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# Delayed sleep phase syndrome in adolescents

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# Objectives

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Gain improved understanding of

- the continuum from normal developmental changes in circadian phase to delayed sleep phase disorder in adolescents
- recommended sleep duration in adolescents and the relationship between sleep duration and health
- the relationship between delayed sleep phase disorder, insomnia, and behavioral independence in adolescents
- treatment strategies for management of delayed sleep phase disorder in adolescents

# Is a phase delay normal for adolescents?

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- A shift of up to 2 hours relative to pre-pubertal sleep-wake cycles is normal<sup>1</sup>. The cause of the phase delay is likely due to
  - 1) Changes in melatonin secretion that parallel shift from “morning” type to “evening” type<sup>2</sup>
  - 2) Homeostatic sleep pressure accumulates more slowly<sup>3</sup>
- DSPS is a likely cause of insomnia in adolescents<sup>4</sup>.
- While a phase delay is statistically normal in adolescents, the current prevalence of delayed sleep phase disorder is much less common (1.1%-4.5% depending on the criteria used).

1. Frey S, Balu S, Greusing S, et al. Consequences of the timing of menarche on female adolescent sleep phase preference. PLoS ONE. 2009;4(4):E5217.
2. Carskadon MA, Acebo C, Jenni OG. Regulation of adolescent sleep: implications for behavior. Ann N Y Acad Sci. 2004;1021:276–291.
3. Jenni OG, Achermann P, Carskadon MA. Homeostatic sleep regulation in adolescents. Sleep. 2005;28(11):1446–1454.
4. Sivertsen B, Pallesen S, Stormark K, et al. Delayed sleep phase syndrome in adolescents: prevalence and correlates in a large population based study. BMC Public Health 2013;13:1163-1173.

# Inter-individual variability in sleep timing for adolescents

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- There are individual differences in blue light responsiveness<sup>1</sup> which likely contribute to the magnitude of the phase shift.
- A variant of the RNA-binding protein for the RBFOX3 gene may combine with the normal phase delay to produce DSPS<sup>2</sup>

1. Wisse P, van der Meijden M, Van Someren J, et al. Individual differences in sleep timing relate to melanopsin-based phototransduction in healthy adolescents and young adults. *Sleep* 2016;39:1305-1310.
2. Amin N, Allebrandt K, van der Spek, A, et al. Genetic variants in RBFOX3 are associated with sleep latency. *Eu J of Human Genetics* 2016;24:1488-1495.

# How much sleep do adolescents need?

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- A joint task force from the AASM, AAP, and CDC performed a thorough review of the literature and recommended that teens age 13-18 should sleep 8-10 hours per 24 hours on a regular basis to promote optimal health<sup>1</sup>.
- Topic areas covered in the systematic review included cardiovascular health, developmental health, human performance, immunology, longevity, mental health, metabolic health, cancer, and pain<sup>2</sup>.

1. Paruthi S, Brooks LJ, D'Ambrosio C, et al. Recommended amount of sleep for pediatric populations: a consensus statement of the American Academy of Sleep Medicine. *J Clin Sleep Med*. 2016;12(6):785–786.
2. Paruthi S, Brooks L, D'Ambrosio C, et al. Consensus statement of the American Academy of Sleep Medicine on the recommended amount of sleep for healthy children: Methodology and discussion. *J Clin Sleep Med* 2016, 12(11):1549-1561.

# Is it normal for adolescents to be sleepy?

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- Clinical vs. statistical “normal” sleep propensity
- Older (Tanner stage 3-5) adolescents are sleepier than younger adolescents<sup>1</sup>
- 48% of adolescents have at least one SOREMP<sup>2</sup>
- Very little normative data on MSLTs in adolescents but more than one SOREMP is abnormal<sup>3</sup>

1. Carskadon M, Harvey K, Duke P, et al. Pubertal changes in daytime sleepiness. *Sleep* 1980;2:453-460.
2. Carskadon M, Wolfson A, Acebo C, et al. Adolescent sleep patterns, circadian timing, and sleepiness at a transition to early school days. *Sleep* 1998;21:871-881.
3. Kotagal S, Nichols C, Grigg-Damberger M, et al. Non-respiratory indications for polysomnography and related procedures in children: An evidence-based review. *Sleep* 2012;35:1451-1466.

# Is there any harm in being a sleep-deprived adolescent?

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- When sleep-deprived (6.5 hours in bed) for 5 consecutive nights, normal adolescents demonstrated symptoms similar to ADHD<sup>1</sup>
  - Lower academic performance
  - Inattentive behavior
  - Lower arousal
- Inconsistent sleep patterns between weekdays and weekends are associated with increased truancy, substance use, and mood disorders<sup>2</sup>

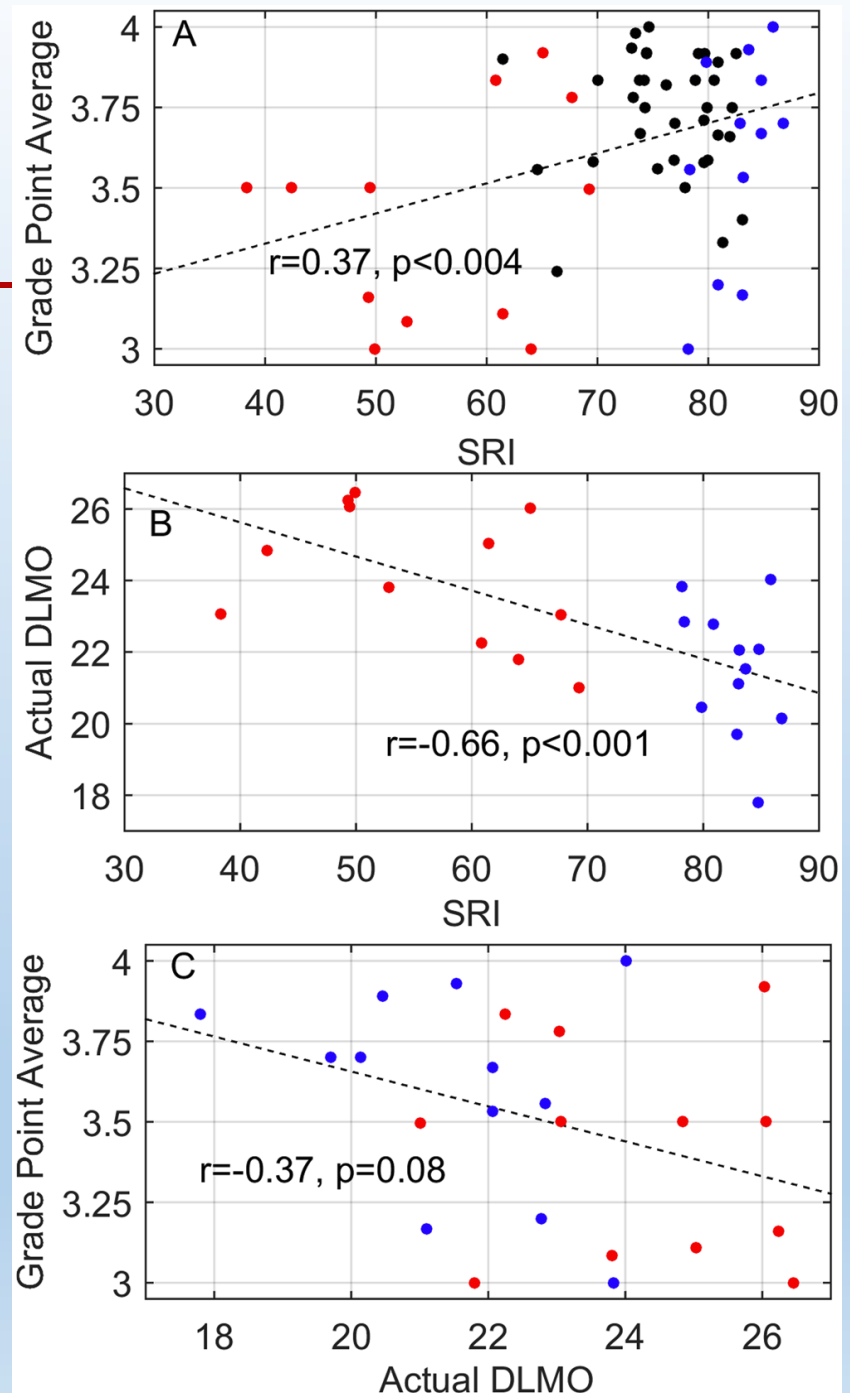
1. Beebe D, Rose D, Amin R. Adolescent health brief: Attention, learning, and arousal of experimentally sleep-restricted adolescents in a simulate classroom. *J. Adolesc Health* 2010;47:523-525.
2. Pasch K, Laska M, Lytle L. Adolescent sleep, risk behaviors, and depressive symptoms: Are they linked? *Am J. Health Behav* 2010;34:237-248.



# Irregular sleep-wake patterns and academic performance

Phillips A, Clerx W, O'Brien C, et al. Irregular sleep/wake patterns are associated with poorer academic performance and delayed circadian and sleep/wake timing. Nature: Scientific reports DOI:10.1038/s41598-017-03171-4.

SRI=sleep regulatory index=%probability of an individual being in the same state (awake or asleep) at any two points in time 24 hours apart.



# Treatment of DSPS in adolescents

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- Evaluation and treatment of comorbid sleep disorders
- Evaluation and interventions for mood disorders, substance use disorders, and environmental/social stress
- Sleep hygiene/sleep education
- Fixed sleep schedule
- CBT
  - Adolescents often pretend to understand when they really don't
  - Adolescents often understand when you think they really don't
  - Consider both self-administered and parent-administered rewards for regularization of sleep patterns and adherence to treatment
  - Appeal to appearance (you look better when you sleep better)
- Light therapy
- Melatonin

# Delayed school start times

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- A start time of 10am for high school greatly reduced illness and improved academic performance<sup>1</sup>.
- Earlier start times are associated with increased risk of car crashes, and later start times reduced car crashes<sup>2</sup>.
- AASM position statement is that middle school and high school start times should be 8:30am or later<sup>3</sup>.

1. Kelley P, Lockley S, Kelley J. Is 8:30am still too early to start school? *Frontiers in Human Neuroscience* 2017;11: doi: 10.3389/fnhum.2017.00588.
2. Vorona R, Szklo-Coxe M, Lamichhane R, et al. Adolescent crash rates and school start times in two central Virginia counties, 2009-2011. *J Clin Sleep Med* 2014;10:1169-1177.
3. Watson N, Martin J, Wise M, et al. Delaying middle school and high school start times promotes student health and performance: An American Academy of Sleep Medicine Position Statement. *J Clin Sleep Med* 2017;13:623-625.

# Melatonin

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- Treatment of children with melatonin has been controversial because high nocturnal levels of melatonin from exogenous melatonin may delay puberty<sup>1</sup>.
- No evidence that low dose melatonin (average dose 2.69 mg) is unsafe or disturbs puberty onset<sup>2</sup>.
- Individual response is variable.
- Best use for melatonin in DSPD is probably as an adjunct to phototherapy with fixed sleep-wake schedule.

1. Srinivasan V, Spence W, Pandi-Perumal S, et al. Melatonin and human reproduction: shedding light on the darkness hormone. *Gynecol Endocrinol* 2009;25:79-785.
2. van Geijlswijk I, Mol R, Toine C, et al. Evaluation of sleep, puberty and mental health in children with long-term melatonin treatment for chronic idiopathic childhood sleep onset insomnia. *Psychopharmacology* 2011;216:111-120.

# CBT plus light therapy

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- In an RCT, CBT plus light therapy is effective and resulted in an increase in total sleep time during the school week of 1 hour<sup>1</sup>.
- Shifts toward morningness are associated with improvement in both mood and sleep quality<sup>2</sup>.
- Adolescents with DSPD may be less sensitive to morning light than those without DSPD<sup>3</sup>.

1. Gradisar M, Dohnt H, Gardner G, et al. A randomized controlled trial of cognitive-behavioral therapy plus bright light therapy for adolescent delayed sleep phase disorder. *Sleep* 2011;34:1671-1680.
2. Hasler B, Buysse D, Bermain A. Shifts towards morningness during behavioral sleep interventions are associated with improvements in depression, positive affect, and sleep quality. *Behav Sleep Med* 2016;14:624-635.
3. Auger R, Burgess H, Dierkhising R et al. Light exposure among adolescents with delayed sleep phase disorder: a prospective cohort study. *Chronobiol Int* 2011;28:911-920.

# Is it the light, the dark, the fixed schedule, or the interaction between these factors that works?

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- Morning blue light and morning dim light both shifted DLMO in young adults with delayed sleep phase, when combined with a fixed early sleep schedule<sup>1</sup>.
- Light timed after the minimum core body temperature in the morning leads to a phase advance<sup>4</sup>
- In adults, when sleep is truncated by waking early, the circadian clock will phase advance<sup>2</sup> but this may not happen in adolescents.
- Even brief (240 ms) flashes of bright light over a 1 hour period in a sleeping person shifts salivary melatonin<sup>3</sup>.

1. Sharkey K, Carskadon M, Figueiro M, et al. Effects of an advanced sleep schedule and morning short wavelength light exposure on circadian phase in young adults with late sleep schedules. *Sleep Med* 2011;12:685-693.
2. Burgess H, Eastman C. A late wake time phase delays the human dim light melatonin rhythm. *Neurosci Lett* 2006;395:191-195.
3. Zeitzer J, Fiscaro R, Ruby N. Millisecond flashes of light phase delay the human circadian clock during sleep. *J Biol Rhythms* 2014;29:370-376.
4. St Hilaire MA, Gooley JJ, Khalsa SB, et al. Human phase response curve to a 1 h pulse of bright white light. *J Physiol* 2012;590:3035-45

# Sleep environment in the home

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- Children and adolescents have better age-appropriate sleep in the presence of household rules for<sup>1</sup>
  - Limited caffeine
  - Regular bedtime
  - No devices on in the bedroom after bedtime
- Exposure to blue-enriched light common on LED screens, even at low intensity, suppresses melatonin<sup>2</sup>.
- Media also tends to
  - Replace time sleeping
  - Produce cognitive and emotional stimulation

1. Buxton O, Chang A, Spilsburgh J. Sleep in the modern family: protective family routines for child and adolescent sleep. *Sleep Health* 2015;1:15-27.
2. Chang A, Aeschbach D, Duffy JF, et al. Impact of evening use of light-emitting electronic readers on circadian timing and sleep latency. *Sleep*. 2012; 35:A206.

# Case examples

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- Implementation of a fixed sleep schedule with gradual phase advance
- Light therapy applications
- RLS and comorbid DSPD
- Family stress initially presenting as DSPD
- PTSD with nightmares and sleep avoidance
- Anxiety disorder with OCPD



# Questions?

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