] and that adolescents with poorer sleep also exhibit less recruitment of the dorsolateral prefrontal cortex during cognitive control.[103] So far, only

two studies have examined the associations between sleep and prefrontal brain areas in children. In one of these studies, sleep duration contributed to neural alterations of prefrontal areas in male children.[104] The second study utilised a longitudinal cohort study, finding that more adverse sleep disturbances during childhood were associated with a thinner dorsolateral prefrontal cortex.[105]

Further, the role that the prefrontal cortex plays in mental health is well established. For example, dysfunction of the prefrontal cortex is a central feature of many psychiatric disorders.[106] Therefore, it could be hypothesized that prefrontal cortex functioning could help to explain the associations between sleep and mental disorders. Specific studies examining how exactly the prefrontal cortex might mediate these associations are required.

Summary and future directions

In this narrative review we present the most recent literature investigating the link between sleep and mental health problems in childhood and adolescence. In the last decade, there has been an increase in longitudinal studies, allowing more information about the potential bi-directionality of associations as well as hints about the potential causal role of sleep in the development of specific mental disorders. To date, more research focuses on adolescence as compared to early childhood and further research should focus on these early stages.

There are three areas that should be considered in future investigation. First, there should be further investigation of the mechanisms underlying the associations between sleep and mental health. Although we have presented here few candidate mechanisms, there are many more mechanisms that could help to account for the associations between sleep and mental health. Second, further research using large population-based cohort studies to investigate the impact of early childhood sleep problems on youth mental health is still needed. Although some studies have been published recently, further evidence on how sleep problems in early

childhood can lead to the development of mental disorders are still needed. Finally, future studies should focus on the treatment of sleep difficulties to prevent or reduce mental health difficulties. This line of enquiry has proved fruitful,[107] but intervention studies focusing on childhood and adolescence are still very scarce.

References

1. Kotagal S, Pianosi P. Sleep disorders in children and adolescents. *BMJ*. 2006;332(7545):828-832.

2. Lewien C, Genuneit J, Meigen C, Kiess W, Poulain T. Sleep-related difficulties in healthy children and adolescents. *BMC Pediatr*. 2021;21(1):82.

3. Polanczyk G V, Salum GA, Sugaya LS, Caye A, Rohde LA. Annual research review: A meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. *J Child Psychol Psychiatry*. 2015;56(3):345-365.

4. Kim-Cohen J, Caspi A, Moffitt TE, Harrington H, Milne BJ, Poulton R. Prior Juvenile Diagnoses in Adults With Mental Disorder: Developmental Follow-Back of a Prospective-Longitudinal Cohort. *Arch Gen Psychiatry*. 2003;60(7):709-717.

5. Harvey AG. INSOMNIA: SYMPTOM OR DIAGNOSIS? *Clin Psychol Rev*. 2001;21(7):1037-1059.

6. Alvaro PK, Roberts RM, Harris JK. A Systematic Review Assessing Bidirectionality between Sleep Disturbances, Anxiety, and Depression. *Sleep*. 2013;36(7):1059-1068.

7. Baglioni C, Battagliese G, Feige B, et al. Insomnia as a predictor of depression: a meta-analytic evaluation of longitudinal epidemiological studies. *J Affect Disord*. 2011;135(1-3):10-19.

8. Gregory AM, O'Connor TG. Sleep problems in childhood: a longitudinal study of

developmental change and association with behavioral problems. *J Am Acad Child Adolesc Psychiatry*. 2002;41(8):964-971.

9. Gregory AM, Sadeh A. Annual Research Review: Sleep problems in childhood psychiatric disorders – a review of the latest science. *J Child Psychol Psychiatry*. 2016;57(3):296-317.

10. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders. 5th Ed*. American Psychiatric Association; 2013.

11. Robinson-Shelton A, Malow BA. Sleep Disturbances in Neurodevelopmental Disorders. *Curr Psychiatry Rep*. 2016;18(1):6.

12. Veatch OJ, Maxwell-Horn AC, Malow BA. Sleep in Autism Spectrum Disorders. *Curr sleep Med reports*. 2015;1(2):131-140.

13. Cohen S, Conduit R, Lockley SW, Rajaratnam SMW, Cornish KM. The relationship between sleep and behavior in autism spectrum disorder (ASD): a review. *J Neurodev Disord*. 2014;6(1):44.

14. Verhoeff ME, Blanken LME, Kocevska D, et al. The bidirectional association between sleep problems and autism spectrum disorder: a population-based cohort study. *Mol Autism*. 2018;9:8.

15. Humphreys JS, Gringras P, Blair PS, et al. Sleep patterns in children with autistic spectrum disorders: a prospective cohort study. *Arch Dis Child*. 2014;99(2):114-118.

16. Becker SP. ADHD and sleep: recent advances and future directions. *Curr Opin Psychol*. 2020;34:50-56.

17. Craig SG, Weiss MD, Hudec KL, Gibbins C. The Functional Impact of Sleep Disorders in Children With ADHD. *J Atten Disord*. 2020;24(4):499-508.

18. Schneider HE, Lam JC, Mahone EM. Sleep disturbance and neuropsychological function in young children with ADHD. *Child Neuropsychol a J Norm Abnorm Dev Child Adolesc*. 2016;22(4):493-506.

19. Vélez-Galarraga R, Guillén-Grima F, Crespo-Eguílaz N, Sánchez-Carpintero R. Prevalence of sleep disorders and their relationship with core symptoms of inattention and hyperactivity in children with attention-deficit/hyperactivity disorder. *Eur J Paediatr Neurol EJPN Off J Eur Paediatr Neurol Soc*. 2016;20(6):925-937.

20. Cao H, Yan S, Gu C, et al. Prevalence of attention-deficit/hyperactivity disorder symptoms and their associations with sleep schedules and sleep-related problems among preschoolers in mainland China. *BMC Pediatr*. 2018;18(1):70.

21. De Crescenzo F, Licchelli S, Ciabattini M, et al. The use of actigraphy in the monitoring of sleep and activity in ADHD: A meta-analysis. *Sleep Med Rev*. 2016;26:9-20.

22. Melegari MG, Vittori E, Mallia L, et al. Actigraphic Sleep Pattern of Preschoolers With ADHD. *J Atten Disord*. 2020;24(4):611-624.

23. Bundgaard A-KF, Asmussen J, Pedersen NS, Bilenberg N. Disturbed sleep and activity in toddlers with early signs of attention deficit hyperactivity disorder (ADHD). *J Sleep Res*. 2018;27(5):e12686.

24. Becker SP, Langberg JM, Eadeh H-M, Isaacson PA, Bourchtein E. Sleep and daytime sleepiness in adolescents with and without ADHD: differences across ratings, daily diary, and actigraphy. *J Child Psychol Psychiatry*. 2019;60(9):1021-1031.

25. Gregory AM, Agnew-Blais JC, Matthews T, Moffitt TE, Arseneault L. ADHD and Sleep Quality: Longitudinal Analyses From Childhood to Early Adulthood in a Twin Cohort. *J Clin child Adolesc Psychol Off J Soc Clin Child Adolesc Psychol Am*

Psychol Assoc Div 53. 2017;46(2):284-294.

26. Tso W, Chan M, Ho FK, et al. Early sleep deprivation and attention-deficit/hyperactivity disorder. *Pediatr Res*. 2019;85(4):449-455.

27. 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(2):121-128.

28. Huhdanpaa H, Morales-Munoz I, Aronen ET, et al. Sleep Difficulties in Infancy Are Associated with Symptoms of Inattention and Hyperactivity at the Age of 5 Years: A Longitudinal Study. *J Dev Behav Pediatr*. 2019;40(6):432-440.

29. Liu X, Liu Z-Z, Liu B-P, Sun S-H, Jia C-X. Associations between sleep problems and ADHD symptoms among adolescents: findings from the Shandong Adolescent Behavior and Health Cohort (SABHC). *Sleep*. 2020;43(6).

30. Carpena MX, Munhoz TN, Xavier MO, et al. The Role of Sleep Duration and Sleep Problems During Childhood in the Development of ADHD in Adolescence: Findings From a Population-Based Birth Cohort. *J Atten Disord*. 2020;24(4):590-600.

31. Solmi M, Radua J, Olivola M, et al. Age at onset of mental disorders worldwide: large-scale meta-analysis of 192 epidemiological studies. *Mol Psychiatry*. 2021.

32. Koopman-Verhoeff ME, Bolhuis K, Cecil CAM, et al. During day and night: Childhood psychotic experiences and objective and subjective sleep problems. *Schizophr Res*. 2019;206:127-134.

33. Lunsford-Avery JR, Orr JM, Gupta T, et al. Sleep dysfunction and thalamic abnormalities in adolescents at ultra high-risk for psychosis. *Schizophr Res*. 2013;151(1-3):148-153.

34. Mayeli A, LaGoy A, Donati FL, Kaskie RE, Najibi SM, Ferrarelli F. Sleep abnormalities in individuals at clinical high risk for psychosis. *J Psychiatr Res*. 2021;137:328-334.

35. Lee YJ, Cho S-J, Cho IH, Jang JH, Kim SJ. The relationship between psychotic-like experiences and sleep disturbances in adolescents. *Sleep Med*. 2012;13(8):1021-1027.

36. Morishima R, Yamasaki S, Ando S, et al. Long and short sleep duration and psychotic symptoms in adolescents: Findings from a cross-sectional survey of 15 786 Japanese students. *Psychiatry Res*. 2020;293:113440.

37. Fisher HL, Lereya ST, Thompson A, Lewis G, Zammit S, Wolke D. Childhood parasomnias and psychotic experiences at age 12 years in a United Kingdom birth cohort. *Sleep*. 2014;37(3):475-482.

38. Thompson A, Lereya ST, Lewis G, Zammit S, Fisher HL, Wolke D. Childhood sleep disturbance and risk of psychotic experiences at 18: UK birth cohort. *Br J Psychiatry*. 2015;207(1):23-29.

39. Morales-Muñoz I, Broome MR, Marwaha S. Association of Parent-Reported Sleep Problems in Early Childhood With Psychotic and Borderline Personality Disorder Symptoms in Adolescence. *JAMA psychiatry*. July 2020.

40. Lunsford-Avery JR, LeBourgeois MK, Gupta T, Mittal VA. Actigraphic-measured sleep disturbance predicts increased positive symptoms in adolescents at ultra high-risk for psychosis: A longitudinal study. *Schizophr Res*. 2015;164(1-3):15-20.

41. Lunsford-Avery JR, Gonçalves B da SB, Brietzke E, et al. Adolescents at clinical-high risk for psychosis: Circadian rhythm disturbances predict worsened prognosis at 1-year follow-up. *Schizophr Res*. 2017;189:37-42.

42. Ng TH, Chung K-F, Ho FY-Y, Yeung W-F, Yung K-P, Lam T-H. Sleep-wake

disturbance in interepisode bipolar disorder and high-risk individuals: a systematic review and meta-analysis. *Sleep Med Rev*. 2015;20:46-58.

43. Comsa M, Anderson KN, Sharma A, Yadav VC, Watson S. The relationship between sleep and depression and bipolar disorder in children and young people. *BJPsych open*. 2022;8(1):e27.

44. Sebela A, Kolenic M, Farkova E, Novak T, Goetz M. Decreased need for sleep as an endophenotype of bipolar disorder: an actigraphy study. *Chronobiol Int*. 2019;36(9):1227-1239.

45. Lopes MC, Boarati MA, Fu-I L. Sleep and Daytime Complaints During Manic and Depressive Episodes in Children and Adolescents With Bipolar Disorder. *Front psychiatry*. 2019;10:1021.

46. Baroni A, Hernandez M, Grant MC, Faedda GL. Sleep Disturbances in Pediatric Bipolar Disorder: A Comparison between Bipolar I and Bipolar NOS. *Front psychiatry*. 2012;3:22.

47. Lunsford-Avery JR, Judd CM, Axelson DA, Miklowitz DJ. Sleep impairment, mood symptoms, and psychosocial functioning in adolescent bipolar disorder. *Psychiatry Res*. 2012;200(2-3):265-271.

48. Gershon A, Singh MK. Sleep in Adolescents With Bipolar I Disorder: Stability and Relation to Symptom Change. *J Clin child Adolesc Psychol Off J Soc Clin Child Adolesc Psychol Am Psychol Assoc Div 53*. 2017;46(2):247-257.

49. Ritter PS, Höfler M, Wittchen H-U, et al. Disturbed sleep as risk factor for the subsequent onset of bipolar disorder--Data from a 10-year prospective-longitudinal study among adolescents and young adults. *J Psychiatr Res*. 2015;68:76-82.

50. Tolentino JC, Schmidt SL. DSM-5 Criteria and Depression Severity: Implications for

Clinical Practice. *Front Psychiatry*. 2018;9.

51. Krystal AD. Psychiatric disorders and sleep. *Neurol Clin*. 2012;30(4):1389-1413.

52. March J, Silva S, Petrycki S, et al. Fluoxetine, cognitive-behavioral therapy, and their combination for adolescents with depression: Treatment for Adolescents With Depression Study (TADS) randomized controlled trial. *JAMA*. 2004;292(7):807-820.

53. Yeo SC, Jos AM, Erwin C, et al. Associations of sleep duration on school nights with self-rated health, overweight, and depression symptoms in adolescents: problems and possible solutions. *Sleep Med*. 2019;60:96-108.

54. 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*. 2014;23(8):681-689.

55. Shochat T, Barker DH, Sharkey KM, Van Reen E, Roane BM, Carskadon MA. An approach to understanding sleep and depressed mood in adolescents: person-centred sleep classification. *J Sleep Res*. 2017;26(6):709-717.

56. Roberts RE, Duong HT. The prospective association between sleep deprivation and depression among adolescents. *Sleep*. 2014;37(2):239-244. doi:10.5665/sleep.3388

57. Roberts RE, Duong HT. Depression and insomnia among adolescents: a prospective perspective. *J Affect Disord*. 2013;148(1):66-71.

58. Shanahan L, Copeland WE, Angold A, Bondy CL, Costello EJ. Sleep problems predict and are predicted by generalized anxiety/depression and oppositional defiant disorder. *J Am Acad Child Adolesc Psychiatry*. 2014;53(5):550-558.

59. Sivertsen B, Harvey AG, Reichborn-Kjennerud T, Ystrom E, Hysing M. Sleep problems and depressive symptoms in toddlers and 8-year-old children: A longitudinal

study. *J Sleep Res*. 2021;30(1):e13150.

60. Conklin AI, Yao CA, Richardson CG. Chronic sleep deprivation and gender-specific risk of depression in adolescents: a prospective population-based study. *BMC Public Health*. 2018;18(1):724.

61. Liu B-P, Wang X-T, Liu Z-Z, et al. Depressive symptoms are associated with short and long sleep duration: A longitudinal study of Chinese adolescents. *J Affect Disord*. 2020;263:267-273.

62. Goldstone A, Javitz HS, Claudatos SA, et al. Sleep Disturbance Predicts Depression Symptoms in Early Adolescence: Initial Findings From the Adolescent Brain Cognitive Development Study. *J Adolesc Heal Off Publ Soc Adolesc Med*. 2020;66(5):567-574.

63. Chang C-H, Chen S-J, Liu C-Y. Pediatric sleep apnea and depressive disorders risk: A population-based 15-year retrospective cohort study. *PLoS One*. 2017;12(7):e0181430.

64. Alfano CA, Ginsburg GS, Kingery JN. Sleep-related problems among children and adolescents with anxiety disorders. *J Am Acad Child Adolesc Psychiatry*. 2007;46(2):224-232.

65. Fletcher FE, Conduit R, Foster-Owens MD, Rinehart NJ, Rajaratnam SMW, Cornish KM. The Association Between Anxiety Symptoms and Sleep in School-Aged Children: A Combined Insight From the Children's Sleep Habits Questionnaire and Actigraphy. *Behav Sleep Med*. 2018;16(2):169-184.

66. Suda M, Nagamitsu S, Obara H, et al. Association between children's sleep patterns and problematic behaviors at age 5. *Pediatr Int*. 2020;62(10):1189-1196.

67. 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(2):248-254.

68. Park K-M, Kim S-Y, Sung D, et al. The relationship between risk of obstructive sleep apnea and other sleep problems, depression, and anxiety in adolescents from a community sample. *Psychiatry Res*. 2019;280:112504.

69. Narmandakh A, Roest AM, Jonge P de, Oldehinkel AJ. The bidirectional association between sleep problems and anxiety symptoms in adolescents: a TRAILS report. *Sleep Med*. 2020;67:39-46.

70. Roberts RE, Duong HT. Is there an association between short sleep duration and adolescent anxiety disorders? *Sleep Med*. 2017;30:82-87.

71. Geng F, Liu X, Liang Y, Shi X, Chen S, Fan F. Prospective associations between sleep problems and subtypes of anxiety symptoms among disaster-exposed adolescents. *Sleep Med*. 2018;50:7-13.

72. Orchard F, Gregory AM, Gradisar M, Reynolds S. Self-reported sleep patterns and quality amongst adolescents: cross-sectional and prospective associations with anxiety and depression. *J Child Psychol Psychiatry*. 2020;61(10):1126-1137.

73. Uren J, Richdale AL, Cotton SM, Whitehouse AJO. Sleep problems and anxiety from 2 to 8 years and the influence of autistic traits: a longitudinal study. *Eur Child Adolesc Psychiatry*. 2019;28(8):1117-1127.

74. Cook F, Conway LJ, Giallo R, Gartland D, Sciberras E, Brown S. Infant sleep and child mental health: a longitudinal investigation. *Arch Dis Child*. 2020;105(7):655-660.

75. Pieters S, Burk WJ, Van der Vorst H, Dahl RE, Wiers RW, Engels RCME. Prospective relationships between sleep problems and substance use, internalizing and externalizing problems. *J Youth Adolesc*. 2015;44(2):379-388.

76. Williamson AA, Mindell JA, Hiscock H, Quach J. Longitudinal sleep problem trajectories are associated with multiple impairments in child well-being. *J Child Psychol Psychiatry*. 2020;61(10):1092-1103.

77. Liu J, Glenn AL, Cui N, Raine A. Longitudinal bidirectional association between sleep and behavior problems at age 6 and 11 years. *Sleep Med*. 2021;83:290-298.

78. Conway A, Miller AL, Modrek A. Testing Reciprocal Links Between Trouble Getting to Sleep and Internalizing Behavior Problems, and Bedtime Resistance and Externalizing Behavior Problems in Toddlers. *Child Psychiatry Hum Dev*. 2017;48(4):678-689.

79. Morales-Muñoz I, Lemola S, Saarenpää-Heikkilä O, et al. Parent-reported early sleep problems and internalising, externalising and dysregulation symptoms in toddlers. *BMJ Paediatr open*. 2020;4(1):e000622.

80. Mindell JA, Leichman ES, DuMond C, Sadeh A. Sleep and Social-Emotional Development in Infants and Toddlers. *J Clin Child Adolesc Psychol*. 2017;46(2):236-246.

81. Sivertsen B, Harvey AG, Reichborn-Kjennerud T, Torgersen L, Ystrom E, Hysing M. Later emotional and behavioral problems associated with sleep problems in toddlers: a longitudinal study. *JAMA Pediatr*. 2015;169(6):575-582.

82. Nunes S, Campbell MK, Klar N, Reid GJ, Stranges S. Relationships between sleep and internalizing problems in early adolescence: Results from Canadian National Longitudinal Survey of Children and Youth. *J Psychosom Res*. 2020;139:110279.

83. Aronen ET, Lampenius T, Fontell T, Simola P. Sleep in children with disruptive behavioral disorders. *Behav Sleep Med*. 2014;12(5):373-388.

84. Scharf RJ, Demmer RT, Silver EJ, Stein REK. Nighttime sleep duration and

externalizing behaviors of preschool children. *J Dev Behav Pediatr*. 2013;34(6):384-391.

85. Constantin E, Low NCP, Dugas E, Karp I, O'Loughlin J. Association Between Childhood Sleep-Disordered Breathing and Disruptive Behavior Disorders in Childhood and Adolescence. *Behav Sleep Med*. 2015;13(6):442-454.

86. Quach JL, Nguyen CD, Williams KE, Sciberras E. Bidirectional Associations Between Child Sleep Problems and Internalizing and Externalizing Difficulties From Preschool to Early Adolescence. *JAMA Pediatr*. 2018;172(2):e174363.

87. Tomasiello M, Temcheff CE, Martin-Storey A, Bégin V, Poirier M, Déry M. Self and parent-reported sleep problems of adolescents with childhood conduct problems and comorbid psychological problems. *J Adolesc*. 2021;92:165-176.

88. Belanger M-E, Bernier A, Simard V, Desrosiers K, Carrier J. Sleeping Toward Behavioral Regulation: Relations Between Sleep and Externalizing Symptoms in Toddlers and Preschoolers. *J Clin Child Adolesc Psychol*. 2018;47(3):366-373.

89. Bonuck K, Freeman K, Chervin RD, Xu L. Sleep-disordered breathing in a population-based cohort: behavioral outcomes at 4 and 7 years. *Pediatrics*. 2012;129(4):e857-65.

90. Blake MJ, Trinder JA, Allen NB. Mechanisms underlying the association between insomnia, anxiety, and depression in adolescence: Implications for behavioral sleep interventions. *Clin Psychol Rev*. 2018;63:25-40.

91. Dahl RE, El-Sheikh M. Considering sleep in a family context: Introduction to the special issue. *J Fam Psychol*. 2007;21(1):1-3.

92. Brand S, Gerber M, Hatzinger M, Beck J, Holsboer-Trachsler E. Evidence for similarities between adolescents and parents in sleep patterns. *Sleep Med*. 2009;10(10):1124-1131.

93. Vazsonyi AT, Harris C, Terveer AM, Pagava K, Phagava H, Michaud P-A. Parallel mediation effects by sleep on the parental warmth-problem behavior links: evidence from national probability samples of Georgian and Swiss adolescents. *J Youth Adolesc*. 2015;44(2):331-345.

94. Madrid-Valero JJ, Rubio-Aparicio M, Gregory AM, Sánchez-Meca J, Ordoñana JR. Twin studies of subjective sleep quality and sleep duration, and their behavioral correlates: Systematic review and meta-analysis of heritability estimates. *Neurosci Biobehav Rev*. 2020;109:78-89.

95. Lewis KJS, Gregory AM. Heritability of Sleep and Its Disorders in Childhood and Adolescence. *Curr Sleep Med Reports*. 2021;7(4):155-166.

96. O'Connell KS, Frei O, Bahrami S, et al. Characterizing the Genetic Overlap Between Psychiatric Disorders and Sleep-Related Phenotypes. *Biol Psychiatry*. 2021;90(9):621-631.

97. Byrne EM. The relationship between insomnia and complex diseases—insights from genetic data. *Genome Med*. 2019;11(1):57.

98. Ohi K, Ochi R, Noda Y, et al. Polygenic risk scores for major psychiatric and neurodevelopmental disorders contribute to sleep disturbance in childhood: Adolescent Brain Cognitive Development (ABCD) Study. *Transl Psychiatry*. 2021;11(1):187.

99. Horne JA. Human sleep, sleep loss and behaviour. Implications for the prefrontal cortex and psychiatric disorder. *Br J Psychiatry*. 1993;162:413-419.

100. Dahl RE. The regulation of sleep and arousal: Development and psychopathology. *Dev Psychopathol*. 1996;8(1):3-27.

101. Cheng W, Rolls E, Gong W, et al. Sleep duration, brain structure, and psychiatric and

cognitive problems in children. *Mol Psychiatry*. 2021;26(8):3992-4003.

102. Urrila AS, Artiges E, Massicotte J, et al. Sleep habits, academic performance, and the adolescent brain structure. *Sci Rep*. 2017;7:41678.

103. Telzer EH, Fuligni AJ, Lieberman MD, Galván A. The effects of poor quality sleep on brain function and risk taking in adolescence. *Neuroimage*. 2013;71:275-283.

104. Reidy BL, Hamann S, Inman C, Johnson KC, Brennan PA. Decreased sleep duration is associated with increased fMRI responses to emotional faces in children. *Neuropsychologia*. 2016;84:54-62.

105. Kocevska D, Muetzel RL, Luik AI, et al. The Developmental Course of Sleep Disturbances Across Childhood Relates to Brain Morphology at Age 7: The Generation R Study. *Sleep*. 2017;40(1).

106. Gamo NJ, Arnsten AFT. Molecular modulation of prefrontal cortex: rational development of treatments for psychiatric disorders. *Behav Neurosci*. 2011;125(3):282-296.

107. Freeman D, Sheaves B, Goodwin GM, et al. The effects of improving sleep on mental health (OASIS): a randomised controlled trial with mediation analysis. *The lancet Psychiatry*. 2017;4(10):749-758.