

Sleep Disorders in Children with ADHD

Robert Rudock, MD, MBA

October 2, 2026

Conflict of Interest Disclosures for Speakers

- No conflicts of interest to disclose.
- The unlabeled and investigational use of medications, most of which are not approved by the US Food and Drug Administration for pediatric use, will be discussed.

Learning Objectives

- Upon completion of this course, attendees should be able to:
 - Appreciate that children with ADHD have higher rates of sleep problems
 - Understand how circadian and dopamine pathway differences influence sleep disruption
 - Develop strategies to distinguish ADHD symptoms from daytime sleepiness

ADHD and Sleep

- 25-55% of children with ADHD also have sleep problems
- Up to 75% of adolescents with ADHD have sleep problems

ADHD and Sleep

- 25-55% of children with ADHD also have sleep problems
- Up to 75% of adolescents with ADHD have sleep problems
 - Bedtime resistance
 - Sleep initiation difficulty / prolonged sleep latency
 - Overnight awakenings / decreased sleep efficiency
 - Trouble waking up in the morning / sleep inertia
 - Daytime sleepiness
 - Sleep disordered breathing

ADHD

Clinical Practice Guideline for the Diagnosis, Evaluation, and Treatment of Attention-Deficit/Hyperactivity Disorder in Children and Adolescents

Mark L. Wolraich, MD, FAAP^a, Joseph F. Hagan Jr, MD, FAAP^{b,c}, Carla Allan, PhD^{d,e},
Eugenia Chan, MD, MPH, FAAP^{f,g}, Dale Davison, MSpEd, PCC^{h,i}, Marian Earls, MD, MTS,
FAAP^{j,k}, Steven W. Evans, PhD^{l,m}, Susan K. Flinn, MAⁿ, Tanya Froehlich, MD, MS, FAAP^{o,p},
Jennifer Frost, MD, FAAFP^{q,r}, Joseph R. Holbrook, PhD, MPH^s, Christoph Ulrich Lehmann,

KAS 3: In the evaluation of a child or adolescent for ADHD, the PCC should include a process to at least screen for comorbid conditions, including emotional or behavioral conditions (eg, anxiety, depression, oppositional defiant disorder, conduct disorders, substance use), developmental conditions (eg, learning and language disorders, autism spectrum disorders), and physical conditions (eg, tics, sleep apnea). (Grade B: strong recommendation.)

ADHD

- Persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development

ADHD

- Persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development
- 7.2% overall prevalence

ADHD

- Persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development
- 7.2% overall prevalence
 - Boys are twice as likely to be diagnosed with ADHD
 - Girls with ADHD are more likely to have comorbid anxiety and/or depression

ADHD Diagnostic Criteria

- Persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development, as characterized by (1) and/or (2):
 - 1. Inattention (≥ 6 features)
 - 2. Hyperactivity and impulsivity (≥ 6 features)
- Symptoms must present prior to 12 years
- Must occur in two or more settings
- Affects social, academic, and/or occupational functioning
- Not better explained by another disorder

ADHD Diagnostic Criteria

- **Inattention**

- Careless mistakes
- Difficulty sustaining attention
- Does not seem to listen when spoken to
- Does not follow through on instructions/tasks
- Avoids sustained mental effort
- Loses things
- Easily distracted
- Forgetful in daily activities

- **Hyperactivity and impulsivity**

- Fidgets
- Leaves seat
- Runs or climbs at inappropriate times
- Unable to play quietly
- Appears “on the go”
- Talks excessively
- Blurts out answer
- Difficulty waiting
- Interrupts others

ADHD Diagnostic Criteria

- **Inattention**

- Careless mistakes
- Difficulty sustaining attention
- Does not seem to listen when spoken to
- Does not follow through on instructions/tasks
- Avoids sustained mental effort
- Loses things
- Easily distracted
- Forgetful in daily activities

- **Hyperactivity and impulsivity**

- Fidgets
- Leaves seat
- Runs or climbs at inappropriate times
- Unable to play quietly
- Appears “on the go”
- Talks excessively
- Blurts out answer
- Difficulty waiting
- Interrupts others

- **Sleepiness**

- Restlessness
- Emotional lability
- Irritability
- Aggression
- Behavior problems
- Quiet
- Listless
- Inattentive
- Unfocused
- Withdrawn



ADHD and Sleep

- “Does she have ADHD or is she just tired?”
 - “Is the ADHD making it difficult to fall asleep, or is the poor sleep causing the ADHD?”
-
- “The ADHD and insomnia feed off of each other.”
 - “The stimulant is just going to keep him awake even more.”
 - “When he sleeps well, he doesn’t need his ADHD medication.”
 - “I don’t want to start a stimulant because I’m convinced that if we just fix his sleep, then he won’t be hyperactive anymore.”



ADHD and Sleep

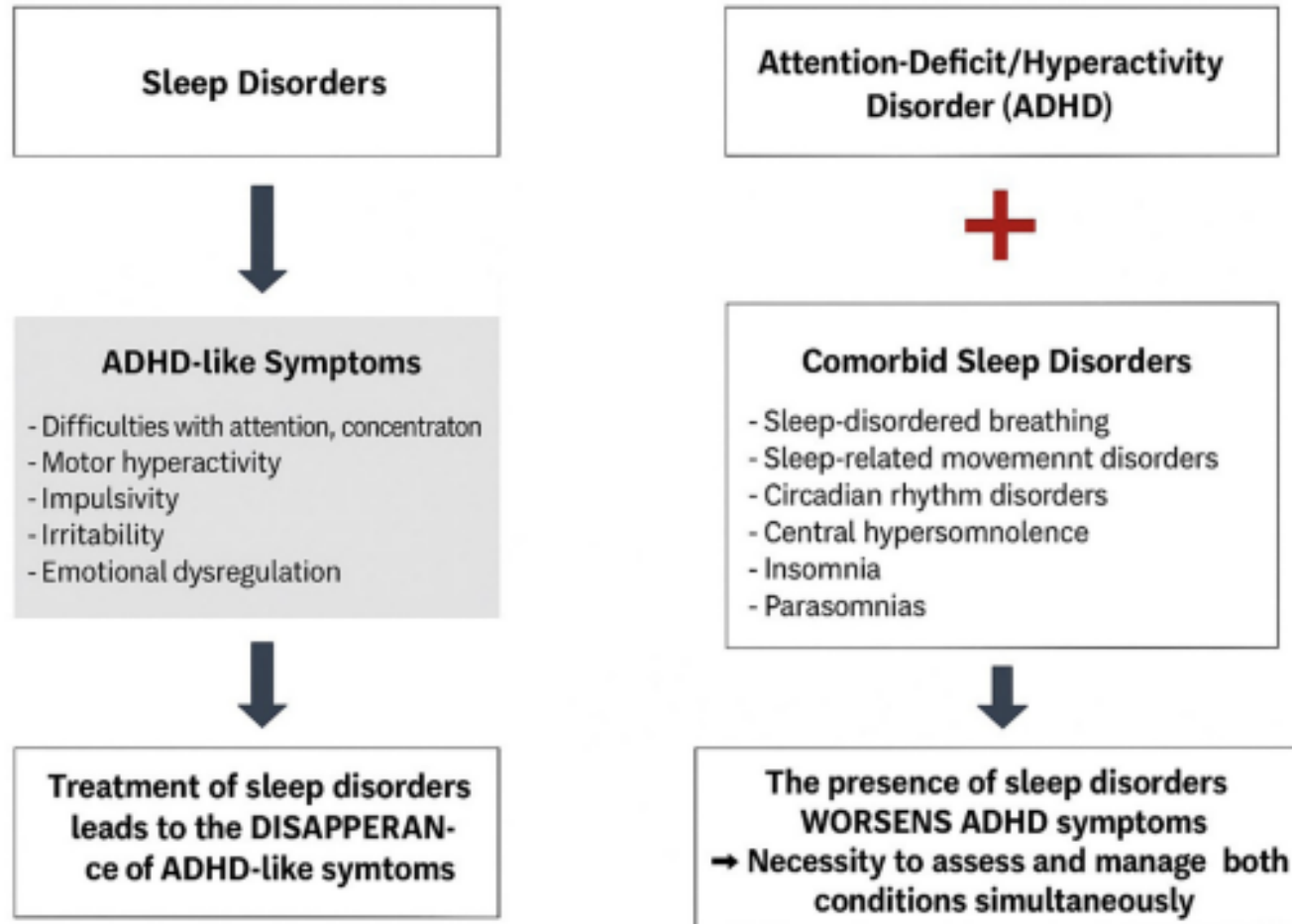


Fig. 1. Distinction between ADHD symptoms and ADHD disorder.

Sleep Disordered Breathing

Sleep Disordered Breathing



NIH Public Access

Author Manuscript

N Engl J Med. Author manuscript; available in PMC 2013 December 20.

Published in final edited form as:

N Engl J Med. 2013 June 20; 368(25): 2366–2376. doi:10.1056/NEJMoa1215881.

A Randomized Trial of Adenotonsillectomy for Childhood Sleep Apnea

Carole L. Marcus, M.B., B.Ch., René H. Moore, Ph.D., Carol L. Rosen, M.D., Bruno Giordani, Ph.D., Susan L. Garetz, M.D., H. Gerry Taylor, Ph.D., Ron B. Mitchell, M.D., Raouf Amin, M.D., Eliot S. Katz, M.D., Raanan Arens, M.D., Shalini Paruthi, M.D., Hiren Muzumdar, M.D., David Gozal, M.D., Nina Hattiangadi Thomas, Ph.D., Janice Ware, Ph.D., Dean Beebe, Ph.D., Karen Snyder, M.S., Lisa Elden, M.D., Robert C. Sprecher, M.D., Paul Willging, M.D., Dwight Jones, M.D., John P. Bent, M.D., Timothy Hoban, M.D., Ronald D. Chervin, M.D., Susan S. Ellenberg, Ph.D., Susan Redline, M.D., M.P.H., and for the Childhood Adenotonsillectomy Trial (CHAT)

Sleep Disordered Breathing



NIH Public Access

Author Manuscript

N Engl J Med. Author manuscript; available in PMC 2013 December 20.

Published in final edited form as:

N Engl J Med. 2013 June 20; 368(25): 2366–2376. doi:10.1056/NEJMoa1215881.

A Randomized Trial of Adenotonsillectomy for Childhood Sleep Apnea

Carole L. Marcus, M.B., B.Ch., René H. Moore, Ph.D., Carol L. Rosen, M.D., Bruno Giordani, Ph.D., Susan L. Garetz, M.D., H. Gerry Taylor, Ph.D., Ron B. Mitchell, M.D., Raouf Amin, M.D., Eliot S. Katz, M.D., Raanan Arens, M.D., Shalini Paruthi, M.D., Hiren Muzumdar, M.D., David Gozal, M.D., Nina Hattiangadi Thomas, Ph.D., Janice Ware, Ph.D., Dean Beebe, Ph.D., Karen Snyder, M.S., Lisa Elden, M.D., Robert C. Sprecher, M.D., Paul Willging, M.D., Dwight Jones, M.D., John P. Bent, M.D., Timothy Hoban, M.D., Ronald D. Chervin, M.D., Susan S. Ellenberg, Ph.D., Susan Redline, M.D., M.P.H., and for the Childhood Adenotonsillectomy Trial (CHAT)

- “...surgical treatment for the obstructive sleep apnea syndrome in school-age children did not significantly improve attention or executive function as measured by neuropsychological testing...”

Sleep Disordered Breathing

- Pediatric OSA
 - ~3% in the general population
 - 25 – 30% in children with ADHD

Sleep Disordered Breathing

- Pediatric OSA
 - ~3% in the general population
 - 25 – 30% in children with ADHD
- 18-item Waldrop scale
 - “...hyperactive behavior is associated with the presence of minor physical anomalies in boys, not girls...”

High palate:

Roof of mouth:

Definitely steepled 2

Flat and narrow at the top 1

Furrowed tongue (one with deep ridges) 1

Sleep Disordered Breathing

TABLE 1. DEMOGRAPHIC, COGNITIVE, AND HIGH-SENSITIVITY C-REACTIVE PROTEIN CHARACTERISTICS OF 103 CHILDREN WITH HABITUAL SNORING, 102 CHILDREN WITH OBSTRUCTIVE SLEEP APNEA, AND 73 CONTROL CHILDREN

	Snoring Children (n = 205)			p Value		
	Group 1: Nonsnoring (n = 73)	Group 2: No OSA (n = 103)	Group 3: OSA (n = 102)	Group 1 vs. Group 2	Group 1 vs. Group 3	Group 2 vs. Group 3
Age, yr	6.3 ± 0.3	6.6 ± 0.3	6.4 ± 0.4	NS	NS	NS
Sex, F:M	33:40	46:57	43:59	NS	NS	NS
African American, n (%)	21 (29)	35 (30)	31 (30)	NS	NS	NS
BMI, kg/m ²	16.8 ± 0.5	17.1 ± 0.6	17.0 ± 0.5	NS	NS	NS
GCA < 85%, n (%)	0	12 (11.7)	57 (55.9)	< 0.003	< 0.000001	< 0.0001; OR, 9.61 (CI, 4.46–21.07)
hsCRP, mg/dl	0.18 ± 0.05	0.19 ± 0.07	0.36 ± 0.11	NS	< 0.01	< 0.01
WBC count, cells/mm ³	6,261 ± 873	6,161 ± 667	6,242 ± 673	NS	NS	NS
Platelet count, × 10 ³ /mm ³	297.6 ± 55.9	315.2 ± 75.3	355.7 ± 85.5	NS	< 0.03	< 0.04

Definition of abbreviations: BMI = body mass index; CI = confidence interval; F:M = female:male; GCA = general conceptual ability score; hsCRP = high-sensitivity C-reactive protein; NS = not significant; OR = odds ratio; OSA = obstructive sleep apnea; WBC, white blood cell.

Sleep Disordered Breathing

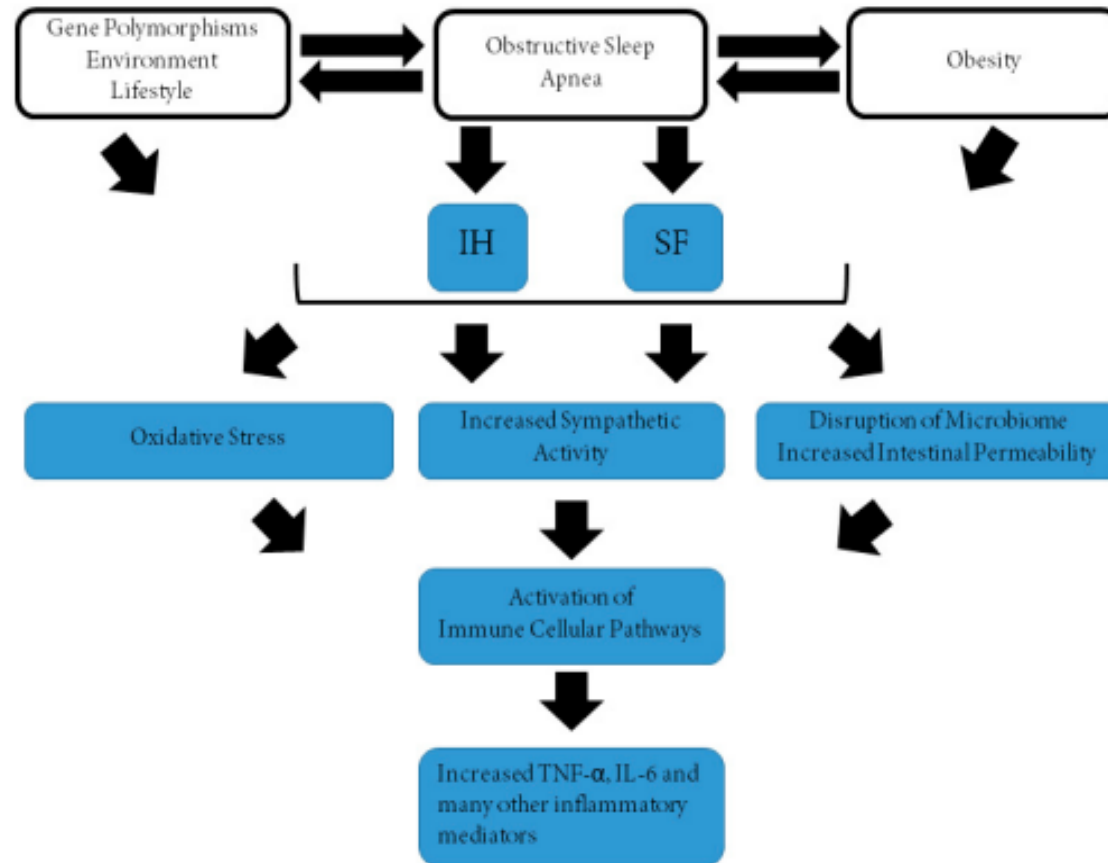
Table 2

Comparisons of characteristics between OSAHS group and OSAHS + ADHD group in different age groups.

Parameters	4–5 years		<i>P</i>	6–11 years		<i>P</i>
	OSAHS	OSAHS + ADHD		OSAHS	OSAHS + ADHD	
Allergic rhinitis			.023			.935
Yes	109 (67.28)	59 (79.73)		85 (65.89)	43 (61.43)	
No	53 (32.72)	15 (20.27)		44 (34.11)	27 (38.57)	
Tonsil			.138			.026
<II°	78 (48.15)	38 (51.35)		71 (55.04)	25 (34.72)	
II°	84 (51.85)	36 (48.65)		58 (44.96)	47 (65.27)	
Adenoid	0.732 ± 0.22	0.877 ± 0.202	.001	0.688 ± 0.225	0.741 ± 0.211	.127
OSA-18 scale						
Sleep disturbances	15.525 ± 5.199	18.636 ± 4.892	<.001	14.962 ± 5.592	17.965 ± 7.151	.002
Physical suffering	15.329 ± 4.317	17.138 ± 3.881	.004	14.443 ± 3.748	16.536 ± 4.365	.001
Emotional distress	8.329 ± 3.118	13.308 ± 3.653	<.001	8.344 ± 3.378	12.429 ± 4.285	<.001
Daytime problems	8.025 ± 2.835	10.338 ± 3.089	<.001	8.023 ± 3.223	11.554 ± 3.379	<.001
Parent or caretaker concern	16.043 ± 6.55	18.877 ± 5.447	.002	15.29 ± 5.747	17.214 ± 6.038	.040
AHI	8.3 ± 3.4	12 ± 4.5	.002	8.6 ± 2.8	13.5 ± 4.1	<.001
Lowest oxygen saturation	85 ± 36.3	71 ± 27.4	.001	84 ± 32.8	68 ± 29.6	<.001

ADHD = attention deficit hyperactivity disorder, AHI = apnea–hypopnea index, OSAHS = obstructive sleep apnea–hypopnea syndrome.

Sleep Disordered Breathing



Sleep Disordered Breathing

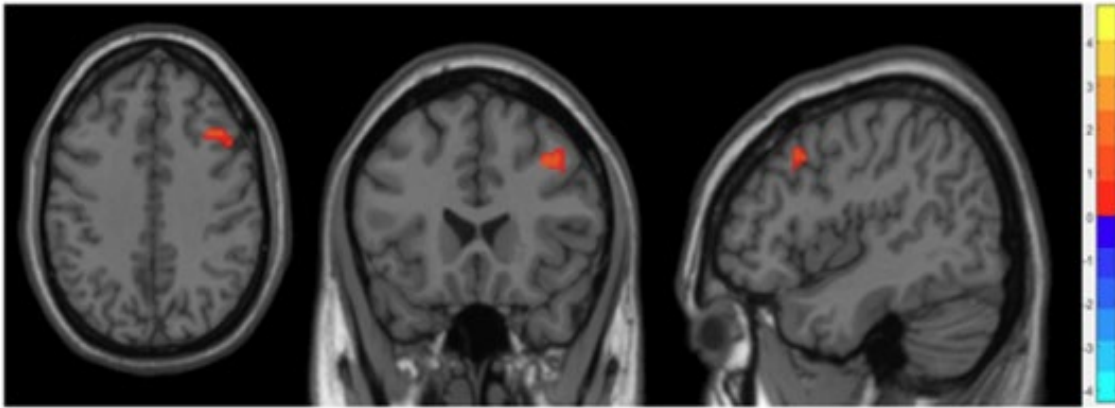


FIGURE 1

It showed the difference regions of GMV in slices with various directions between the OSA and non-OSA groups ($P < 0.05$, GRF corrected). The red clusters indicate a larger GMV for children with OSA than for controls.

- Right frontal middle gyrus is larger in children with OSA compared to children without OSA
 - Negatively correlated with expressive attention

Circadian Influences

Circadian Influences

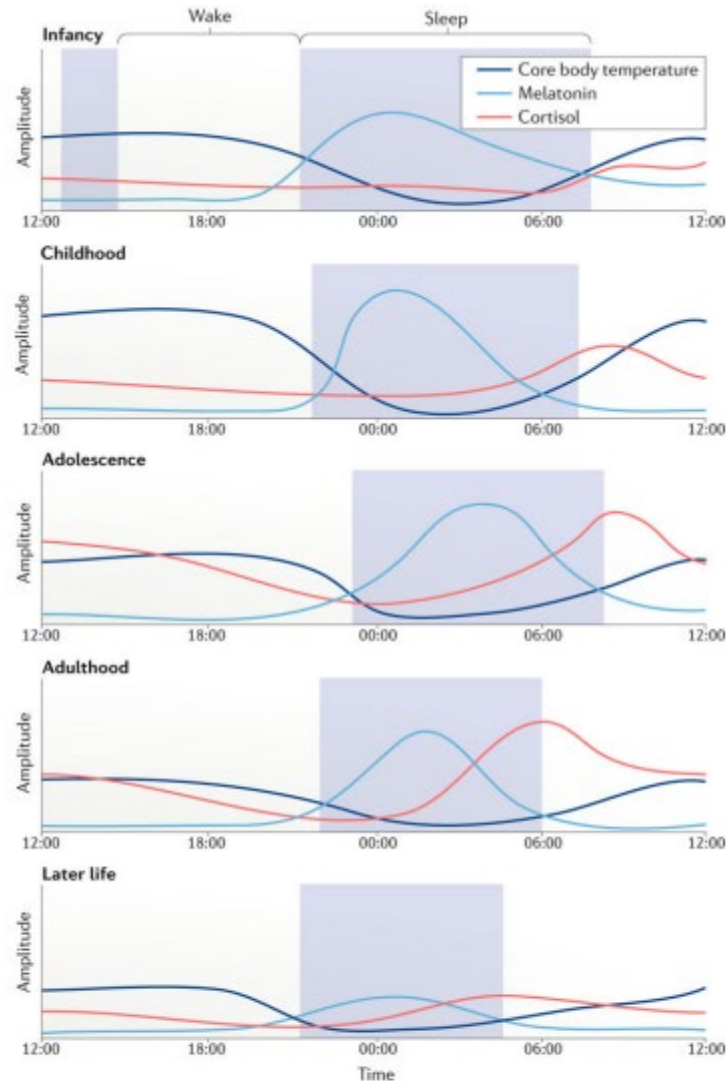
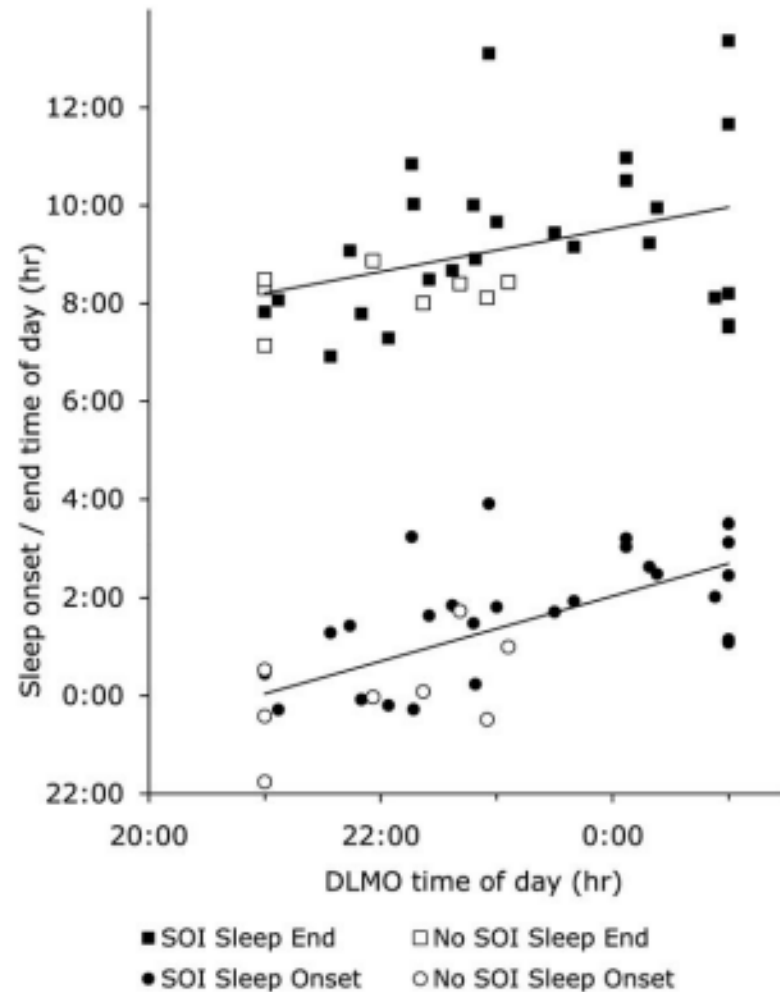
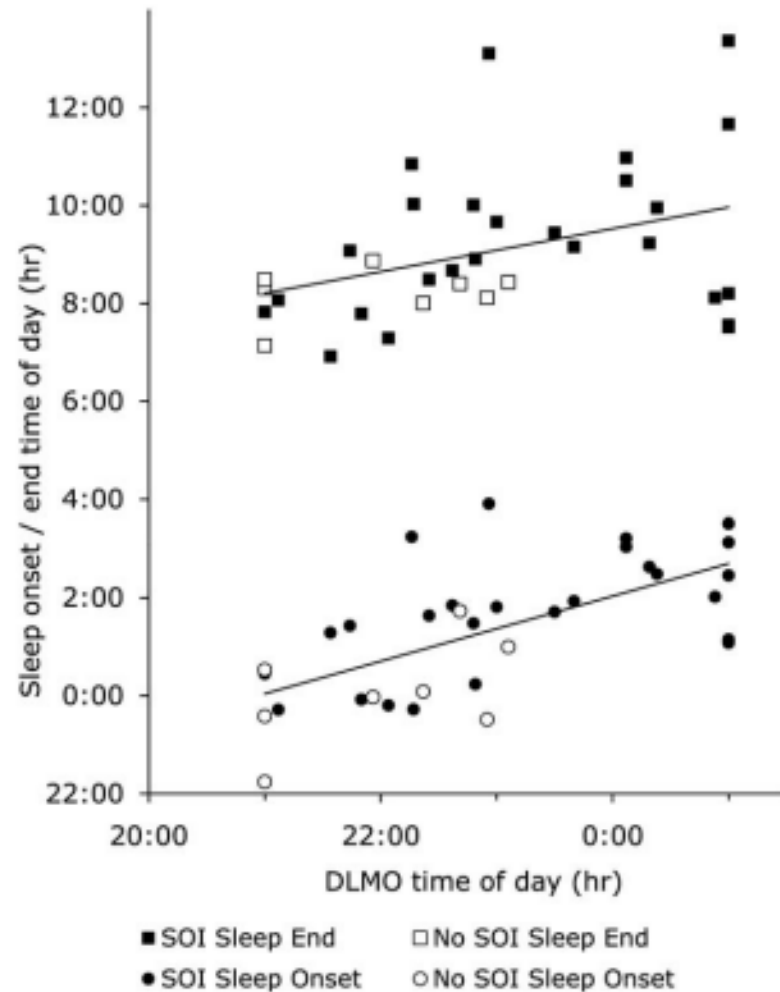


Fig. 2 | . rhythms across the lifespan.

Circadian Influences

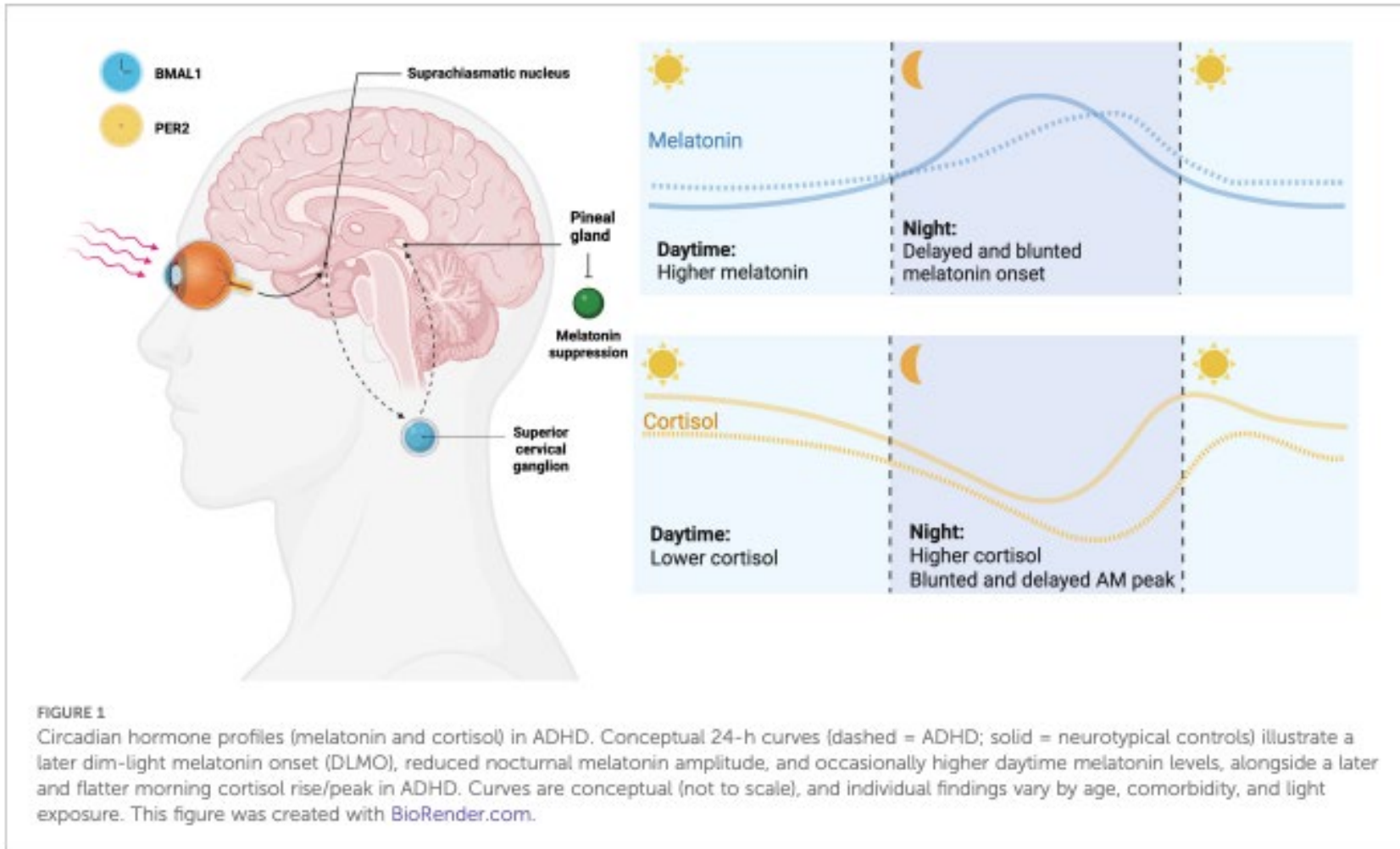


Circadian Influences

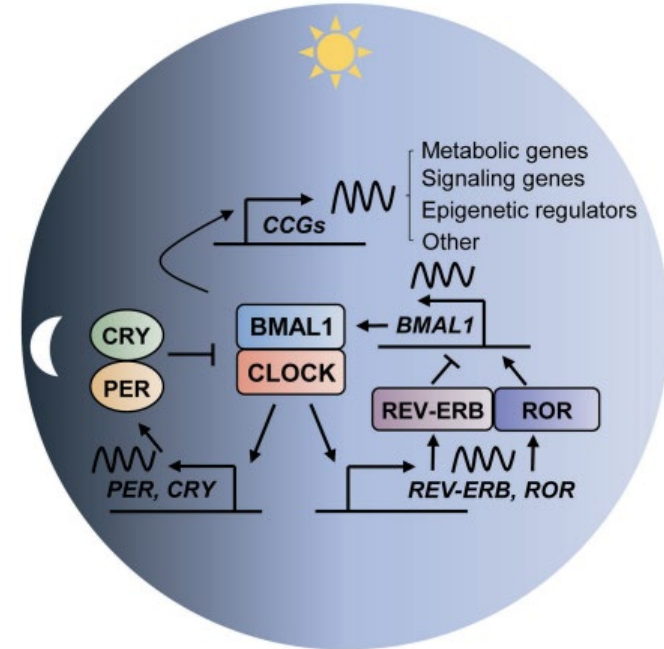
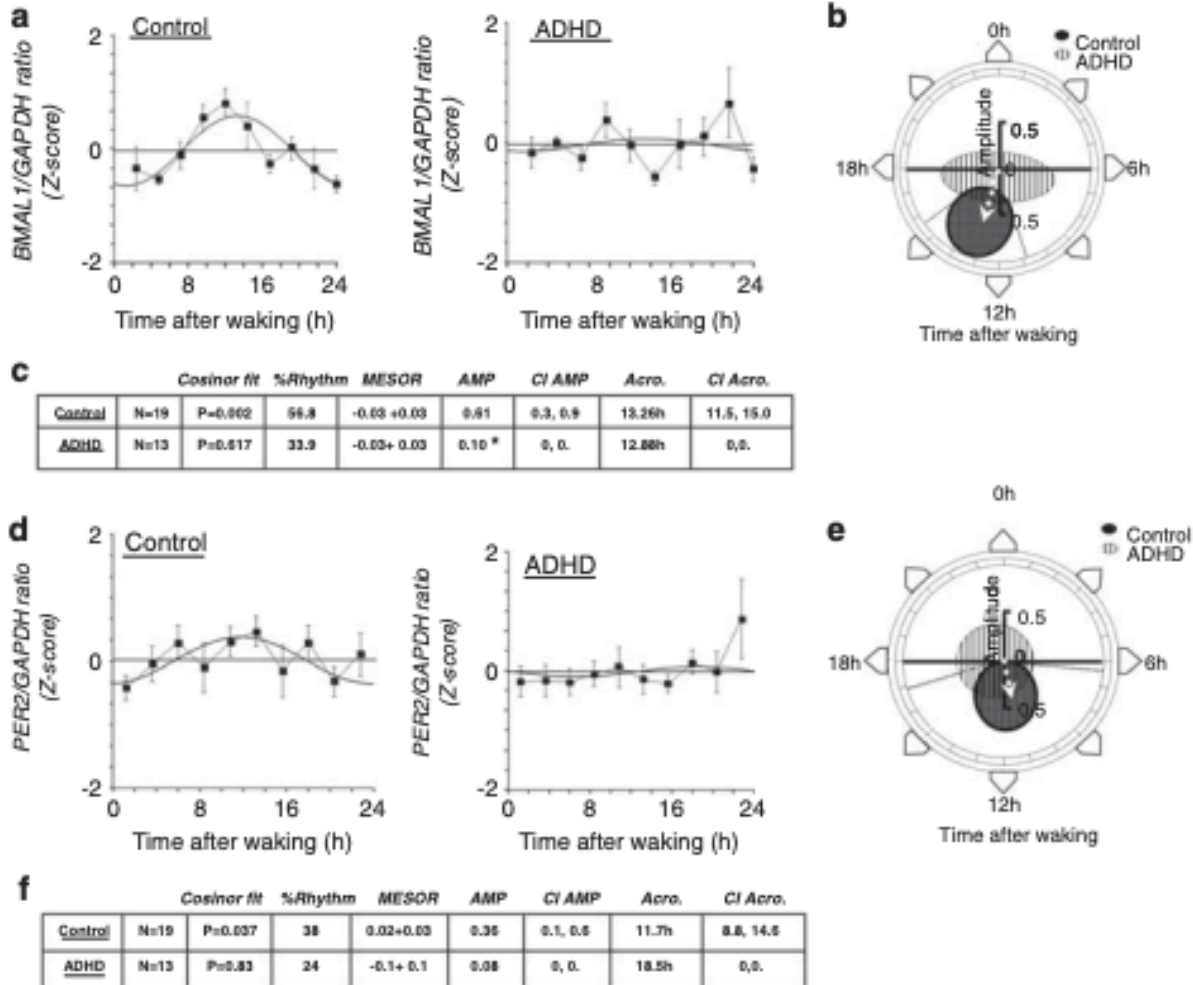


- Melatonin Onset Delayed
 - 45 minutes in children
 - 90 minutes in adults

Circadian Influences



Circadian Influences



Circadian Influences

TABLE 2
Outcome Variables

Variable	Melatonin			Placebo			p Value ^a
	Baseline	Treatment	Change	Baseline	Treatment	Change	
DLMO (hr:min)	20:37 ± 0:56	19:53 ± 1:06	-0:44 ± 1:07	20:32 ± 0:54	20:45 ± 1:06	+0:13 ± 0:59	<.0001*
Sleep							
Sleep onset (hr:min)	21:40 ± 0:59	21:13 ± 0:58	-0:27 ± 0:48	21:38 ± 0:47	21:48 ± 0:48	+0:10 ± 0:37	<.0001*
Sleep latency (min)	53.0 ± 22.0	31.7 ± 30.7	-21.3 ± 33.0	47.3 ± 23.2	50.4 ± 30.4	+3.0 ± 31.7	.001*
Total time asleep (min)	518.9 ± 48.3	538.7 ± 55.0	+19.8 ± 61.9	533.8 ± 47.8	520.2 ± 47.5	-13.6 ± 50.6	.01*
Sleep efficiency (%)	80.1 ± 5.5	82.7 ± 7.5	+2.6 ± 8.9	82.4 ± 5.7	80.3 ± 5.9	-2.1 ± 7.1	.011*
Difficulty falling asleep ^b	3.4 ± 0.9	2.2 ± 0.9	-1.2 ± 1.3	3.2 ± 0.7	3.1 ± 1.0	-0.1 ± 0.8	<.0001*
Problem behavior							
Core problems _{parents}	4.0 ± 1.3	4.8 ± 1.3	+0.7 ± 0.9	4.3 ± 1.3	4.5 ± 1.2	+0.2 ± 0.8	.002*
Core problems _{teacher}	4.6 ± 1.0	5.3 ± 1.1	+0.7 ± 0.9	4.4 ± 1.2	4.9 ± 1.4	+0.5 ± 1.0	.41
CBCL	63.0 ± 16.0	55.1 ± 18.4	-8.0 ± 8.8	61.5 ± 21.8	45.3 ± 25.7	-16.2 ± 18.2	.083
TRF	46.1 ± 20.7	42.1 ± 19.1	-4.0 ± 12.5	52.2 ± 26.1	48.1 ± 25.0	-4.0 ± 16.4	.29
Quality of life							
TACQOL-P _{total}	170.4 ± 19.9	179.1 ± 21.8	+8.7 ± 13.0	168.8 ± 22.5	176.9 ± 22.5	+8.1 ± 9.1	.82
Cognition							
Interference control (EFT)							
ΔReaction time ^c (ms)	50.1 ± 37.1	33.1 ± 33.0	-17.0 ± 43.2	41.8 ± 27.8	32.3 ± 25.4	-9.5 ± 34.4	.37
ΔError incidence ^d (%)	3.4 ± 4.0	3.8 ± 3.5	+0.4 ± 4.5	3.8 ± 3.7	3.2 ± 3.5	-0.6 ± 3.6	.28
Sustained attention (SADT)							
Inaccuracy (%) ^e	12.6 ± 7.6	12.2 ± 7.2	-0.3 ± 4.5	12.0 ± 6.7	12.34 ± 7.3	+0.4 ± 5.6	.52
Task completion time (s)	469.0 ± 153.0	410.5 ± 142.6	-58.5 ± 77.8	489.4 ± 187.1	428.2 ± 171.9	-61.2 ± 85.5	.58

Note: DLMO = salivary dim light melatonin onset; CBCL = Child Behavior Checklist, total score; TRF = Teacher's Report Form, total score; TACQOL-P = TNO-AZL Questionnaire for Children's Health-Related Quality of Life, Parent Form; EFT = Eriksen Flanker Task; SADT = Sustained Attention Dots Task (Amsterdam Neuropsychological Tasks).

^a General linear model repeated-measures test on group differences in pre- to posttreatment changes.

^b Mean difficulty falling asleep as reported by parents, averaged over 7 days on a scale of 1 (not difficult) to 5 (very difficult).

^c Difference in reaction time between incongruent and congruent trials.

^d Difference in error incidence between incongruent and congruent trials.

^e Percentage of misses plus false alarms relative to the total number of trials.

* Statistically significant difference ($p = .05$, two-sided).

Circadian Influences

TABLE 2
Outcome Variables

Variable	Melatonin			Placebo			p Value ^a
	Baseline	Treatment	Change	Baseline	Treatment	Change	
DLMO (hr:min)	20:37 ± 0:56	19:53 ± 1:06	-0:44 ± 1:07	20:32 ± 0:54	20:45 ± 1:06	+0:13 ± 0:59	<.0001*
Sleep							
Sleep onset (hr:min)	21:40 ± 0:59	21:13 ± 0:58	-0:27 ± 0:48	21:38 ± 0:47	21:48 ± 0:48	+0:10 ± 0:37	<.0001*
Sleep latency (min)	53.0 ± 22.0	31.7 ± 30.7	-21.3 ± 33.0	47.3 ± 23.2	50.4 ± 30.4	+3.0 ± 31.7	.001*
Total time asleep (min)	518.9 ± 48.3	538.7 ± 55.0	+19.8 ± 61.9	533.8 ± 47.8	520.2 ± 47.5	-13.6 ± 50.6	.01*
Sleep efficiency (%)	80.1 ± 5.5	82.7 ± 7.5	+2.6 ± 8.9	82.4 ± 5.7	80.3 ± 5.9	-2.1 ± 7.1	.011*
Difficulty falling asleep ^b	3.4 ± 0.9	2.2 ± 0.9	-1.2 ± 1.3	3.2 ± 0.7	3.1 ± 1.0	-0.1 ± 0.8	<.0001*
Problem behavior							
Core problems _{—parents}	4.0 ± 1.3	4.8 ± 1.3	+0.7 ± 0.9	4.3 ± 1.3	4.5 ± 1.2	+0.2 ± 0.8	.002*
Core problems _{—teacher}	4.6 ± 1.0	5.3 ± 1.1	+0.7 ± 0.9	4.4 ± 1.2	4.9 ± 1.4	+0.5 ± 1.0	.41
CBCL	63.0 ± 16.0	55.1 ± 18.4	-8.0 ± 8.8	61.5 ± 21.8	45.3 ± 25.7	-16.2 ± 18.2	.083
TRF	46.1 ± 20.7	42.1 ± 19.1	-4.0 ± 12.5	52.2 ± 26.1	48.1 ± 25.0	-4.0 ± 16.4	.29
Quality of life							
TACQOL-P _{—total}	170.4 ± 19.9	179.1 ± 21.8	+8.7 ± 13.0	168.8 ± 22.5	176.9 ± 22.5	+8.1 ± 9.1	.82
Cognition							
Interference control (EFT)							
ΔReaction time ^c (ms)	50.1 ± 37.1	33.1 ± 33.0	-17.0 ± 43.2	41.8 ± 27.8	32.3 ± 25.4	-9.5 ± 34.4	.37
ΔError incidence ^d (%)	3.4 ± 4.0	3.8 ± 3.5	+0.4 ± 4.5	3.8 ± 3.7	3.2 ± 3.5	-0.6 ± 3.6	.28
Sustained attention (SADT)							
Inaccuracy (%) ^e	12.6 ± 7.6	12.2 ± 7.2	-0.3 ± 4.5	12.0 ± 6.7	12.34 ± 7.3	+0.4 ± 5.6	.52
Task completion time (s)	469.0 ± 153.0	410.5 ± 142.6	-58.5 ± 77.8	489.4 ± 187.1	428.2 ± 171.9	-61.2 ± 85.5	.58

Note: DLMO = salivary dim light melatonin onset; CBCL = Child Behavior Checklist, total score; TRF = Teacher's Report Form, total score; TACQOL-P = TNO-AZL Questionnaire for Children's Health-Related Quality of Life, Parent Form; EFT = Eriksen Flanker Task; SADT = Sustained Attention Dots Task (Amsterdam Neuropsychological Tasks).

^a General linear model repeated-measures test on group differences in pre- to posttreatment changes.

^b Mean difficulty falling asleep as reported by parents, averaged over 7 days on a scale of 1 (not difficult) to 5 (very difficult).

^c Difference in reaction time between incongruent and congruent trials.

^d Difference in error incidence between incongruent and congruent trials.

^e Percentage of misses plus false alarms relative to the total number of trials.

* Statistically significant difference ($p = .05$, two-sided).

Table 1. Effect of discontinuing melatonin treatment on sleep and behaviour

Effect	No. of children (%)
No change of sleeping pattern	1 (1.5)
Delay of sleep onset time	60 (92.3)
Delay of wake up time	20 (30.8)
Changing daytime behaviour	19 (29.2)

Circadian Influences

Journal of Psychiatric Research 81 (2016) 87–94



Contents lists available at ScienceDirect

Journal of Psychiatric Research

journal homepage: www.elsevier.com/locate/psychires



ADHD, circadian rhythms and seasonality



Dora S. Wynchank ^{a,*}, Denise Bijlenga ^a, Femke Lamers ^b, Tannetje I. Bron ^a,
Wim H. Winthorst ^c, Suzan W. Vogel ^a, Brenda W. Penninx ^b, Aartjan T. Beekman ^b,
J. Sandra Kooij ^a

^a PsyQ Expertise Center Adult ADHD, The Hague, The Netherlands

^b Department of Psychiatry and EMGO, Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands

^c Department of Psychiatry, University Medical Center Groningen, University of Groningen, The Netherlands

Dopamine Pathway

Dopamine Pathway

- Pediatric Restless Legs Syndrome (RLS)
 - 1.9% in the general population
 - 11 - 42.9% in children with ADHD
 - RLS symptoms in adolescents is associated with later ADHD diagnosis

Dopamine Pathway

- RLS and ADHD implicated in dopamine dysregulation
 - Lower dopamine levels in nigrostriatal region
 - Lower iron levels

Dopamine Pathway

Dopamine Synthesis

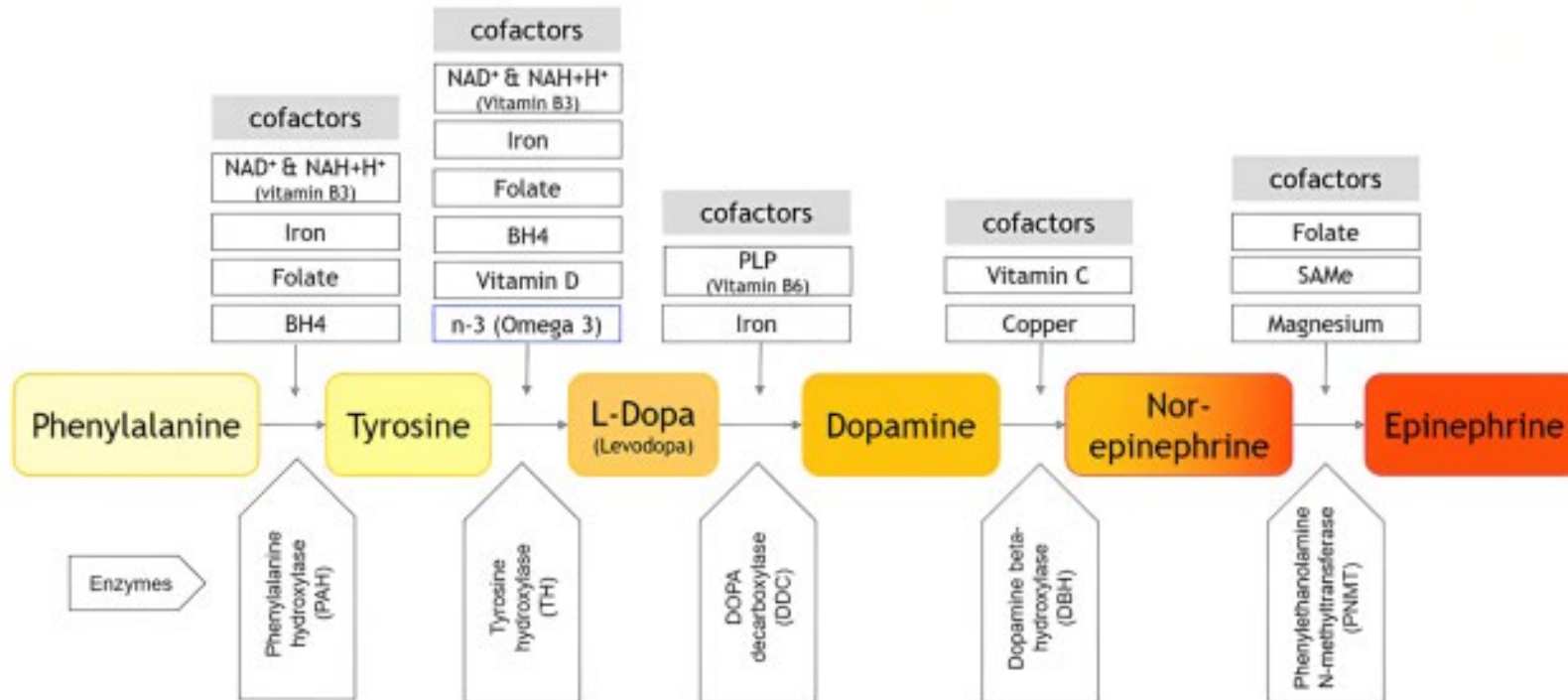


Fig. 2 The dopamine synthesis pathway and its cofactors

Dopamine Pathway

Dopamine Synthesis

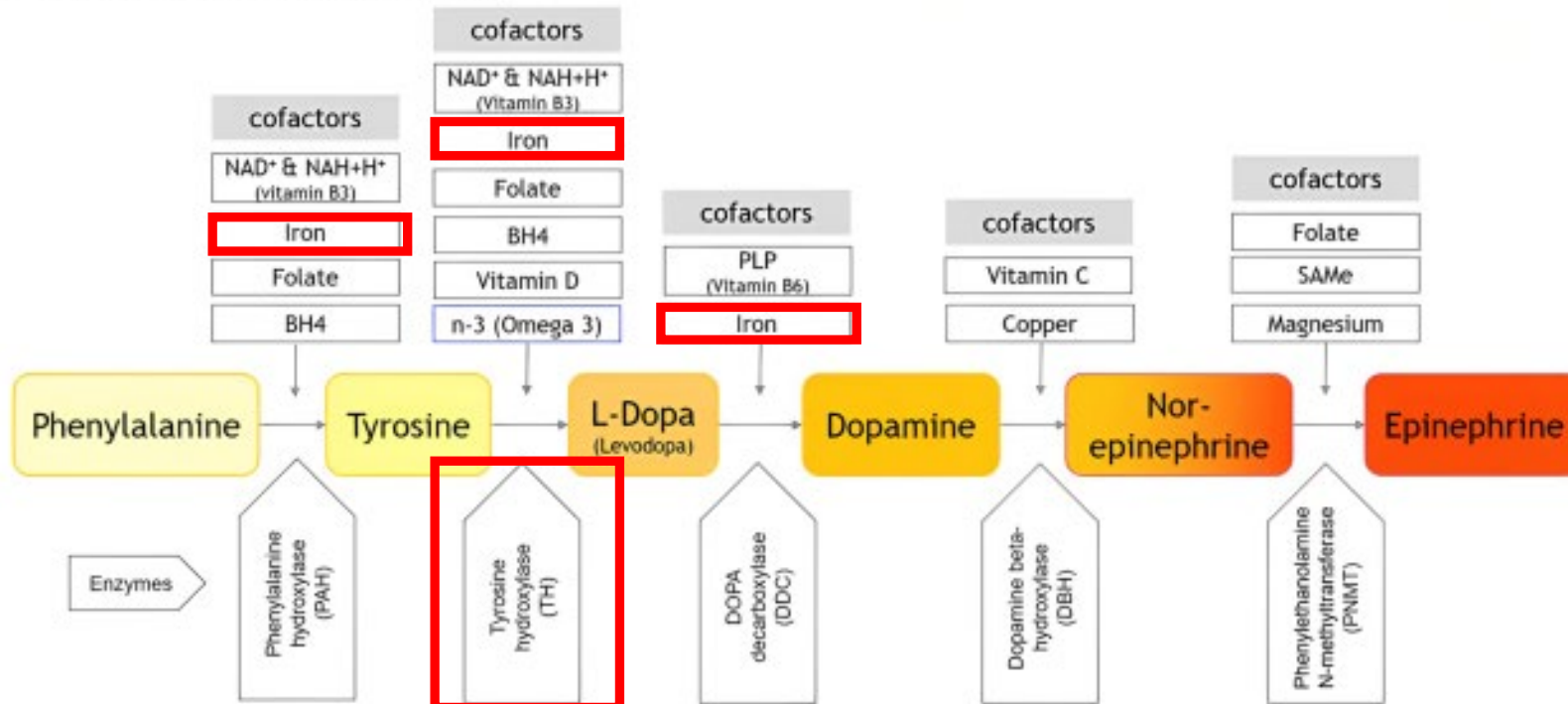


Fig. 2 The dopamine synthesis pathway and its cofactors

Dopamine Pathway

Serotonin Synthesis

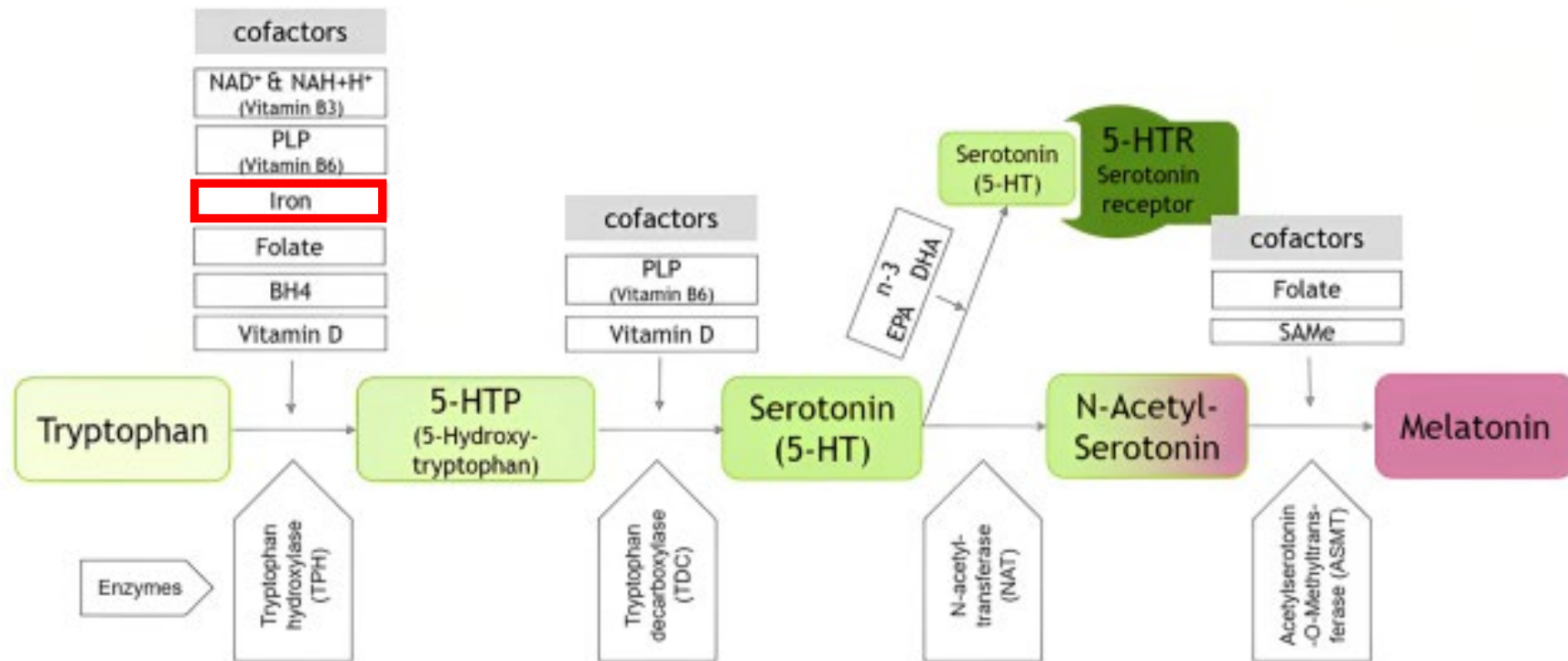
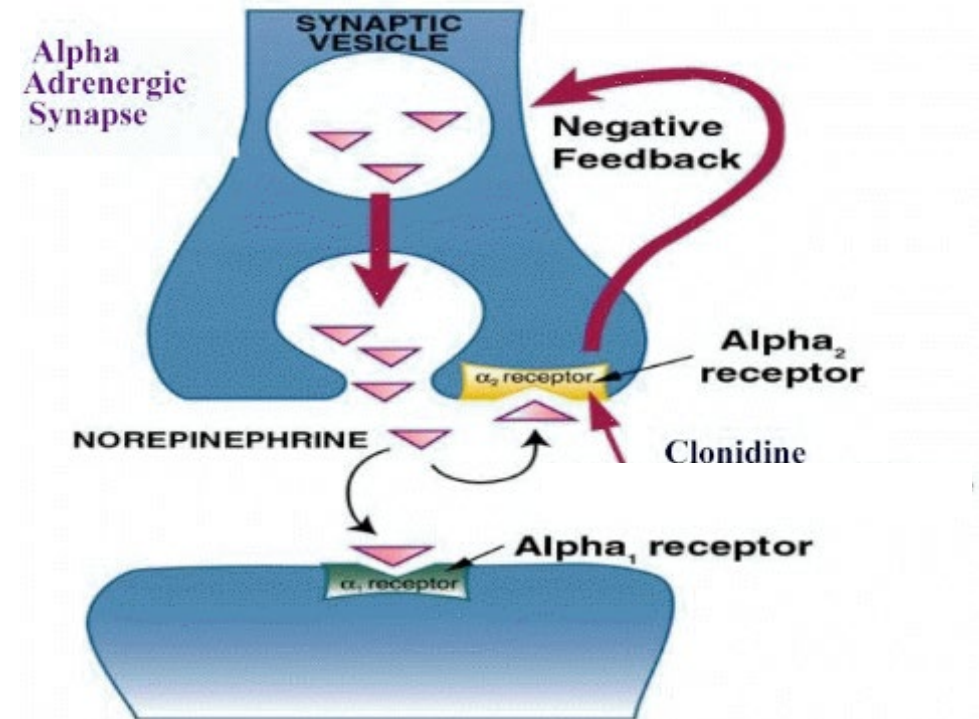
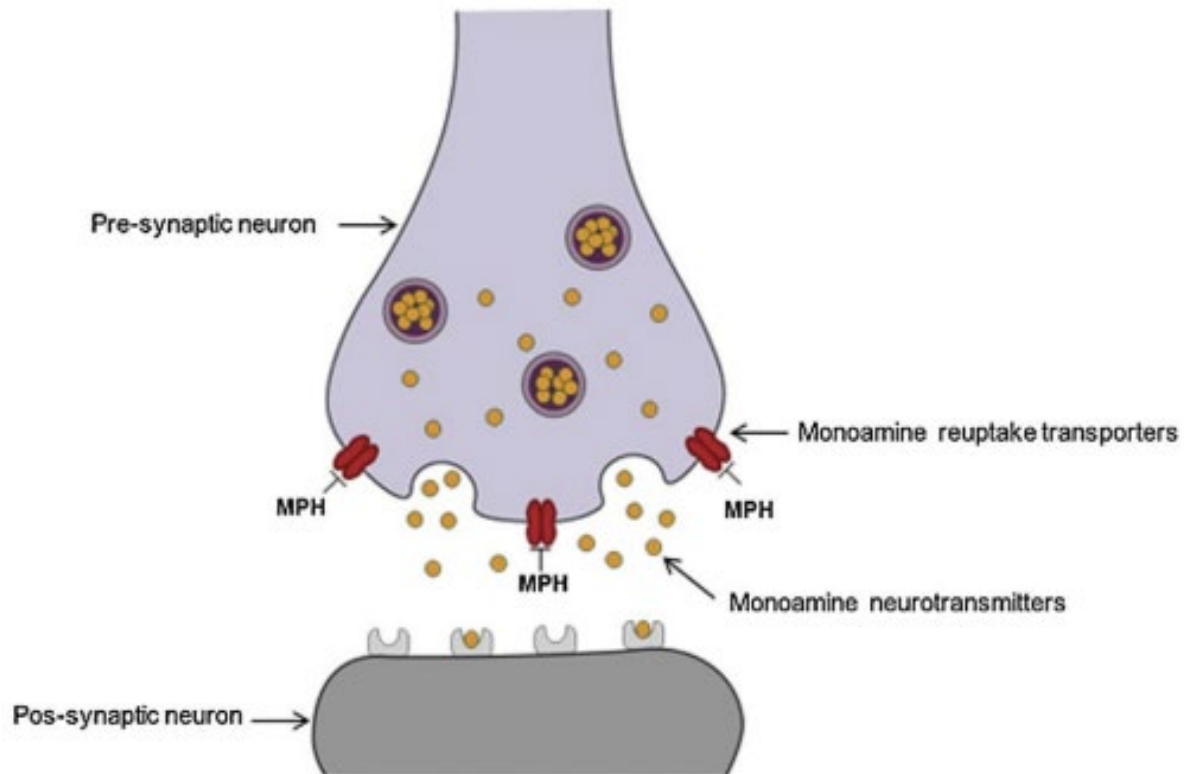


Fig. 3 The serotonin synthesis pathway and its cofactors

Dopamine Pathway



Dopamine Pathway

- Dopamine transporter is main target of stimulants
 - Likely don't need to worry about stimulants worsening sleep at night
 - If it happens, it's likely temporary

Parasomnias

Parasomnias

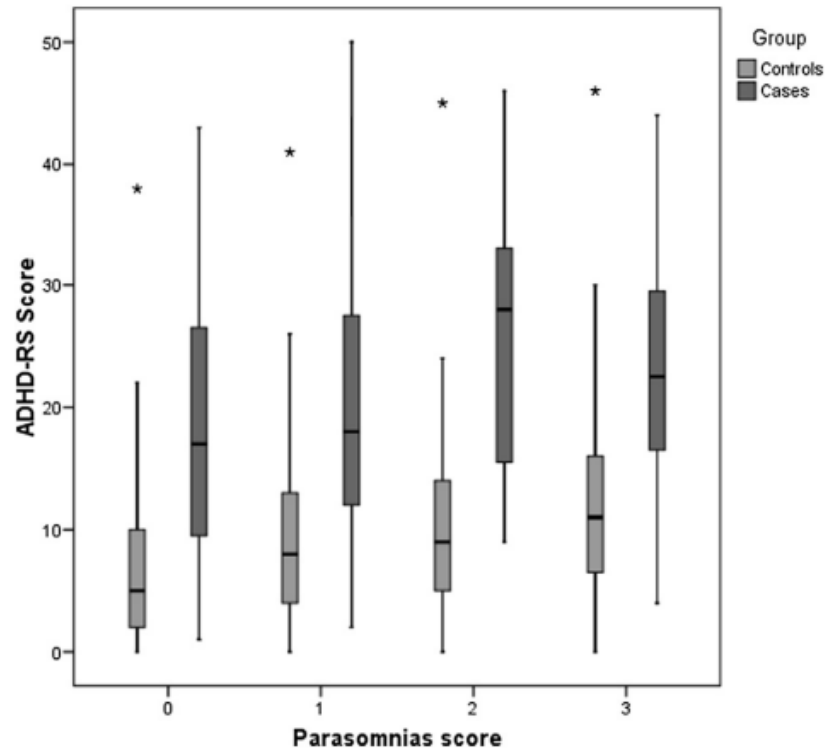


Fig. 1 – Correlation between parasomnias score (0 = none, 1 = one parasomnia, 2 = two parasomnias, 3 = three or more parasomnias) and ADHD-RS score in cases and controls.

- “...the higher the total ADHD-RS score, the higher the number of parasomnias...”

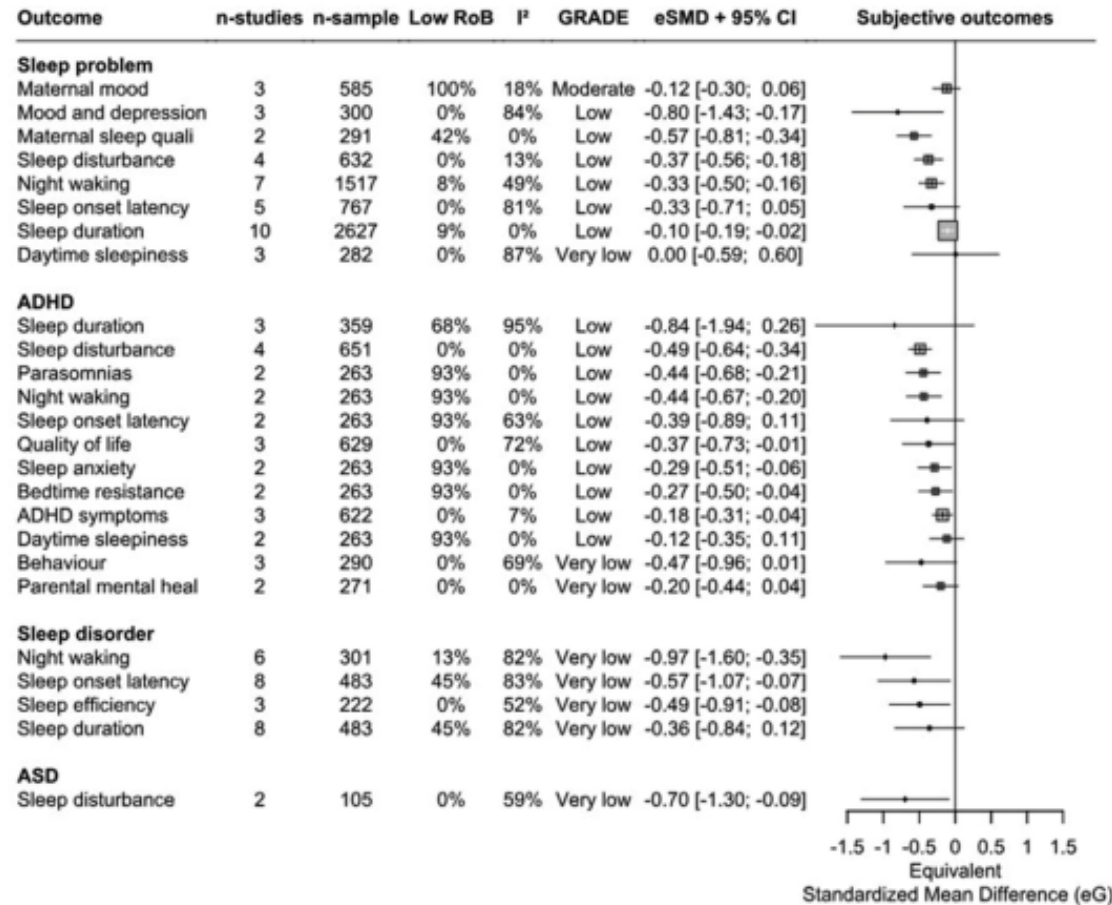
Insomnia

Insomnia

- 25-50% of children and adolescents with ADHD have concurrent anxiety
 - May present with more inattentiveness and less impulsivity
 - Often with less aggressive symptoms
 - Worrying thoughts may present as racing thoughts at night
 - Stimulants may worsen underlying anxiety

Insomnia

FIGURE 2 Behavioral/Pschoeducation Sleep Interventions Pooled Together on Subjective Sleep Outcomes



Note: Quantitative meta-analytic synthesis of the efficacy of behavioral/psychoeducation sleep interventions pooled together on subjective sleep outcomes across clinical populations. ADHD = attention-deficit/hyperactivity disorder; ASD = autism spectrum disorder; GRADE = Grading of Recommendations, Assessment, Development and Evaluations; RoB = risk of bias; SMD = standardized mean difference.

Insomnia

- Coordinate with provider managing ADHD to optimize daytime/evening symptoms to facilitate the transition to sleep
- Treat any underlying anxiety symptoms
- No FDA approved hypnotics for children
 - Melatonin or ramelteon
 - Alpha-2 agonists (clonidine and guanfacine)
 - Z-drugs (zolpidem, eszopiclone) seem to be ineffective in children with ADHD

Thank you!

References

- American Psychiatric Association. (2022). Diagnostic and statistical manual of mental disorders (5th ed., text rev.).
- Baird AL, Coogan AN, Siddiqui A, Donev RM, Thome J. Adult attention-deficit hyperactivity disorder is associated with alterations in circadian rhythms at the behavioural, endocrine and molecular levels. *Mol Psychiatry*. 2012 Oct;17(10):988-95. doi: 10.1038/mp.2011.149. Epub 2011 Nov 22. PMID: 22105622.
- Beebe DW, Gozal D. Obstructive sleep apnea and the prefrontal cortex: towards a comprehensive model linking nocturnal upper airway obstruction to daytime cognitive and behavioral deficits. *J Sleep Res*. 2002 Mar;11(1):1-16. doi: 10.1046/j.1365-2869.2002.00289.x. PMID: 11869421.
- Bioulac S, Claret-Tournier A. Sleep disturbances in Attention-Deficit/Hyperactivity Disorder: State of the art and management. *Encephale*. 2026 Jun;52(35):S51-S56. doi: 10.1016/j.encep.2026.04.002. PMID: 42297542.
- Blumer JL, Findling RL, Shih WJ, Soubrane C, Reed MD. Controlled clinical trial of zolpidem for the treatment of insomnia associated with attention-deficit/ hyperactivity disorder in children 6 to 17 years of age. *Pediatrics*. 2009 May;123(5):e770-6. doi: 10.1542/peds.2008-2945. PMID: 19403468.
- Blunden SL, Milte CM, Sinn N. Diet and sleep in children with attention deficit hyperactivity disorder: preliminary data in Australian children. *J Child Health Care*. 2011 Mar;15(1):14-24. doi: 10.1177/1367493510385020. Epub 2011 Feb 11. PMID: 21317167.
- 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 Sep;48(9):894-908. doi: 10.1097/CHI.0b013e3181ac09c9. PMID: 19625983.
- Del Campo N, Chamberlain SR, Sahakian BJ, Robbins TW. The roles of dopamine and noradrenaline in the pathophysiology and treatment of attention-deficit/hyperactivity disorder. *Biol Psychiatry*. 2011 Jun 15;69(12):e145-57. doi: 10.1016/j.biopsych.2011.02.036. Epub 2011 May 6. PMID: 21550021.
- Givan DC. The sleepy child. *Pediatr Clin North Am*. 2004;51:15-31.
- Gozal D, Crabtree VM, Sans Capdevila O, Witcher LA, Kheirandish-Gozal L. C-reactive protein, obstructive sleep apnea, and cognitive dysfunction in school-aged children. *Am J Respir Crit Care Med*. 2007 Jul 15;176(2):188-93. doi: 10.1164/rccm.200610-1519OC. Epub 2007 Mar 30. PMID: 17400731; PMCID: PMC1994211.
- Hoebert M, van der Heijden KB, van Geijlswijk IM, Smits MG. Long-term follow-up of melatonin treatment in children with ADHD and chronic sleep onset insomnia. *J Pineal Res*. 2009 Aug;47(1):1-7. doi: 10.1111/j.1600-079X.2009.00681.x. Epub 2009 May 27. PMID: 19486273.
- Hornsey SJ, Gosling CJ, Jurek L, Nourredine M, Telesia L, Solmi M, Butt I, Greenwell K, Muller I, Hill CM, Cortese S; DISCA Team. Umbrella Review and Meta-Analysis: The Efficacy of Nonpharmacological Interventions for Sleep Disturbances in Children and Adolescents. *J Am Acad Child Adolesc Psychiatry*. 2025 Mar;64(3):329-345. doi: 10.1016/j.jaac.2024.10.015. Epub 2024 Nov 26. PMID: 39608635.
- Hvolby A. Associations of sleep disturbance with ADHD: implications for treatment. *Atten Defic Hyperact Disord* 2015; 7: 1-18 [RCA] [PMID: 25127644]
- Kheirandish-Gozal L, Gozal D. Obstructive Sleep Apnea and Inflammation: Proof of Concept Based on Two Illustrative Cytokines. *Int J Mol Sci*. 2019 Jan 22;20(3):459. doi: 10.3390/ijms20030459. PMID: 30678164; PMCID: PMC6387387.
- Konofal E, Cortese S, Marchand M, Mouren MC, Arnulf I, Lecendreux M. Impact of restless legs syndrome and iron deficiency on attention-deficit/hyperactivity disorder in children. *Sleep Med*. 2007;8(7-8):711-715.
- Lee, Y. Roles of circadian clocks in cancer pathogenesis and treatment. *Exp Mol Med* 53, 1529-1538 (2021).
- León-Barriera R, Ortegon RS, Chaplin MM, Modesto-Lowe V. Treating ADHD and Comorbid Anxiety in Children: A Guide for Clinical Practice. *Clin Pediatr (Phila)*. 2023 Jan;62(1):39-46. doi: 10.1177/00099228221111246. Epub 2022 Jul 19. PMID: 35854648.
- Liu X, Liu ZZ, Liu BP, Sun SH, Jia CX. Associations between sleep problems and ADHD symptoms among adolescents: findings from the Shandong Adolescent Behavior and Health Cohort (SABHC). *Sleep*. 2020 Jun 15;43(6):zsz294. doi: 10.1093/sleep/zsz294. PMID: 31790135.
- Logan RW, McClung CA. Rhythms of life: circadian disruption and brain disorders across the lifespan. *Nat Rev Neurosci*. 2019 Jan;20(1):49-65. doi: 10.1038/s41583-018-0088-y. PMID: 30459365; PMCID: PMC6338075.
- Loureiro-Vieira, Sara & Costa, Vera & Bastos, Maria & Carvalho, Félix & Capela, João. (2017). Methylphenidate effects in the young brain: friend or foe?. *International Journal of Developmental Neuroscience*. 60. 34-47. 10.1016/j.ijdevneu.2017.06.002.

References

- • Luu B, Fabiano N. ADHD as a circadian rhythm disorder: evidence and implications for chronotherapy. *Front Psychiatry*. 2025 Dec 10;16:1697900. doi: 10.3389/fpsyt.2025.1697900. PMID: 41450833; PMCID: PMC12728042.
- • Mader IM. Recovery from (treatment-resistant) depression after lifestyle changes and micronutrient precision supplementation: a preliminary field study in patients. *BMC Psychol*. 2023 Aug 11;11(1):229. doi: 10.1186/s40359-023-01263-7. PMID: 37568156; PMCID: PMC10422823.
- • Marcus CL, Moore RH, Rosen CL, Giordani B, Garetz SL, Taylor HG, Mitchell RB, Amin R, Katz ES, Arens R, Paruthi S, Muzumdar H, Gozal D, Thomas NH, Ware J, Beebe D, Snyder K, Elden L, Sprecher RC, Willging P, Jones D, Bent JP, Hoban T, Chervin RD, Ellenberg SS, Redline S; Childhood Adenotonsillectomy Trial (CHAT). A randomized trial of adenotonsillectomy for childhood sleep apnea. *N Engl J Med*. 2013 Jun 20;368(25):2366-76. doi: 10.1056/NEJMoa1215881. Epub 2013 May 21. PMID: 23692173; PMCID: PMC3756808.
- • Marcus CL, Moore RH, Rosen CL, Giordani B, Garetz SL, Taylor HG, Mitchell RB, Amin R, Katz ES, Arens R, Paruthi S, Muzumdar H, Gozal D, Thomas NH, Ware J, Beebe D, Snyder K, Elden L, Sprecher RC, Willging P, Jones D, Bent JP, Hoban T, Chervin RD, Ellenberg SS, Redline S; Childhood Adenotonsillectomy Trial (CHAT). A randomized trial of adenotonsillectomy for childhood sleep apnea. *N Engl J Med*. 2013 Jun 20;368(25):2366-76. doi: 10.1056/NEJMoa1215881. Epub 2013 May 21. PMID: 23692173; PMCID: PMC3756808.
- • Marten F, Keuppens L, Baeyens D, Boyer BE, Danckaerts M, Cortese S, Van der Oord S. Sleep parameters and problems in adolescents with and without ADHD: A systematic review and meta-analysis. *JCPP Adv* 2023; 3: e12151 [RCA] [PMID: 37720581]
- • Migueis DP, Lopes MC, Casella E, Soares PV, Soster L, Spruyt K. Attention deficit hyperactivity disorder and restless leg syndrome across the lifespan: A systematic review and meta-analysis. *Sleep Med Rev*. 2023 Jun;69:101770. doi: 10.1016/j.smrv.2023.101770. Epub 2023 Feb 27. PMID: 36924608.
- • Owens J, Weiss M, Nordbrock E, Mattingly G, Wigal S, Greenhill LL, Chang WW, Childress A, Kupper RJ, Adjei A. Effect of Aptensio XR (Methylphenidate HCl Extended-Release) Capsules on Sleep in Children with Attention-Deficit/Hyperactivity Disorder. *J Child Adolesc Psychopharmacol*. 2016 Dec;26(10):873-881. doi: 10.1089/cap.2016.0083. Epub 2016 Oct 18. PMID: 27754700; PMCID: PMC5178023.
- • Owens JA, Babcock D, Weiss M. Evaluation and Treatment of Children and Adolescents With Excessive Daytime Sleepiness. *Clin Pediatr (Phila)*. 2020 May;59(4-5):340-351. doi: 10.1177/0009922820903434. Epub 2020 Mar 13. PMID: 32167377; PMCID: PMC7160754.
- • Pastor P, Reuben C, Duran C, Hawkins L. Association between diagnosed ADHD and selected characteristics among children aged 4-17 years: United States, 2011-2013. *NCHS Data Brief*. 2015 May;(201):201. PMID: 25974000.
- • Sangal RB, Blumer JL, Lankford DA, Grinnell TA, Huang H. Eszopiclone for insomnia associated with attention-deficit/hyperactivity disorder. *Pediatrics*. 2014 Oct;134(4):e1095-103. doi: 10.1542/peds.2013-4221. PMID: 25266438.
- • Thomas R, Sanders S, Doust J, Beller E, Glasziou P. Prevalence of attention-deficit/hyperactivity disorder: a systematic review and meta-analysis. *Pediatrics*. 2015 Apr;135(4):e994-1001. doi: 10.1542/peds.2014-3482. Epub 2015 Mar 2. PMID: 25733754.
- • Tung I, Li JJ, Meza JI, Jezior KL, Kianmahd JS, Hentschel PG, O'Neil PM, Lee SS. Patterns of Comorbidity Among Girls With ADHD: A Meta-analysis. *Pediatrics*. 2016 Oct;138(4):e20160430. doi: 10.1542/peds.2016-0430. Epub 2016 Sep 21. PMID: 27694280; PMCID: PMC9923580.
- • Van der Heijden KB, Smits MC, Van Someren EJ, Ridderinkhof KR, Gunning WB. Effect of melatonin on sleep, behavior, and cognition in ADHD and chronic sleep-onset insomnia. *J Am Acad Child Adolesc Psychiatry*. 2007 Feb;46(2):233-41. doi: 10.1097/01.chi.0000246055.76167.0d. PMID: 17242627.
- • Van Veen MM, Kooij JJ, Boonstra AM, Gordijn MC, Van Someren EJ. Delayed circadian rhythm in adults with attention-deficit/hyperactivity disorder and chronic sleep-onset insomnia. *Biol Psychiatry*. 2010 Jun 1;67(11):1091-6. doi: 10.1016/j.biopsych.2009.12.032. Epub 2010 Feb 16. PMID: 20163790.
- • Wagner ML, Walters AS, Fisher BC. Symptoms of attention-deficit/ hyperactivity disorder in adults with restless legs syndrome. *Sleep*. 2004;27(8):1499-150
- • Waldrop M, Goering JD. Hyperactivity and minor physical anomalies in elementary school children. *Am J Orthopsychiatry*. (1971) 41:602-7. doi: 10.1111/j.1939-0025.1971.tb03219.x
- • Wajszilber D, Santiseban JA, Gruber R. Sleep disorders in patients with ADHD: impact and management challenges. *Nat Sci Sleep*. 2018 Dec 14;10:453-480. doi: 10.2147/NSS.S163074. PMID: 30588139; PMCID: PMC6299464.

References

- • Weiss MD, Surman C, Khullar A, Owens J, He E, Cataldo M, Donnelly G. Effect of a Multilayer, Extended-Release Methylphenidate Formulation (PRC-063) on Sleep in Adolescents with Attention-Deficit/Hyperactivity Disorder: A Randomized, Double-Blind, Fixed-Dose, Placebo-Controlled Trial Followed by a 6-Month Open-Label Follow-Up. *J Child Adolesc Psychopharmacol*. 2021 Nov;31(9):623-630. doi: 10.1089/cap.2021.0087. Epub 2021 Oct 28. PMID: 34714112.
- • Wise MS. Childhood narcolepsy. *Neurology*. 1998;50(2 suppl 1):S37-S42.
- • Wolraich ML, Hagan JF Jr, Allan C, Chan E, Davison D, Earls M, Evans SW, Flinn SK, Froehlich T, Frost J, Holbrook JR, Lehmann CU, Lessin HR, Okechukwu K, Pierce KL, Winner JD, Zurehellen W; SUBCOMMITTEE ON CHILDREN AND ADOLESCENTS WITH ATTENTION-DEFICIT/HYPERACTIVE DISORDER. Clinical Practice Guideline for the Diagnosis, Evaluation, and Treatment of Attention-Deficit/Hyperactivity Disorder in Children and Adolescents. *Pediatrics*. 2019 Oct;144(4):e20192528. doi: 10.1542/peds.2019-2528. Erratum in: *Pediatrics*. 2020 Mar;145(3):e20193997. doi: 10.1542/peds.2019-3997. PMID: 31570648; PMCID: PMC7067282.
- • Wu J, Gu M, Chen S, Chen W, Ni K, Xu H, Li X. Factors related to pediatric obstructive sleep apnea-hypopnea syndrome in children with attention deficit hyperactivity disorder in different age groups. *Medicine (Baltimore)*. 2017 Oct;96(42):e8281. doi: 10.1097/MD.00000000000008281. PMID: 29049225; PMCID: PMC5662391.
- • Wynchank DS, Bijlenga D, Lamers F, Bron TI, Winthorst WH, Vogel SW, Penninx BW, Beekman AT, Kooij JS. ADHD, circadian rhythms and seasonality. *J Psychiatr Res*. 2016 Oct;81:87-94. doi: 10.1016/j.jpsychires.2016.06.018. Epub 2016 Jun 27. PMID: 27423070.
- • Youssef NA, Ege M, Angly SS, Strauss JL, Marx CE. Is obstructive sleep apnea associated with ADHD? *Ann Clin Psychiatry*. 2011 Aug;23(3):213-24. PMID: 21808754.
- • Yu C, Fu Y, Lu Y, Huang Y, Chen F, Wei J, Li L, Ampadu JA, Wang Y, Zheng W, Jiang C, Li W, Lui S, Cai X. Alterations of brain gray matter volume in children with obstructive sleep apnea. *Front Neurol*. 2023 May 16;14:1107086. doi: 10.3389/fneur.2023.1107086. PMID: 37265465; PMCID: PMC10230248.
- • <https://www.iowaclinic.com/specialties/primary-care/pediatrics/18-early-warning-signs-of-adhd-you-can-observe-in-your-children/>
- • https://www.pharmacology2000.com/nursing_pharmacology/Central/sedhyp/NSedative16.htm