



Sleep Health Advisory Committee Report from the Research Task Group

November 9, 2022

Review of Research:

*Positive impact of delayed school
start times*



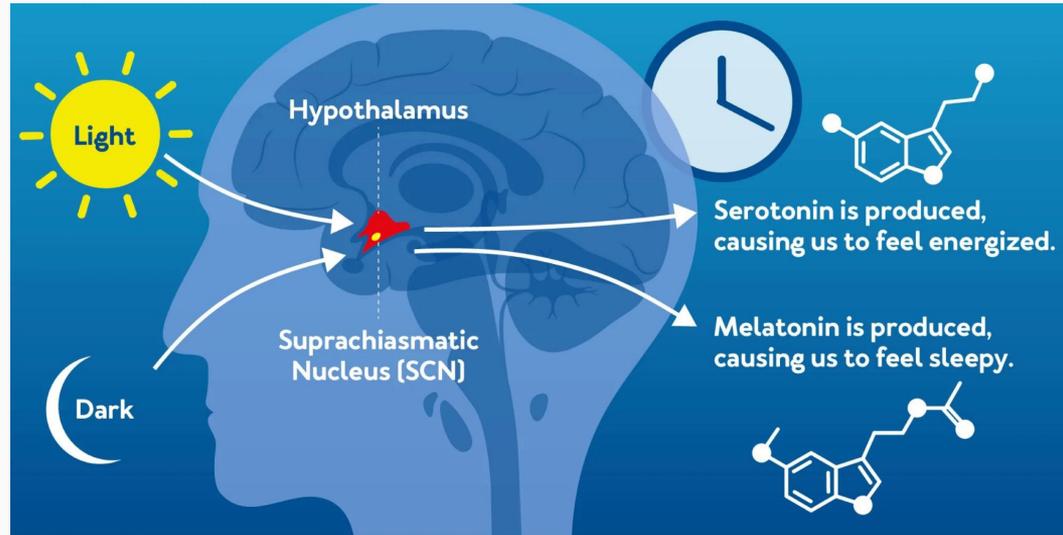
Key topics:

- Biology of sleep
- Sleep hygiene
- Impact on health
- Impact on academic performance
- Impact on student safety
- Potential importance for our Shrewsbury district

Circadian rhythm ₁

'circa diem' - around a day

- Internal time-keeping system that helps regulate sleep-wake cycle and other metabolic processes
- Run by our hypothalamus (body temp, thirst, hunger, etc.)
- This 'clock' doesn't have a perfect 24 hour period
- Delays of 1-3 hrs in puberty, which drives later bedtimes, later wake time ₄

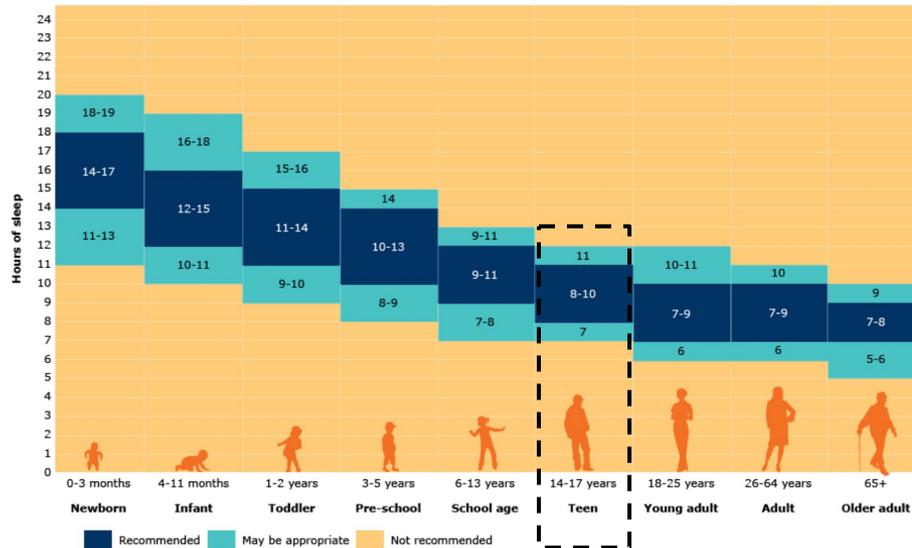


Delayed Sleep-Wake Phase Disorder

- The most common circadian rhythm disturbance in adolescents and young adults ₂
- Marked by a delay in circadian phase ₃
 - Promotes wakefulness until later at night
 - Drives sleep later into the morning
- Associated with negative outcomes
 - Lower grades
 - Alcohol and tobacco use
 - Elevated anxiety and depression scores ₂

'Best practice' recommendations: NSF, AASM

Sleep duration recommendations by age from the National Sleep Foundation*



* These recommendations are very similar, but not identical to those from the American Academy of Sleep Medicine (AASM).^[1,2]

Recommended sleep times for children

Age group	Recommended sleep time
Infants 4 to 12 months	12 to 16 hours (including naps)
Toddlers 1 to 2 years	11 to 14 hours (including naps)
Children 3 to 5 years	10 to 13 hours (including naps)
Children 6 to 12 years	9 to 12 hours
Teens 13 to 18 years	8 to 10 hours

For optimal health, daytime functioning, and development, the above sleep times are recommended on a regular basis. These consensus recommendations were made by the American Academy of Sleep Medicine^[1] and endorsed by the American Academy of Pediatrics^[2].

Sleep Hygiene

Sleep Hygiene = *healthy sleep habits*

Evidence-based practices:

1. Communication between caregivers and children/teens
2. Caregiver involvement in the sleep routine
3. Enough time for sleep
4. Establish and keep consistent bedtime routines
5. Limit technology prior to bedtime



Sleep Hygiene

Best practices...

1. Waking up at the same time each day
2. Changing the bedroom environment
3. Eating habits prior to bed
4. Caffeine intake
5. Physical activity



School Start vs. Sleep Time: University of Minnesota Study

- 9,000+ high school students
- 3 states, 5 districts, 8 public high schools
- Later start times associated with more high school students getting 8+ hours of sleep

Table 4. Percent of High School Students Sleeping At Least 8 Hours Per School Night by School Start Time

School Start Time	7:30 AM	7:35 AM	8:00 AM	8:00 AM	8:05 AM	8:20 AM	8:35 AM	8:35 AM	8:35 AM	8:55 AM
School Year	2010-2011	2011-2012	2011-2012	2010-2011	2011-2012	2010-2011	2010-2011	2010-2011	2010-2011	2012-2013
District & State	Boulder Valley School District, CO	Teton County Schools, WY	Boulder Valley School District, CO	Mahtomedi School District, MN	Boulder Valley School District, CO	St. Louis Park High School, MN	South Washington Co., MN	South Washington Co., MN	South Washington Co., MN	Teton County Schools, WY
School	Fairview High School	Jackson Hole High School	Boulder High School	Mahtomedi High School	Fairview High School	St. Louis Park High School	Woodbury High School	East Ridge High School	Park High School	Jackson Hole High School
Sample Size	333	446	1379	884	1353	902	1249	960	1407	459
Sleep ≥ 8 hours/night	33.6%	44.2%	44.5%	49.7%	42.5%	49.8%	57.0%	58.9%	60.0%	66.2%

Benefits of later start times: Denver, Colorado Study

- Observational study: elementary school (ES), middle school (MS), and high school (HS) students
- Surveyed before and after change in start time
- 24,000 - 30,000 students surveyed each year

	Pre-change	Post-change (6 months)	Follow-up (18 months)	Post-Pre Difference	Key points
ES (Grades 3-5) : school start time change was 60 minutes earlier					
Weekday bedtime	21:13	21:01	21:02	- 12 minutes	ES experienced earlier bedtimes
Weekday duration	9.87 hours	9.69 hours	9.67 hours	- 11 minutes	11 minute difference not clinically meaningful
Weekend oversleep	14 minutes	26 minutes	28 minutes	+ 12 minutes	Minimal increase in weekend oversleep
MS (Grades 6-8) : school start time change was 40 to 60 minutes later					
Weekday bedtime	21:49	21:58	21:59	+ 9 minutes	Students are not staying up much later
Weekday duration	8.63 hours	9.11 hours	9.06 hours	+ 29 minutes	Total of an extra 2.4 hours of sleep per week
Weekend oversleep	1.13 hours	0.60 hours	0.64 hours	- 32 minutes	Decreased need to “catch-up” on sleep on weekends
HS (Grades 9-12) : school start time change was 70 minutes later					
Weekday bedtime	22:23	22:37	22:46	+ 14 minutes	Students are not staying up much later
Weekday duration	7.39 hours	8.14 hours	7.99 hours	+ 45 minutes	Total of an extra 3.8 hours of sleep per week
Weekend oversleep	2.05 hours	1.21 hours	1.28 hours	-77 minutes	Decreased need to “catch-up” on sleep on weekends

Impact on Mental Health

Researchers who study the relationship between sleep and depression are unanimous:

Adequate sleep could greatly improve many U.S. teenagers' mental health

- Research shows a strong connection between poor sleep habits and symptoms of depression: in a 2019 study, Widome and colleagues showed that 1 in 3 students who slept < 6 hours per night had a higher number of depression symptoms compared with about 1 in 10 students who got 8+ hours
- Insufficient sleep and daytime sleepiness seem to have the most robust relationship with mood dysregulation, poor-quality sleep and irregular sleep patterns are also associated with depressed mood
- Recent studies have focused on the relationship between sleep and suicidal ideation: sleeping < 8 hours / night seems to be associated with a nearly 3x increased risk of suicide attempts

Addiction

- Diagnosing and treating primary sleep disorders, particularly in adolescents, can prevent the development of addiction in susceptible individuals
- Studies in scientific journals suggest the relation is bi-directional and review evidence showing that sleep/alertness disturbance affects all phases of the addiction cycle, including the initiation, maintenance and relapse of substance use disorder



Attention Deficit Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD)

- Strong association of evening chronotype with behavioral problems, severity of ASD, ADHD symptoms
- Found stat sig ($p < .05$ to $p < .001$) association with multiple sleep disorders; co-morbid anxiety, depression
- Less sleep could exacerbate problematic behaviors associated with ADHD and ASD

Table 2 Differences in sleep problems between ADHD, ASD, and controls

	ADHD (N = 44)	ASD (N = 67)	Control (N = 243)	p
DIMS	11.05 (4.13)	12.06 (3.69)	8.74 (2.78)	ADHD and ASD > Control***
SBD	4.20 (1.46)	4.25 (1.69)	3.98 (1.17)	NS
DA	4.02 (1.49)	4.25 (1.52)	3.70 (1.12)	ASD > Control**
SWTD	10.91 (4.01)	10.62 (3.79)	9.00 (2.59)	ADHD and ASD > Control***
DES	9.00 (3.20)	8.91 (2.73)	7.44 (2.06)	ADHD and ASD > Control***
SHY	3.75 (2.16)	3.71 (1.94)	2.97 (1.43)	ADHD > Control* and ASS > Control**
TSP	42.93 (10.99)	43.74 (9.79)	35.83 (7.22)	ADHD and ASD > Control***
Prevalence ^a	28 (63.6%)	44 (64.7%)	61 (25.1%)	ADHD and ASD > Control***

Values are means and standard deviations

DIMS Disorders of initiating and maintaining sleep, *SBD* sleep breathing disorders, *DA* disorders of arousal, *SWTD* sleep-wake transition disorders, *DES* disorders of excessive somnolence, *SHY* sleep hyperhidrosis, *TSP* total sleep problem score

NS not significant ($p > 0.05$)

* Significant at the 0.05 level

** Significant at the 0.01 level

*** Significant at the 0.001 level

^a Prevalence: total score >39

Physical Health Challenges

- Lack of sleep is a contributor to obesity in adolescents: impacts on eating and activity behaviors (Jean-Philippe Chaput* and Caroline Dutil).
- A 2010 study at an independent high school in Rhode Island found that after delaying the start time by just 30 minutes, students did sleep more and showed significant improvements in alertness and mood.
- Longer sleep duration was associated with lower adiposity indicators, better emotional regulation, better academic achievement, and better quality of life/well-being in that review.

Impact on Academic Performance: Grades

- Measured GPA difference after instituting later school start time
- Overall there was an increase in GPA across the board; although, in some scenarios, there was no significant change (Wahlstorm et al., 2014)

Grade Level	District/School					
	Fairview	Boulder	Mahtomedi	Saint Louis Park	South Washington County	Jackson Hole High School
All Grades	Increase	Increase	Increase, Decrease	<i>ns</i>	Increase, Decrease	Increase
9 th Grade	Increase	N/A	Increase, Decrease	N/A	N/A	Increase
10 th Grade	<i>ns</i>	N/A	Increase, Decrease	N/A	Increase	Increase
11 th Grade	Increase	N/A	Increase	N/A	Increase	Increase
12 th Grade	Increase	N/A	Increase, Decrease	N/A	Increase	Increase

Impact on Academic Performance: Test Scores

- Measured difference in standardized test scores after instituting later start times
- Overall trend shows an increase, although minor and not statistically significant (Wahlstorm et al., 2014)

Table 38. Independent group comparisons of standardized test scores. Subject areas with observed changes are reported. Significant findings are in **Bold**. More details are available in Appendices C-H.

Test/Tested Subject	District/School					
	Fairview	Boulder	Mahtomedi	Saint Louis Park	South Washington County	Jackson Hole High School
Math	<i>ns</i>	<i>ns</i>	N/A	<i>ns</i>	Increase	Decrease
Reading	<i>ns</i>	<i>ns</i>	N/A	<i>ns</i>	<i>ns</i>	<i>ns</i>
Writing	Decrease	<i>ns</i>	N/A	<i>ns</i>	<i>ns</i>	<i>ns</i>
Science	<i>ns</i>	<i>ns</i>	N/A	Not Tested	<i>ns</i>	<i>ns</i>
Composite (ACT or PLAN)	<i>ns</i>	Increase	Increase	<i>ns</i>	<i>ns</i>	<i>ns</i>

*Note: *ns* = Not significant; N/A = Change in scoring scales; Not Tested = No test administered in that area

Student Safety

Data is from 2013-2022

[MassDOT: Crash Data Portal \(state.ma.us\)](https://state.ma.us)

8,513 Total Crashes

Fatal Injury Crashes

* **23**

Serious Injury Crashes

🚑 **118**

Minor Injury Crashes

🚶 **653**

Possible Injury Crashes

❓ **706**

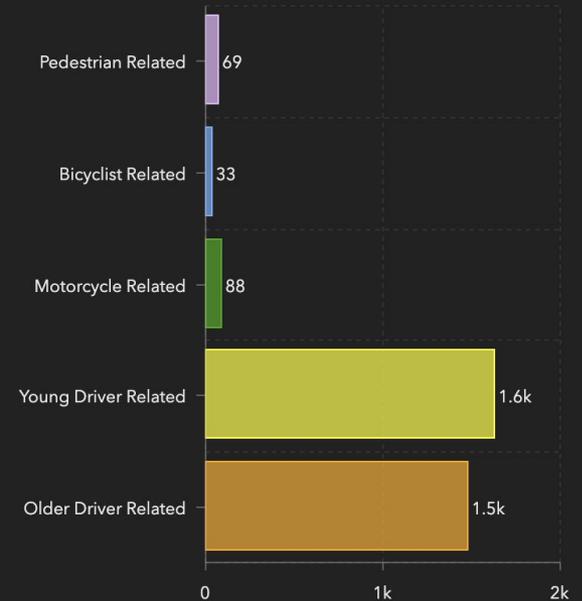
No Injury Crashes

⚠️ **6,645**

Other Crashes (unknown, not reported, etc.)

⚠️ **368**

Crash Type Summary



Delayed Start Times and Teen Motor Vehicle Crash (MVC) Rates: Cherry Creek School District (Colorado) Study

Daytime drowsiness survey of 10th and 11th grade CCSD students

School start time was delayed 70 minutes (7:10 am to 8:20 am)

Compared Colorado Department of Transportation data on teen MVC rates from 2015-2019 for CCSD (Arapahoe County) and three neighboring counties where no school start time change had been made. They found:

- **Less Frequent Drowsy Driving Post-Change** = 10.7% [9.8% at follow up] *less than baseline*
- **Significant Decrease in Weekday, Teen MVC Rates** = *specifically afternoon, rear-end crashes – the kinds of crashes involving drowsy drivers*
- **Reduction in Daytime Drowsiness and MVC Rates Maintained Two Years Later** = *suggesting the staying power of the policy change*

Delayed Start Times and Teen Motor Vehicle Crash (MVC) Rates: Virginia County Study

Vorona et al. (2014) compared teen MVC rates in two Virginia counties (one with an earlier school start time, and one delayed 85 minutes). They found:

- **Significant MVC Rate Reduction Post Change = 48.8/1,000 versus 37.9/1,000; $p=0.04$**
- **Reduction in Crash Rates Maintained Four Years Later = authors replicated their previous two-year study to generate four total years of evidence**

Vorona, R.D., Szklo-Coxe, M., Lamichhane, R., Ware, J.C., McNallen, A., & Leszczyszyn, D. (2014). Adolescent crash rates and school start times in two central Virginia counties, 2009-2011: A follow-up study to a southeastern Virginia study, 2007-2008. *Journal of Clinical Sleep Medicine*, 10(11), 1169-1177E.

Delayed Start Times and Sports Injuries: *Consumer Health News* Preliminary Study

Consumer Health News (2012) warns that sleep deprivation yields an increased risk of sports injuries in teens. In a study of 112 California middle and high-school-aged teenage athletes, the researchers found:

- **Sleep Deprivation = Increased Risk of Teen Sports Injuries**
- **Athletes who Slept 8+ hours Versus Peers Who Did Not = 68% less likely**
- **As Student Athletes Age, 2.3X More Likely To Get Hurt than younger peers**

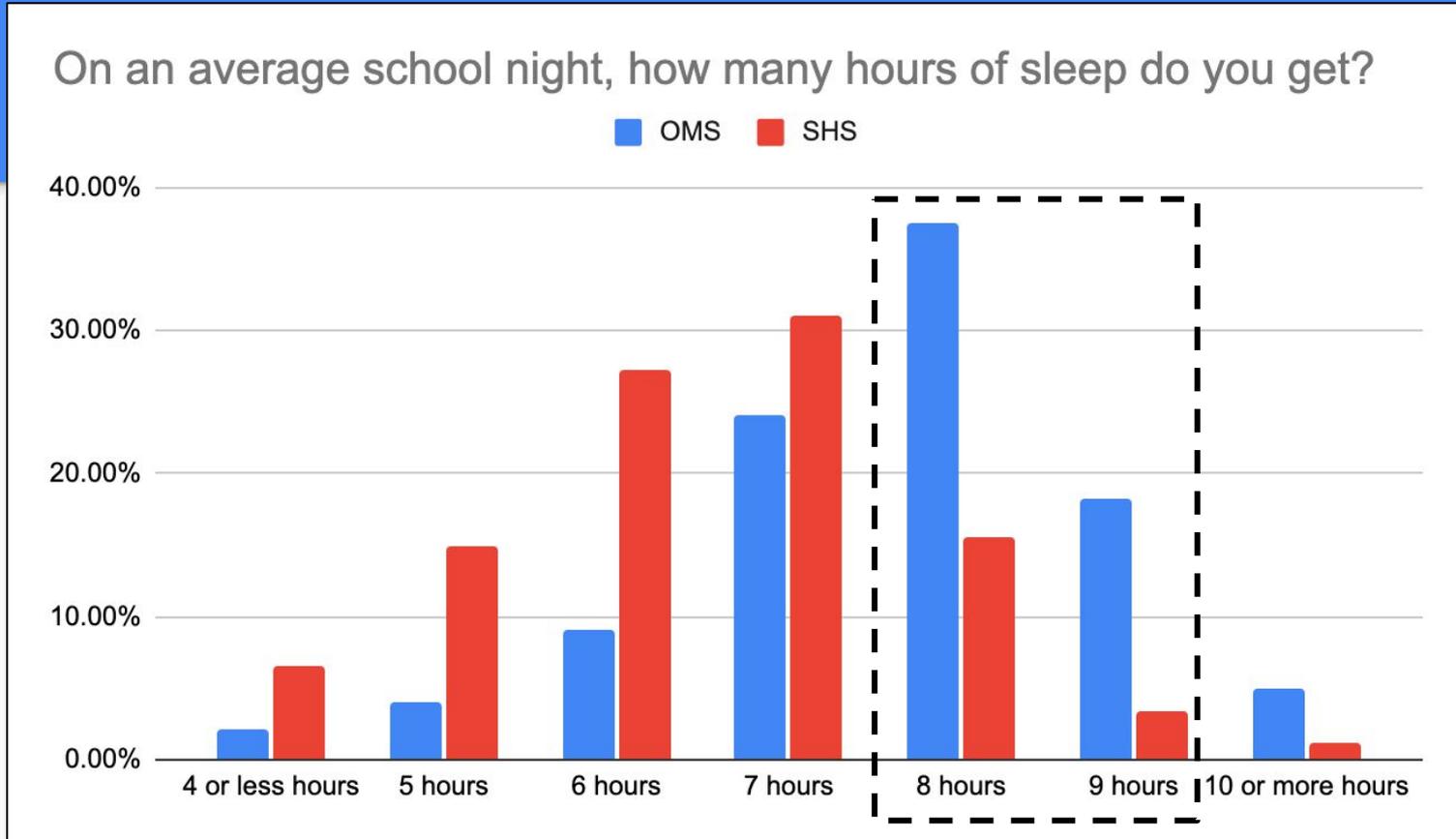
Consumer Health News (2012). Lack of sleep may trip up student athletes; Less shuteye, higher grades linked to increased injuries in study. link.gale.com/apps/doc/A305988965/ITOF?u=mliin_n_umass&sid=ebsco&xid=49647605

Why does this connect to Shrewsbury?

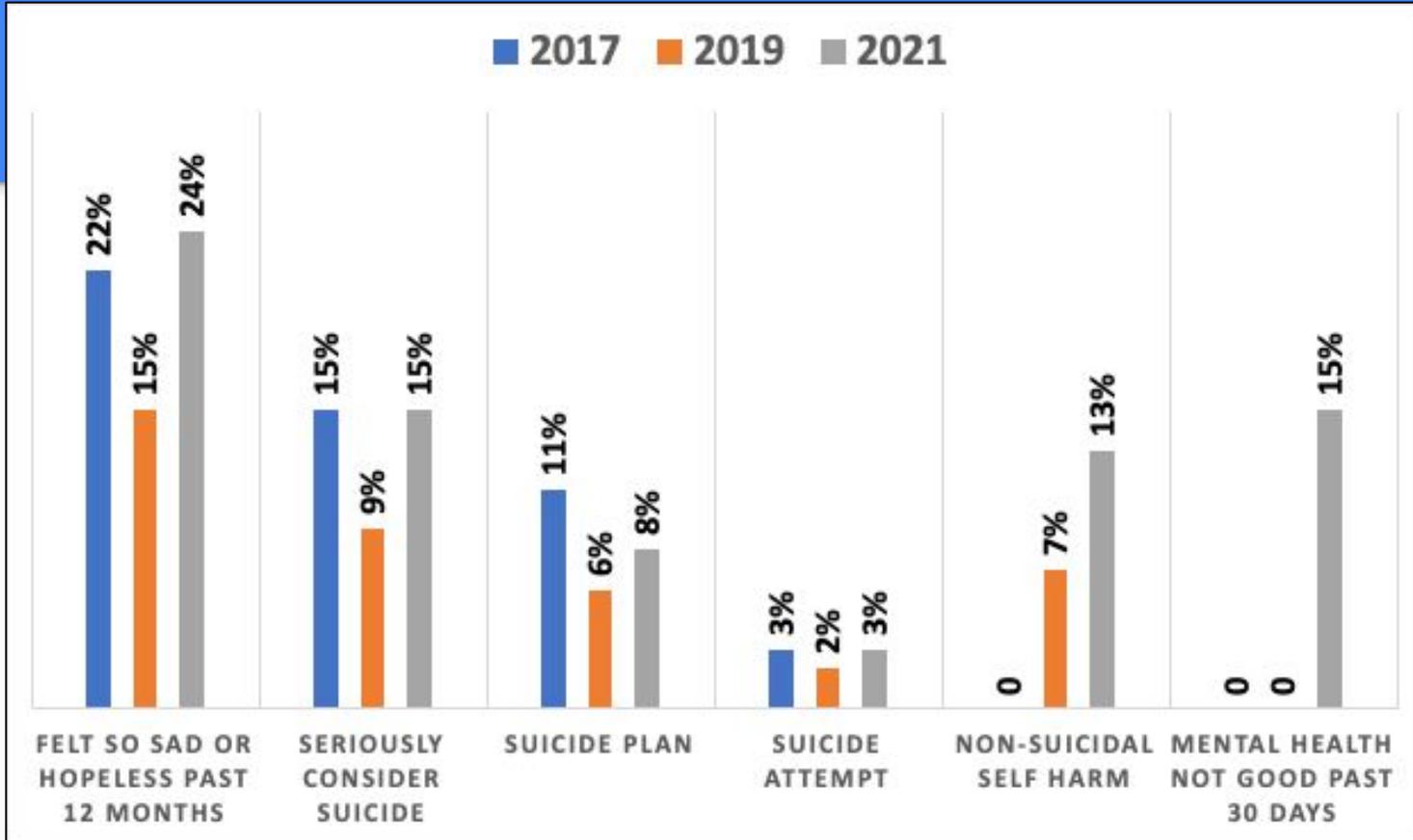
Let's review some of the Shrewsbury Public School screening data from the Regional Youth Health Survey (RYHS).

- Sleep
- Mental Health

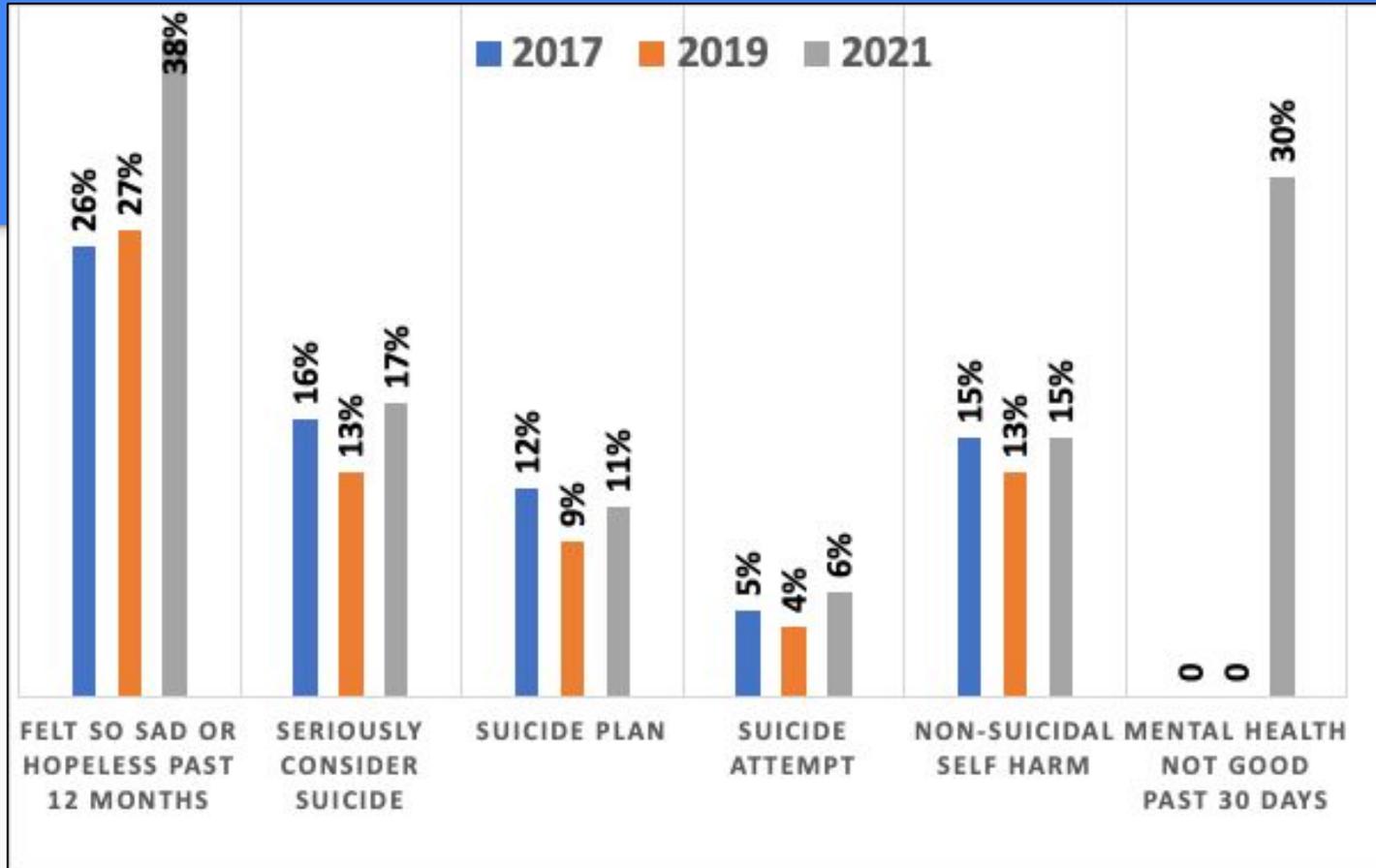
Sleep Habits - OMS and SHS



Mental Health Trends - OMS



Mental Health Trends - SHS



Taken with permission from the 5/4/2022 School Committee Slides

Conclusions

1. Data from scientific journals show clear signals that sleep debt + shift to evening chronotype adversely impacts high school students
 - a. Mental well being (depression, anxiety, suicidal ideation)
 - b. Physical disease (obesity, diabetes)
 - c. Behavioral disorders (exacerbates ADHD, ASD)
2. Trends in data also suggest negative impact / increased risk in other areas
 - a. Academics
 - b. General safety (e.g. car accidents)
 - c. Long-term health issues
3. Limitations
 - a. Clear signals in data, but more studies required to confirm
 - b. Relies heavily on 'meta analysis': analyses of multiple studies, which means data sets may not be directly comparable due to different study designs, statistical analyses, student demographics, etc.

Recommendations

1. Continue analyses of other factors and dynamics that would be affected by shifting school start times
 - a. Logistics
 - b. Budget
 - c. Child Care
2. Engage with stakeholders outside of the Shrewsbury school district to get 'their take'
 - a. Neighboring districts / districts with comparable demographics
 - b. Subject matter experts / KOLs in the field of sleep requirements for youth across various developmental stages
3. Consider any future shift in school start times for interventional 'pre-post' studies
 - a. Measure mental well being, physical health, etc. prior to the delayed start time; take same measurements during and after delayed start time to show differences (improvements or challenges)
 - b. Collect data on safety, hours of sleep prior to, during, and post-delayed start to see trends over time

Questions or Comments?



References (Biology of Sleep)

1. Allada and Bass Circadian Mechanisms in Medicine N Engl J Med 2021; 384:550-561
2. Saxvig Prevalence and correlates of delayed sleep phase in high school students Sleep Med. 2012 Feb;13(2):193-9. Epub 2011 Dec 6
3. American Academy of Sleep Medicine Intl Classification of Sleep Disorders, 3rd ed
4. Hagenauer Adolescent changes in the Homeostatic and Circadian Regulation of Sleep Dev Neurosci. 2009 Jun; 31(4): 276–284

References (Mental Health)

1. Insufficient Sleep in Adolescents and Young Adults: An Update on Causes and Consequences Judith Owens, ADOLESCENT SLEEP WORKING GROUP and COMMITTEE ON ADOLESCENCE Pediatrics 2014;134:e921 DOI: 10.1542/peds.2014-1696
2. Andrew J. Fuligni et al., "Individual Differences in Optimum Sleep for Daily Mood During Adolescence," Journal of Clinical Child and Adolescent Psychology 48, no. 3 (2019): 469-79.
3. Reference: Schools Start Too Early | Sleep and Sleep Disorders | CDC

References (Mental Health)

4. Policy Statement School Start Times for Adolescents

www.pediatrics.org/cgi/doi/10.1542/peds.2014-1697 doi:10.1542/peds.2014-1697
PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275)

5. Aaron T. Berger, Kyla L. Wahlstrom, Rachel Widome, “Relationships Between Sleep Duration and Adolescent Depression: A Conceptual Replication,” *Sleep Health* 5, no. 2 (2019): 175-9, doi:10.1016/j.sleh.2018.12.003.

6. Addiction and Sleep Disorders Jonathan Ek 1 , William Jacobs 2 , Brett Kaylor 2 , W Vaughn McCall 2 PMID: 33537944 DOI: 10.1007/978-3-030-61663-2_12 *Adv Exp Med Biol.* 2021;1297:163-171. doi: 10.1007/978-3-030-61663-2_12.

7. Sleep and alertness disturbance and substance use disorders: A bi-directional relation Timothy Roehrs 1 , Mohammad Sibai 2 , Thomas Roth 3 Affiliations expand PMID: 3358209 PMCID: PMC7996967 DOI: 10.1016/j.pbb.2021.173153 2021 Apr;203:173153. doi: 10.1016/j.pbb.2021.173153. Epub 2021 Feb 12.

References

- Consumer Health News (2012). Lack of sleep may trip up student athletes; Less shuteye, higher grades linked to increased injuries in study. link.gale.com/apps/doc/A305988965/ITOF?u=mlyn_n_umass&sid=ebsco&xid=49647605
- Meltzer, L. J., Plog, A. E., Swenka, D., Reeves, D., & Wahlstrom, K. L. (2022). Drowsy driving and teen motor vehicle crashes: Impact of changing school start times. *Journal of Adolescence*, *94*, 800–805. <https://doi.org/10.1002/jad.12053>.
- Perfect, M. M. & Frye, S. S. (2018). Sleep Problems: Helping Handout for Home. National Association of School Psychologists.
- Swaab H et al. ECAP 2018 (AASM)
- Vorona, R.D., Szklo-Coxe, M., Lamichhane, R., Ware, J.C., McNallen, A., & Leszczyszyn, D. (2014). Adolescent crash rates and school start times in two central Virginia counties, 2009-2011: A follow-up study to a southeastern Virginia study, 2007-2008. *Journal of Clinical Sleep Medicine*, *10*(11), 1169-1177E.
- Wahlstorm, K. L., Dretzke, B. J., Gordon, M. F., Peterson, K., Edwards, K., & Gudla, J. (2014, February). Examining the impact of later high school start times on the health and academic performance of high school students: A multi-site study. University of Minnesota. <https://files.eric.ed.gov/fulltext/ED596205.pdf>.
- Wise MS et al. JCSM 2016