



Contents lists available at ScienceDirect

Sleep Health

Journal of the National Sleep Foundation

journal homepage: sleephealthjournal.org

Social relationships and the sleep-health nexus in adolescence: evidence from a comprehensive model with bi-directional effects



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ARTICLE INFO

Article history:

Received 24 January 2017

Received in revised form 7 April 2017

Accepted 10 May 2017

Keywords:

Sleep duration

Body mass index

Depression

Substance use

Social relationships

Adolescents

ABSTRACT

Objective: The goal of this study was to assess the bi-directional effects of sleep and health (body mass index [BMI], depression, and substance use) among adolescents in the presence of comprehensive controls for social relationships and daily stressors and supports.

Design: Longitudinal survey.

Setting: Data were obtained from the *Study of Early Child Care and Youth Development*, a longitudinal survey designed and administered by the Eunice Kennedy Shriver National Institute of Child Health and Human Development.

Participants: At total of 974 adolescents ages 12–15; 50% girls.

Measurements: Total sleep time was derived from difference between usual bedtime and arise time; youths self-reported the frequency of using alcohol, tobacco, and marijuana, and most of the predictors of sleep-health (e.g., parental monitoring, school and peer attachment); youth's body mass index and physical development (i.e., Tanner stage score) were assessed in clinics.

Results: Teen sleep duration declined and health deteriorated from age 12–15, but results from a 2-stage least squares analysis showed and that sleep duration was among the strongest predictors of teen health; by contrast, BMI, depression, and substance use had no effect on sleep duration. Youth sleep and health were both determined by changes in family structure, income, parental monitoring, school and peer attachment, time spent in homework and on the computer, and physical development (health only).

Conclusions: The constellation of teens' social ties and daily stressors affects the sleep-health nexus, and future studies should account for this complexity and diversity of teens' lives.

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At a time when young people aspire to assume adult roles and identities, they are often sleep deprived and struggle with threats to their health in the forms of weight gain, depression, and substance use. Since teen sleep and health problems often emerge and crystallize at the same point in the life course it would be logical to think that sleep and well-being are bi-directional in their associations. Yet, review essays point out that most studies test only the effect of sleep on health and often fail to estimate the converse effect that weight gain/obesity,¹ depression,² and substance use³ disrupts sleep. More important, of the growing number of longitudinal analyses of the associations between sleep and teen health, most studies control for only a few social covariates as moderators, usually the family, but sometimes school, peers and time use. As social scientists point out, teens' social ties determine health behaviors, and it is not

just one social bond that matters, but rather the “constellation of social ties” that determines teen health behaviors.⁴ This study draws on the medical and social science literatures on teen sleep and well-being to estimate a comprehensive model of the bi-directional associations between sleep and health.

Teenagers' short sleep durations are well known, with the most recent estimate showing that only 56 percent of Americans aged 12–17 get sufficient sleep.⁵ Some research has focused on developmental processes to explain teens' shorter sleep duration,^{6,7} especially during puberty. Among other things, going through puberty is associated with alterations in circadian rhythms and delayed release of melatonin affecting sleep.^{7–9} These findings suggest a developmental explanation for teens' later bedtimes and shorter sleep durations.

Sleep researchers, of course, have considered contextual impacts on teens' sleep. Indeed, a valuable perspective on this is offered by Dahl,¹⁰ who suggested that sleep and anxiety are antithetical to each other. That is, because sleep involves the loss of most sensory perception of the environment, a sense of safety and security is

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necessary for sleeping well at night. This argument has been most often applied to study family effects on sleep, finding that family conflict or weak attachment with family members triggers anxiety that disrupts sleep;¹¹ conversely, strong feelings of love and emotional security in one's family is conducive to healthy sleep.¹² One extension of this perspective showed that teens' sleep is disrupted by the anxiety of living in a low-income family.¹³

Dahl's sleep-anxiety perspective dovetails with social science descriptions of the stress process, positing that the health impacts of stressful life events can be ameliorated by receiving social support from key associations in one's life.^{14,15} Social science research on adolescents has established that social support improves mental and physical health,^{16–21} and delinquency research shows that via strong attachments to parents, teachers, and friends, youths internalize pro-social norms that lower the propensity to engage in deviant behaviors.^{22–24} Yet, when social scientists focus on social factors and overlook the importance of sleep, their multivariate models cannot reveal the relative strength of sleep versus social ties in predicting teen health behaviors. This, of course, can lead to an erroneous understanding of important factors influencing the sleep–health nexus.

Besides the family, schools are important fixtures in teens' lives. For the most part, sleep researchers have focused on how disrupted sleep in adolescence produces a persistent tiredness and lack of motivation that is harmful to academic performance.²⁵ Yet, two studies reported that homework demands and academic pressures cause teens to stay up later at night and get less sleep,^{26,27} and another study implicates academic pressures as a cause of teen overeating and weight gain.²⁸ When youths bond with teachers and school staff, however, a heightened sense of connectedness and security improves their emotional well-being,^{18,29,30} and is associated with lower rates of substance use.^{23,31}

Peers are also important to teens, and sleep researchers show that interacting with peers is a factor that leads to later bedtimes on school nights, as does using the computer.^{26,32,33} Yet, sleep scholars generally neglect to examine the sleep effects of peer associations in multivariate models. Social science research shows that having supportive friends reduces depression and other emotional problems,^{34,35} whereas associating with delinquent friends increases rates of delinquency among teens.^{22,36,37} Other studies emphasize that peers who care about teens can act as deterrents to delinquency and steer teens into pro-social activities.^{18,23}

Summary of theoretical/analytical model

There is a paucity of comprehensive multivariate studies that evaluate the relative strength of the multitude of factors affecting teens' sleep. Further, the same social contextual factors that affect teen sleep also determine adolescent health, yet most sleep studies limit their consideration to only a few social moderators, and social science studies ignore sleep as a determinant of adolescent health. Finally, although sleep and health problems emerge and crystallize at the same point in the life course, rarely are the bidirectional associations between sleep and health examined in the context of teens' lives. The model shown in Fig. 1 addresses these limitations in prior research by estimating bidirectional models of sleep duration and three health outcomes (body mass index [BMI], depression, and substance use) in the presence of a full set of controls for youths' lives in social context. To estimate the model, sleep duration and health outcomes at age 12 are used as stability coefficients for their respective age 15 values, indicating that those with sleep and health problems at age 12 are likely to experience these problems to a greater degree at age 15. The model in Fig. 1 was estimated using two-stage least

squares regression in the PROC SYSLIN procedure in the SAS (v.9) software package.

Method

Participants

This study draws from the *Study of Early Child Care and Youth Development* (SECCYD), a longitudinal study of children sponsored by Eunice Kennedy Shriver National Institute of Child Health and Human Development. Mothers in 10 catchment areas were recruited into the study immediately after giving birth in 1991. The original 1364 families were representative of families in the geographic areas from which they were recruited, and the focal children and their families were followed until children reached age 15 ($n = 974$ children). Typical of most longitudinal studies, attrition is higher among minority children and those from low-income families.³⁸ Children were analyzed at ages 12 to 15 because sleep durations shorten and health problems emerge and crystallize at these ages. Table 1 reports univariate descriptive statistics on all variables included in the analyses below; missing data on the predictors of teen sleep and health were imputed using the EM (estimation and maximization) algorithm in the PROC MI procedure in SAS.³⁹ The models were re-run without imputing missing values on predictors ($n = 691$) and the findings were substantively similar to those shown below.

Sleep and health measures

Youth self-reported their usual bedtimes and arise times, yielding a measure of *sleep duration* on school nights (analyses of sleep duration on weekends yielded substantively similar results). Calculating sleep duration as the difference between bedtime and arise time produces less error than asking a single question about the length of sleep or recording sleep duration in a diary.⁴⁰ Further, if the error in measuring sleep duration is random, the associations estimated in Fig. 1 are likely to be unbiased (albeit inefficient) when sleep duration is the dependent variable, and attenuated when sleep duration predicts health outcomes.^{38,41} As Table 1 shows, average sleep duration declines from more than 9 hours at age 12 to a little less than 8 hours by age 15.

Youths annually visited health clinics for check-ups, and the first health outcome, *body mass index*, was recorded in these visits and standardized to percentile scores. Second, youths responded to the short form of the Child Depression Inventory⁴² that presented 10 sets of three statements asking how children felt in regards to being in a dysphoric mood, lacking pleasure, and their self-esteem. For each statement, children could describe themselves as normative (e.g., 0 = "I am sad once in a while"), in the middle (1 = "I am sad many times"), or as exhibiting depressive symptoms (2 = "I am sad all the time"). Responses to the 10 statements were summed; higher scores indicate more frequent *depressive symptoms* (alpha reliabilities were .8 in each year). Third, substance use was measured by self-reports of the frequency of smoking, drinking alcohol, and using marijuana in the past year; item responses ranged from 0 = *never* to 2 = *more than twice* and the index was constructed from the sum of the three items. Table 1 shows that the average youth increased from the 63rd to the 66th percentile on body mass index, and reported more depressive symptoms and substance use with age.

Social stressors and supports

Most measures of youths' social supports and stressors were taken at age 12 to capture initial effects of social context on teen sleep and health, and the difference between age-15 and age-12 scores captured changes in youths' supports and stressors. First,

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