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Targeting Sleep Duration and Timing for Prevention of Adolescent Obesity

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Adolescent obesity is highly prevalent,[1] but there is mounting evidence that this public health problem can be partly addressed by targeting improvements in sleep patterns. Currently, 58% of middle school-aged children and 78% of high school-aged adolescents sleep insufficiently.[2,3] Meta-analyses of cross-sectional studies indicate that shorter sleep duration is associated with up to an 80% increased likelihood of childhood obesity.[4,5] Longitudinal studies, providing evidence of temporality, report that adolescents with shorter sleep durations are more likely to have higher body mass index growth trajectories,[6] and a meta-analysis reported that shorter sleep duration was associated with a 2-fold increased risk of developing obesity in childhood.[7] These data support the need for the experimental evaluation of sleep extension interventions for the prevention and treatment of adolescent obesity. However, sleep is multidimensional and few studies have examined whether sleep traits other than duration also contribute to adolescent obesity and related cardiometabolic risk. Sleep timing traits are of particular interest, given that circadian rhythms have been linked to metabolism and weight regulation.

In this issue of *JAMA Pediatrics*, Cespedes Feliciano et al[8] helped to address this gap by testing whether sleep timing traits were associated with fat mass and cardiometabolic risk factors in a large cross-sectional sample of adolescents (N = 804; aged 12-17 years; 52.0% female) enrolled in Project Viva, a cohort study of mother-child dyads from Massachusetts. Self-reported evening chronotype, a pattern characterized by a later bedtime and later awakening, was associated with higher fat mass in girls. Furthermore, the participants wore an actigraphy device on their wrist for 1 week that allowed for an objective estimate of the sleep timing trait "social jet lag" (the midsleep point difference between weekend nights and weekday nights). Again, a sex difference was observed: later sleep mid-point on weekend nights, relative to weeknights, was associated with higher fat mass in girls. More important,

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the fat mass associations described for chronotype and social jet lag were attenuated, but remained, after adjustment for sleep duration. These results indicate that sleep timing needs to be considered for the prevention and treatment of adolescent obesity, particularly among girls. No associations were observed between these sleep timing traits and cardiometabolic markers.[8]

These findings build on the extensive epidemiologic data linking shorter sleep duration with adolescent obesity. A critical next step is to ensure that the findings regarding sleep duration and sleep timing are integrated so that overall sleep patterns are optimized to help manage adolescent weight status. For example, a prior Project Viva study reported an association between shorter sleep duration and higher fat mass among adolescents of both sexes.[9] However, no sleep timing trait was included as a covariate in that prior study, so it is not known if the sleep duration associations with fat mass are independent of sleep timing. Given the findings of the present study by Cespedes Feliciano et al,[8] future studies should consider adjusting for sleep timing when investigating the association between sleep duration and cardiometabolic outcomes. It may also be of interest to test for interactions between sleep duration and sleep timing traits to determine if there are optimal combinations of sleep duration and timing to ideally help prevent or treat adolescent obesity. Otherwise, it will be challenging to translate these findings into effective sleep intervention approaches. Should we primarily target sleep duration extension in adolescents? Or would it be more efficacious for weight management to primarily focus on aligning adolescents' sleep periods with their sleep timing preferences? Given substantial intraindividual variability in pediatric sleep patterns, optimal combinations may also depend on other characteristics, such as race/ethnicity and medical and psychiatric comorbidities,[10] and additional research is needed.

Delaying high school start times is one approach that can increase sleep duration and reduce social jet lag, as discussed by Cespedes Feliciano et al.[8] A growing number of school districts in the United States are adopting later high school start time policies. To accommodate this change, elementary school start times are typically advanced and middle school start times often remain unchanged; therefore, this policy change may not reach the middle school-aged children included in the sample.[8] Although this change may initially require some logistical reorganization–on the part of teachers and school personnel, families, athletic teams, and other community stakeholders–it is feasible and affordable and can essentially reach all high school students within a school district. In Seattle, Washington, delaying high school start times by 1 hour increased median sleep duration by 30 minutes per night (6.8-7.4 hours).[11] Adolescents' weekday bedtimes did not change, but their wake times were later, resulting in a better correspondence between weekday and weekend sleep timing (ie, reduced social jet lag). This policy-level approach therefore is positively associated with both sleep duration and 1 sleep timing trait; it will be important to evaluate if delayed school start times also yield improvements in weight status among adolescents.

Delaying high school start times is a promising approach for increasing sleep duration and reducing social jet lag. However, it should be emphasized that this approach does not change timing of sleep onset and does not change sleep duration or sleep timing on weekend nights.[11] Furthermore, the increased median sleep duration to 7.4 hours per night means that more than half of the adolescents still do not meet the recommended minimum of 8 hours of sleep

per day.[3,11] These points of emphasis are important because laboratory-based sleep restriction studies show that very short sleep duration (4-5 hours per night) leads to rapid weight gain as a consequence of excess caloric intake, which occurs in the late evening[12,13]; data from nocturnal animals consistently demonstrate that the equivalent of night eating in humans is particularly obesogenic.[14] In addition, adolescents who are experimentally restricted to 6.5 hours per night of sleep via later timing of sleep onset consume foods with a higher glycemic index.[15] Therefore, promoting earlier bedtimes to increase sleep duration and reduce opportunities to eat later at night may be the most efficacious sleep-promoting approach to ensure healthier weight among adolescents. Of course, successfully changing the timing of sleep onset to occur earlier will be challenging among adolescents who prefer later bedtimes. For these adolescents, ensuring an earlier sleep schedule with a set wake time on both weekdays and weekends maybe particularly important. Cespedes Feliciano et al[8] also discuss the use of bright-light therapy during the daytime and limiting screen time exposure, especially in the bedroom and close to bedtime. These behavioral approaches may be critical for helping adolescents achieve earlier timing of sleep onset.

Much has been written about precision health care, an effort to match patients with specific preventive measures or therapies most likely to be effective for them. Although often discussed in the context of oncology, results such as those from the study by Cespedes Feliciano et al[8] help to inform the delivery of a different type of precision health care: precision primary care and adolescent medicine. Understanding commonalities as well as differences between sleep for adolescent girls and boys, as highlighted in the study, can help clinicians tailor their messages as they provide guidance and suggestions to adolescents and their parents to improve sleep and, consequently, health. Anticipatory guidance during the transition to adolescence or onset of puberty about changes in sleep duration, circadian preferences, and sleep timing maybe especially beneficial. These messages have become increasingly important as the links between sleep and obesity have been better defined.

In summary, shorter sleep duration and later sleep timing have been implicated with adolescent obesity. Cespedes Feliciano et al[8] provide compelling evidence that an evening preference and social jet lag are linked to increased adiposity in adolescent girls, even when considering sleep duration and other sociodemographic factors. Delaying high school start times can increase sleep duration and reduce social jet lag by facilitating later wake times, but we do not yet know if this policy-level change reduces the prevalence of adolescent obesity and it does not completely resolve insufficient sleep duration. Interventions that also target earlier timing of sleep onset could further help to improve overall sleep patterns and improve adolescent weight status. The tailoring of messages to specific subgroups of adolescents, enabled by studies like the one by Cespedes Feliciano et al,[8] may help pediatric clinicians become more effective and efficient in providing advice that addresses the epidemics of poor sleep and obesity in adolescence. Future research should examine the relative contribution of sleep duration and timing to cardiometabolic outcomes longitudinally, as well as the outcome of behavioral sleep interventions that aim to optimize sleep duration and timing in adolescence.

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REFERENCES

1. Hales CM, Fryar CD, Carroll MD, Freedman DS, Ogden CL. Trends in obesity and severe obesity prevalence in US youth and adults by sex and age, 2007-2008 to 2015-2016. JAMA. 2018;319(16): 1723–1725. doi:10.1001/jama.2018.3060 [PubMed: 29570750]
2. Wheaton AG, Jones SE, Cooper AC, Croft JB. Short sleep duration among middle school and high school students—United States, 2015. MMWR Morb Mortal Wkly Rep. 2018;67(3):85–90. doi:10.15585/mmwr.mm6703a1 [PubMed: 29370154]
3. Paruthi S, Brooks LJ, 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. doi:10.5664/jcsm.6288 [PubMed: 27707447]
4. Chen X, Beydoun MA, Wang Y. Is sleep duration associated with childhood obesity? a systematic review and meta-analysis. Obesity (Silver Spring). 2008;16(2):265–274. doi:10.1038/oby.2007.63 [PubMed: 18239632]
5. Cappuccio FP, Taggart FM, Kandala NB, et al. Meta-analysis of short sleep duration and obesity in children and adults. Sleep. 2008;31(5):619–626. doi:10.1093/sleep/31.5.619 [PubMed: 18517032]
6. Mitchell JA, Rodriguez D, Schmitz KH, Audrain-McGovern J. Sleep duration and adolescent obesity. Pediatrics. 2013;131(5):e1428–e1434. doi:10.1542/peds.2012-2368 [PubMed: 23569090]
7. Miller MA, Kruisbrink M, Wallace J, Ji C, Cappuccio FP. Sleep duration and incidence of obesity in infants, children, and adolescents: a systematic review and meta-analysis of prospective studies. Sleep. 2018;41(4):zsy018. doi:10.1093/sleep/zsy018
8. Cespedes Feliciano EM, Rifas-Shiman SL, Quante M, Redline S, Oken E, Taveras EM. Chronotype, socialjet lag, and cardiometabolic risk factors in early adolescence [published online September 16,2019]. JAMA Pediatr. doi:10.1001/jamapediatrics.2019.3089
9. Cespedes Feliciano EM, Quante M, Rifas-Shiman SL, Redline S, Oken E, Taveras EM. Objective sleep characteristics and cardiometabolic health in young adolescents. Pediatrics. 2018;142(1):e20174085. doi:10.1542/peds.2017-4085 [PubMed: 29907703]
10. Becker SP, Sidol CA, Van Dyk TR, Epstein JN, Beebe DW. Intraindividual variability of sleep/wake patterns in relation to child and adolescent functioning: a systematic review. Sleep Med Rev. 2017;34:94–121. doi:10.1016/j.smrv.2016.07.004 [PubMed: 27818086]
11. Dunster GP, de la Iglesia L, Ben-Hamo M, et al. Sleepmore in Seattle: Later school start times are associated with more sleep and better performance in high school students. Sci Adv. 2018;4(12): eaau6200. doi:10.1126/sciadv.aau6200 [PubMed: 30547089]
12. Spaeth AM, Dinges DF, Goel N. Effects of experimental sleep restriction on weightgain, caloric intake, and meal timing in healthy adults. Sleep. 2013;36(7):981–990. doi:10.5665/sleep.2792 [PubMed: 23814334]
13. Markwald RR, Melanson EL, Smith MR, et al. Impact of insufficient sleep on total daily energy expenditure, food intake, and weight gain. Proc Natl Acad Sci USA. 2013;110(14):5695–5700. doi:10.1073/pnas.1216951110 [PubMed: 23479616]
14. Hatori M, Vollmers C, Zarrinpar A, et al. Time-restricted feeding without reducing caloric intake prevents metabolic diseases in mice fed a high-fat diet. Cell Metab. 2012;15(6):848–860. doi:10.1016/j.cmet.2012.04.019 [PubMed: 22608008]

15. Beebe DW, Simon S, Summer S, Hemmer S, Strotman D, Dolan LM. Dietary intake following experimentally restricted sleep in adolescents. Sleep. 2013;36(6):827–834. doi:10.5665/sleep.2704 [PubMed: 23729925]