

ADHD and Sleep: A Bidirectional Relationship

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ADHD and Sleep: A Bidirectional Relationship



Objectives



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ADHD and Sleep: A Bidirectional Relationship



ADHD Neurobiological Overview

Definition: ADHD is a neurodevelopmental disorder characterized by persistent inattention and/or hyperactivity-impulsivity that impairs functioning or development.

Genetics:

- ADHD risk ↑ 2-8x in first-degree relatives.
- Heritability estimated at **76%**

Neurochemical Basis:

- Reduced dopamine & norepinephrine activity in frontal-subcortical circuits.
- These catecholamines modulate behavior via fronto-striato-cerebellar pathways.

Neuroimaging Findings:

- Structural differences in **prefrontal cortex (PFC)**, **striatum**, and **cerebellum**.
- PFC activity influenced by dopamine and orexin/hypocretin systems.

EEG & Sleep:

- ↑ Theta, ↓ Alpha/Beta waves → underactive executive networks.
- Sleep studies show reduced NREM stability

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ADHD diagnostic criteria

- **Symptom Domains** (≥6 for children; ≥5 for age 17+):
 - **Inattention:** careless mistakes, distractibility, forgetfulness, disorganization.
 - **Hyperactivity/impulsivity:** fidgeting, excessive talking, interrupting, restlessness.
- **Diagnostic Criteria:**
 - Onset before age 12.
 - Present in **≥2 settings** (e.g., home, school, work).
 - Cause functional impairment.
 - Not better explained by another disorder.
- **Presentation Types:**
 - Predominantly inattentive
 - Predominantly hyperactive/impulsive
 - Combined
- **Diagnostic Method**
 - Uses various scales and instruments evaluating performance of the individual in various social/participation contexts



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ADHD in children

- Deficits in executive function:
 - Emotional symptoms (irritability, ease of negative emotional experience, and emotional lability)
 - Poor self-regulation
 - Low frustration tolerance
- Result in behavior problems:
 - internalizing (eg, anxious, depressed mood)
 - externalizing (eg, oppositional/defiance, poor conduct, irritability)



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ADHD in adults

Working Memory Deficits

Adults with ADHD struggle to hold and manipulate information over short periods, affecting task performance.

Task-Shifting Challenges

Difficulty in smoothly transitioning between tasks or mental states is common among adults with ADHD.

Impaired Self-Monitoring

Limited awareness and regulation of one's performance reduce effectiveness in managing tasks.

Initiation and Self-Inhibition Issues

Challenges to independently start tasks and control impulses impact daily productivity.



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ADHD and Sleep

In people with ADHD, **Sleep problems** affect up to **70% of children**, and **25-50% of adults**. These include:

- Poor sleep habits (e.g., screen use)
- Behavioral sleep issues (e.g., trouble falling/staying asleep)
- Primary sleep disorders (e.g., SDB, RLS, insomnia)



Silverstein, R. (2022). Sleep and ADHD: A complex and bidirectional relationship. *Sleep Medicine Reviews*, 63, 101643.

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The relationship between ADHD and Sleep Disorders



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The relationship between ADHD and Sleep Disorders

- Sleep issues may:
 - Mimic ADHD symptoms
 - Exacerbate existing ADHD
 - Be **caused or worsened** by ADHD or its medications
- ADHD treatment may:
 - Directly affect sleep
 - Indirectly improve sleep via better functioning
 - Be moderated by sleep issues (insomnia may prevent effective dosing)

Silverstein, R. (2022). Sleep and ADHD: A complex and bidirectional relationship. *Sleep Medicine Reviews*, 63, 101643.

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Sleep issues seen with ADHD



Silverstein, R. (2022). Sleep and ADHD: A complex and bidirectional relationship. *Sleep Medicine Reviews*, 63, 101643. <https://doi.org/10.1016/j.smrv.2022.101643>

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ADHD and Restless Legs Syndrome (RLS)

- Pathophysiologic connections
 - Iron deficiency, common in ADHD and RLS
 - Dopaminergic deficiency may play a role in both conditions
- More RLS patients (26%) than insomnia patients (6%) had ADHD symptoms, indicating that insomnia is not the only link between RLS and ADHD
- RLS sufferers were more likely to have the hyperactivity-impulsivity ADHD subtype



Ray, M., Ho, D., Tan, J., Phillips, A., Bhatia, S., & Miller, A. (2018). Association Between Restless Legs Syndrome and Adult ADHD in a German Community-Based Sample. *Journal of Affective Disorders*, 225, 388-398.

Goldstein, M., Tannock, R., & Schachar, R. (2018). Association Between Restless Legs Syndrome and Adult ADHD in a German Community-Based Sample. *Journal of Affective Disorders*, 225, 388-398.

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Sleep-Disordered Breathing (SDB) & ADHD



Neurobiological Impact of SDB:

- ↓ Oxygen saturation & ↑ CO₂ (hypercapnia)
- Oxidative stress & free radicals
- ↑ Inflammatory cytokines (e.g., IL-6, TNF-α)
- Affects brain regions like the **prefrontal cortex**
- Leads to **cortical dysfunction** → inattention, hyperactivity, impulsivity



Sedky K, Bennett DS, Canavito KS. Attention deficit hyperactivity disorder and sleep-disordered breathing in pediatric populations: a meta-analysis. *Sleep Med Rev*. 2014 Aug;18(4):349-56. OWENS, JUDITH A. M.D., M.P.H.. The ADHD and Sleep Consortium: A Review. *Journal of Developmental & Behavioral Pediatrics* 26(4) p 312-322, August 2005.

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Clinical Relevance:

- SDB often co-occurs with ADHD symptoms in children
- SDB can lead to both externalizing (impulsivity, decreased attention, hyperactivity, aggression) and internalizing (somatic complaints, social withdrawal) behaviors
- Still debatable if treating OSA helps avoid medications for ADHD



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Pediatric Considerations:

- SDB commonly due to **adenoid tonsil enlargement**
- Occurs between ages 2-8, overlapping with ADHD onset
- Screening for OSA/SDB may benefit children diagnosed with ADHD

Sedky K, Bennett DS, Canavito KS. Attention deficit hyperactivity disorder and sleep-disordered breathing in pediatric populations: a meta-analysis. *Sleep Med Rev*. 2014 Aug;18(4):349-56. OWENS, JUDITH A. M.D., M.P.H.. The ADHD and Sleep Consortium: A Review. *Journal of Developmental & Behavioral Pediatrics* 26(4) p 312-322, August 2005.

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- Prospective study in 40 children (6-16yo, BMI<25) with diagnosis of ADHD, without previous orthodontic treatment (and age/sex matched controls without ADHD diagnosis)
- Confirmed that ADHD subjects had higher risk of OSA
- No difference in dental measures between ADHD and controls
- More ADHD subjects presented with bruxism compared to controls (40% vs 7.5%)

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Case Report:

- ADHD diagnosed at age 21; started on Adderall without prior sleep evaluation.
- At age 29, diagnosed with OSA (AHI: 19) after developing hypertension and snoring.
- Started CPAP; stopped ADHD meds at age 32 due to side effects.
- At age 41, had not restarted stimulants, remained compliant with CPAP, had no ADHD symptoms

Key Question: Was ADHD misdiagnosed?

- Recommendation:** Screen for sleep disorders, particularly OSA, before diagnosing ADHD or starting stimulant therapy.

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Circadian Rhythm Delay in ADHD

- Disturbances in diurnal rhythms of endocrine secretion, CLOCK gene expression and activity
- Delayed pattern of melatonin secretion
- Stronger evening tendencies

Korman, M., Palm, D., Lizon, A., Fabbro, F., Tucha, O., Thome, J., & Corgan, A. N. (2018). ADHD 24/7: Circadian clock genes, chronotherapy and sleep/wake cycle insufficiencies in ADHD. *The World Journal of Biological Psychiatry*, 21(2), 156-171.

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Hvolby A. Associations of sleep disturbance with ADHD: implications for treatment. *Atten Defic Hyperact Disord*. 2015 Mar;7(1):1-18.

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Management of sleep disturbances in children with ADHD

- Melatonin**
 - Decreased sleep onset latency, increased total sleep time, improved sleep efficiency, advanced DLMO by 44 minutes
 - Most studies did not show significant improvement in ADHD symptoms
- Clonidine**
 - Beneficial effect started within 30 minutes of dose and lasted till morning
 - Less oppositional behavior, reduced sleep latency, less restless sleep, increased total sleep time, improved morning awakening
- Magnesium**
 - No determined efficacy
 - Give at moderate doses (<200mg/d)
 - Side-effects can include nausea, diarrhea and cramps
- Guafacine, Zolpidem, Eszopiclone**
 - No improvement in sleep onset latency, persistent sleep and time of awakening
- Antidepressants (bupropion, venlafaxine, duloxetine)**
 - Improvement in ADHD symptoms, useful in ADHD with comorbid depression

Bloch MH, Mulqueen J. Nutritional supplements for the treatment of ADHD. *Child Adolesc Psychiatr Clin N Am*. 2014 Oct;23(4):883-97.

Corlese, S., Fuseto Veronesi, G., Gabellone, A., Margari, A., Marzulli, L., Malera, E., ... Margari, L. (2024). The management of sleep disturbances in children with attention deficit/hyperactivity disorder (ADHD): an update of the literature. *Expert Review of Neurotherapeutics*, 24(6), 585–596. © 2025 Informa. All rights reserved.

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Behavioral interventions for insomnia in ADHD

- | | |
|--|---|
|  | Address sleep hygiene: avoid naps, wake up at the same time every day, consistent bedtime routine (ending with a positive ritual), avoid heavy meals and screens (<1h) before bedtime |
|  | Behavioral sleep strategies: graduated extinction (ignoring disruptive behaviors for a predetermined period), bedtime pass, bedtime fading, visual imagery, relaxation exercises, stimulus control, CBT-I |
|  | Keep sleep logs (including tracking screen usage and timing/dose of stimulant medications) |
|  | Lifestyle factors: avoid caffeine until late teenage years, avoid playing violent video games, worry bedtime earlier in the day, |
|  | Behavioral therapy addresses specific problem behaviors by structuring time at home, establishing predictability and routines, and increasing positive attention. |

Hvolby A. Associations of sleep disturbance with ADHD: implications for treatment. *Atten Defic Hyperact Disord*. 2015 Mar;7(1):1-18.

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Blankets and ADHD

- Often introduced by occupational therapists
- Weighted:
 - Deep pressure touch (continuous mechanical stimulations) activates parasympathetic system releasing dopamine and serotonin.
 - Improvements in sleep quality and ADHD-related symptoms
 - Users must be able to remove blanket independently, not recommended for children <3 years or <50 lbs (suffocation risk)
- Ball blanket:
 - Filled with loose balls to stimulate sensory receptors in skin/muscle/joints, to transmit inhibitory signals to CNS
 - Found to reduce sleep onset latency and awakenings



Holby A., & Bilenberg, N. (2010). Use of Ball Blanket in attention-deficit/hyperactivity disorder sleeping problems. *Nordic Journal of Psychiatry*, 65(2), 89–94.

Lönn M, Allé K, Svedberg P, Nygren J, Jarbin H, Larsson I. Experiences of Using Weighted Blankets among Children with ADHD and Sleeping Difficulties. *Occup Ther Int*. 2023 Feb 14;2023:1945290. <https://doi.org/10.1080/14467883.2023.2183015>

Yang Z, Sun S, Sun K, Chen W, Zhang L, Xu J, Xu Q, Liu Z, Ke J, Zhang L, Zhu Y. The effect of weighted blankets on sleep and related disorders: a brief review. *Front Psychiatry*. 2024 Apr 15:1333015. <https://doi.org/10.3389/fpsyt.2024.1333015>

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CBT-I for insomnia in ADHD

- Sleep IntervEntion as Symptom Treatment of ADHD (SIESTA)
- CBT treatment integrating sleep training with motivational interviewing and planning/organizational skills
- RCT with SIESTA-TAU (treatment as usual) vs TAU alone
- Measurement via actigraphy, sleep diaries, and questionnaires
- Primary outcome TST, SLOT, SE, Awakenings
- Secondary Outcomes ADHD symptoms, comorbidities and functional outcomes

[illegible]

Keuppens, L., Marten, F., Baeyens, D., Boyer, B., Danckaerts, M., & Van Der Oord, S. (2023). Sleep intervention as symptom treatment for ADHD (S/ESTA)-Blended CBT sleep intervention to improve sleep, ADHD symptoms and related problems in adolescents with ADHD: Protocol for a randomised controlled trial. *BMC Open*, 13(4), e065355. 29

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Patient Resources



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ADHD & Sleep Disorders: Clinical Considerations

- Individuals with ADHD have a higher prevalence of co-occurring sleep disorders.
- ADHD treatments may either worsen or improve sleep-related symptoms.
- Management of insomnia in ADHD includes pharmacologic, supplement-based, and behavioral interventions.
- **Recommendation:** Screen for sleep disorders—especially OSA—prior to confirming ADHD diagnosis and initiating stimulant therapy.



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Thank you for your attention!

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