Article

The Association Between Sleep Duration and Arrest Among Adolescents

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Abstract

In recent years, sleep duration has received increased scrutiny with respect to criminologically relevant outcomes. No attention, however, has been given to the possible relationship between sleep duration and the likelihood of arrest. Given the negative downstream effects that arrest may have on adolescents, this is an important relationship to investigate. To this end, the current study uses data from the 2018 Florida Youth Substance Abuse Survey ($N = 49{,}360$)

Keywords

sleep duration, self-reported arrest, health behaviors, adolescence, FYSAS

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Introduction

The Office of Juvenile Justice and Delinquency Prevention estimates that nearly 750,000 juveniles were arrested in 2018 (Puzzanchera, 2020). While this number is down 10% from the previous year and 60% from the past decade, the number of juveniles being arrested is still alarming. Equally alarming are the negative effects that contact with the justice system are known to have on juveniles. For example, for juveniles, being stopped by police has been found to be associated with emotional distress (Del Toro et al., 2019; Jackson et al., 2019), depression (Turney, 2020), delinquent behavior (Del Toro et al., 2019), and issues with both sleep duration and quality (Jackson et al., 2020). Further, more formal contact with the justice system (i.e., arrest) also has significant negative effects on youth, including an increase in delinquency (Motz et al., 2020; Mowen et al., 2018; but see Morris & Piquero, 2013), depressive symptoms (Sugie & Turney, 2017), welfare dependence, and school failure (Makarios et al., 2017).

While youths' self-reported delinquency is important to examine in its own right, researchers such as Makarios et al. (2017) argue that some of the negative effects emanating from delinquent acts are mediated by arrest. Specifically, Makarios et al. (2017) state, "evidence reveals that delinquency is more likely to lead to school failure *if youth are arrested*" (p. 699, emphasis added). Further, the act of arrest signals that formal contact with the justice system was necessitated. In other words, arrest separates more serious forms of delinquency from minor forms that may not lead to an arrest. As such, the predictors of juvenile arrest are important to study beyond predictors of juvenile delinquency that is self-reported or goes undetected.

Researchers have identified numerous correlates of adolescent arrest, including, among others, poor parenting strategies (Kirk, 2009; Unnever et al., 2003), low socioeconomic status (Fite et al., 2009; Tapia, 2010), associations with delinquent peers and gang membership (Sittner & Gentzler, 2016; Tapia, 2011), low self-control (Beaver et al., 2009; Unnever et al., 2003), and race (Tapia, 2010, 2011). Yet, one factor that has not been considered as a possible predictor of juvenile arrest is adolescent sleep duration. This is a notable gap, given the growing body of research linking sleep deficiency to a wide range of antisocial behaviors (Short & Weber, 2018) and delinquent outcomes (e.g., Clinkinbeard et al., 2011; Mears et al., 2020; Meldrum et al., 2015, 2020; Peach & Gaultney, 2013).

This study aims to contribute to the literature by examining the association between sleep duration and self-reported arrest among youth. In doing so, this study answers the call of researchers to develop a more complete understanding of the risk factors for adolescent arrest (e.g., Kemp et al., 2017).

Given the growing body of research on sleep and delinquent behavior, a logical next step is to extend the focus to juvenile arrest. Accordingly, this study utilizes data collected from approximately 50,000 middle school and high school students who participated in the 2018 Florida Youth Substance Abuse Survey (FYSAS) to investigate the association between sleep duration and arrest. Prior to discussing the methodology of the study and the results, a review of the relevant literature will be provided. This will begin with a focus on sleep and adolescents. Then, we will shift to a discussion of the relationship between sleep and delinquent behavior. Next, we review the prior research on established predictors of arrest among youth that are important to account for when investigating the association between sleep and arrest.

Literature Review

Sleep and Adolescents

Sleep is an essential part of human life that helps to ensure proper functioning of the mind and body (Walker, 2017). For adolescents, sleep is especially important for proper brain development (Galván, 2020). While sleep requirements vary across life stages, research suggests that adolescents require between 8 and 10 hours of restful sleep per night (Hirshkowitz et al., 2015). However, approximately 75% of adolescents achieve fewer than 8 hours of sleep on school nights (Centers for Disease Control and Prevention, 2018). Researchers posit that, while there are numerous factors that may play a role in decreasing sleep time, one of the main issues is the shift in the circadian rhythm of adolescents. More specifically, the transition into adolescence is marked by a biologically driven predisposition to go to bed later and wake up later (Carskadon et al., 1993). Carskadon et al. (1993) further argue that early school start times do not take this biological shift into consideration. Adding to this, adolescents also face additional pressures that threaten sleep time, such as work responsibilities, increased use of electronics at night, and an increase in bedtime autonomy (Crowley et al., 2018).

Adolescents are in a somewhat precarious position due to the bookending by natural biology and competing social forces that can create what Crowley et al. (2018) refer to as the “perfect storm” for sleep time reduction. These difficulties are further compounded by the behavioral changes occurring during adolescence (e.g., an inclination towards risk-seeking behavior; see Forrest et al., 2019) that could be exacerbated by inadequate sleep time. During adolescence, an increase in risk-taking behavior and changes in important areas of the brain, such as the prefrontal cortex (PFC) and hippocampus, are observed (Spear, 2000). The PFC is involved with regulation of

emotion, attention, judgment, decision-making, and other executive functions. Damage to this area, or areas connected to it, can cause significant impairment that affects these complex processes (Anderson et al., 1999; Telzer et al., 2013). Apart from structural damage, researchers believe another way that functioning of the PFC may be affected is through sleep deficiency (Krause et al., 2017; Telzer et al., 2013). For example, Telzer et al. (2013) found that students with insufficient sleep were focused more on rewards than risk and had reduced decision-making skills. Moreover, Kahn-Greene et al. (2006) found that sleep deficiency was associated with impulsive decisions and an increase in hostile behavior, which was thought to be a result of reduced PFC activity.

Given that impulsivity is a key dimension of low self-control, it would follow that sleep deficiency may influence self-control. Indeed, Meldrum et al. (2015) found a positive association between insufficient sleep and low self-control, and they also observed that low self-control mediated the relationship between insufficient sleep and delinquent behavior. Other research has shown that short sleep duration has negative impacts on mood in adolescents (Short et al., 2020), which may increase the risk of arrest. For example, in a sample of African American adolescents, Umlauf et al. (2011) found that sleep disturbances were associated with an increase in quick temperedness and aggressive behaviors, such as using a knife or gun. Thus, there is a strong theoretical connection between short sleep duration and risk-taking behavior that may be explained by compromised emotional regulation, thoughtful decision-making, and self-control.

Sleep and Delinquent Behavior

The effects of sleep deficiency on adolescents have been well studied as it pertains to many adverse outcomes, including poor academic performance (Dewald et al., 2010), mental health and mood disorders (Jamieson et al., 2020; Short & Louca, 2015), poor physical health (Matthews & Pantesco, 2016; Peach et al., 2015), and numerous other negative behavioral consequences (e.g., Meldrum & Restivo, 2014). Moreover, research into the association between sleep deficiency and criminologically relevant outcomes has gained momentum as of late, and an impressive body of work has linked sleep deficiency with antisocial and risky behaviors (McKnight-Eily et al., 2011; Meldrum & Restivo, 2014; Short & Weber, 2018; Sivertsen et al., 2015) and delinquency (e.g., Backman et al., 2015; Clinkinbeard et al., 2011; Mears et al., 2020; Meldrum & Restivo, 2014; Meldrum et al., 2015, 2020; Peach & Gaultney, 2013; Vazsonyi et al., 2018). For example, McKnight-Eily et al. (2011) found that sleep deficiency was associated with many risky behaviors among high school students, including drug and alcohol use,

sexual activity, and being involved in physical fights. Similarly, Meldrum and Restivo (2014) examined the relationship between sleep deficiency and 12 negative outcomes (e.g., drug and alcohol use, fighting, sexual risk-taking, drunk driving), finding that extreme deficits in sleep (e.g., 5 or fewer hours of sleep at night) were associated with delinquency.

In addition to risky behaviors and other correlates of crime, sleep deficiency also has been found to be associated with various measures of general delinquency (e.g., Backman et al., 2015; Clinkinbeard et al., 2011; Mears et al., 2020; Meldrum & Restivo, 2014; Meldrum et al., 2020). For instance, Meldrum et al. (2020) observed that sleep deficiency was associated with both carrying a handgun to school and general handgun carrying. More specifically, those at the extreme end of sleep deficiency (i.e., 4 or fewer hours of sleep) were 40% more likely to carry a handgun and 85% more likely to carry a handgun to school compared to those who achieved 8 or more hours of sleep per night; these associations were found when controlling for a variety of covariates. Relatedly, using data from the first wave of the National Longitudinal Study of Adolescent Health, Clinkinbeard et al. (2011) investigated the relationship between sleep deficiency and both property and violent delinquency. Their findings indicated that adolescents who reported sleeping 7 or fewer hours had higher levels of property delinquency relative to those who slept 8 or more hours. However, when violent delinquency was examined, only those who achieved 5 or fewer hours of sleep reported higher levels of violent delinquency compared to those achieving 8 or more hours of sleep at night. Taken together, these findings point to a non-linear relationship between sleep and delinquent outcomes, with a more pronounced effect at the lower end of time slept.

Recently, researchers have begun to examine the possible negative consequences of both too little *and* too much sleep. For example, Mears et al. (2020) found a U-shaped relationship between sleep and their primary outcome variable, which included 14 different delinquent behaviors ranging from petty property crime to shooting or stabbing another individual. Their findings suggest that not only does an extreme deficiency in sleep time result in statistically significant increases in delinquency (e.g., Clinkinbeard et al., 2011; Meldrum et al., 2020) but also that those on the extreme high end of sleep time (i.e., 12 or more hours) were likewise more likely to engage in delinquency. These findings might be interpreted as reflecting what Mears et al. (2020) refer to as the "Goldilocks Rule," where optimal sleep duration (i.e., between 8 and 10 hours) is associated with less delinquency compared to too little sleep and too much sleep. While the association between excessive sleep and delinquency may seem counterintuitive, some prior work has pointed to several possibilities as to why this association might exist. For example, Yen et al. (2010) argue that excessive sleep duration in adolescents

may indicate a decrease in connectedness to school and an increase in absenteeism, leading to truancy. Further, it is also plausible that excessive sleep may indicate poor sleep quality (Momoda et al., 2019), which may bring upon a more negative mood (Bei et al., 2017).

Predictors of Juvenile Arrest

The downstream effects of juvenile arrest have received a considerable amount of attention. Research has linked juvenile arrests with numerous negative outcomes, including future offending behavior (Beardslee et al., 2019; Liberman et al., 2014; Mowen et al., 2018; Wiley & Esbensen, 2016; but see Huizinga et al., 2003), poor mental health (Sugie & Turney, 2017), and a wide variety of other deleterious downstream effects (e.g., Lopes et al., 2012; Makarios et al., 2017; Pratt et al., 2016). For example, Mowen et al. (2018) found that even after controlling for delinquency levels at baseline, juveniles who were arrested had a significant increase in offending behavior compared to juveniles who were never arrested. Moreover, Makarios et al. (2017) found that adolescents who were arrested were less likely to graduate high school, more likely to be on welfare, and more likely to engage in risky sexual behaviors. Relatedly, Pratt et al. (2016) found that arrest was associated with a number of "failures," including dropping out of high school, issues with alcoholism, contracting an STD, and being fired, relative to those who were never arrested. Notably, these results held even *after* controlling for important confounding variables such as IQ and low self-control.

Clearly, the effects of arrest on juveniles can be quite serious in nature. While researchers have not examined the relationship between sleep deficiency and juvenile arrest, they have identified several other predictors that are important to account for when considering the association between sleep and arrest. Race/ethnicity, for example, is a significant predictor for juvenile arrest (e.g., Andersen, 2015; Crutchfield et al., 2009; Fite et al., 2009; Tapia, 2010, 2011). More specifically, Hispanic youth have been found to be at a greater risk for arrest compared to White youth, and Black youth are at a greater risk than Hispanic youth (Tapia, 2010). Likewise, Crutchfield et al. (2009) found in their sample of 10th grade students that Blacks were more than twice as likely to be arrested relative to Whites. Additionally, Tapia (2011) found that being a racial minority remained a significant predictor of juvenile arrest even when controlling for past criminal history and offense seriousness. Notably, Fite et al. (2009) examined the relationship between race and juvenile arrest and found that early exposure to other risk factors for arrest explained the majority of the difference in arrest rates between youth of different racial/ethnic groups, with the exception of arrests for drugs.

In addition to race/ethnicity, males[1] and those with a lower socioeconomic status (SES) have an increased likelihood of arrest (e.g., Fite et al., 2009; Hirschfield et al., 2006; Ludwig et al., 2001; Males & Brown, 2014; Tapia, 2010). For example, Ludwig et al. (2001) found that arrest rates increased for juveniles who moved from low-poverty to high-poverty neighborhoods. Further, Tapia (2010) found that juveniles of low SES were at a significantly increased risk of arrest. Interestingly, however, Tapia's (2010) findings suggest that when an interaction effect between race and SES was examined, both Black and Hispanic juveniles with *high* SES status were at an increased risk of arrest compared to Whites. Greater neighborhood disorder, which is often negatively correlated with SES, also has been found to be associated with arrests (Milam et al., 2012). Using a neighborhood disorder scale comprised of indicators from The Neighborhood Inventory for Environmental Typology, Milam et al. (2012) found that, while controlling for other variables, for each additional unit increase in neighborhood disorder was associated with a 27% increase in juvenile drugs arrests.

Low self-control is also a salient predictor of juvenile arrest (Beaver et al., 2009; Unnever et al., 2003; Yun & Lee, 2013; Yun et al., 2014). For example, Beaver et al. (2009) found low self-control to be associated with an increased likelihood of arrest, and they argue that low self-control may impact interactions with police, where negative and hostile responses may increase the likelihood of being arrested. In other words, behavior consistent with low self-control not only sets the stage for crime and delinquency but also may influence how the individual is treated by law enforcement. Extending Beaver et al.'s (2009) study, Yun and Lee (2013) found that poor verbal intelligence, which is related to self-control (see Beaver et al., 2008), was also associated with juvenile arrest, even when controlling for neighborhood characteristics, SES, race, low self-control, and other relevant variables.

Social factors, such as associating with delinquent peers (e.g., Monahan et al., 2014; Sittner & Gentzler, 2016) and gang involvement (e.g., Tapia, 2011), also are correlated with juvenile arrest. For instance, Sittner and Gentzler (2016) found that youths who reported having a close friend who had been in trouble with the police were more than twice as likely to be arrested compared to those who did not associate with delinquent peers. Debate persists as to why this may be the case (e.g., possible self-selection into delinquent peer groups), though the literature suggests that parental monitoring may be an effective form of social control that provides some protection against arrest (Kirk, 2009; Unnever et al., 2003). Kirk (2009), for example, found that parental monitoring and juvenile arrest have a statistically significant inverse relationship that holds even when school and neighborhood characteristics are taken into consideration. However, ineffective

parenting (e.g., authoritarian, inconsistent, etc.) and parental arrest have been associated with an increase in likelihood of arrest among juveniles (e.g., Vidourek et al., 2016; but see also Sittner & Gentzler, 2016).

Important for present considerations, the variables discussed above—in addition to arrest—are correlated with poorer sleep. For example, while low self-control has been shown to be a strong predictor of arrest (e.g., Beaver et al., 2009), sleep duration and self-control also have been found to be positively correlated (Barnes & Meldrum, 2015). Similarly, while those involved in gangs are more likely to be arrested (Tapia, 2011), adolescents who report short sleep durations are also more likely to be involved with gangs (Owens et al., 2017). Due to the association between the variables discussed above and both arrest and sleep, they should be accounted for when examining the relationship between sleep duration and arrest.

The Current Study

The prior discussion reveals that sleep duration is associated with different forms of crime and delinquency. Importantly, however, no previous study has examined the possibility of a sleep-arrest relationship. While some forms of delinquency associated with sleep duration may be quite serious in nature (e.g., Meldrum et al., 2020), it cannot be assumed that the individuals were ultimately arrested and therefore subjected to the potential deleterious downstream effects that arrest may have on juveniles. To fill this gap in the literature, the current study will examine the association between sleep duration and self-reported arrest. Further, most studies on the effects of sleep on delinquent behavior generally are focused on sleep deficiency (e.g., fewer than 8 hours). However, the recent study by Mears et al. (2020) hints at significant effects at *both* extremes of sleep duration on delinquency, and the authors call for additional research into the non-linear association between sleep and antisocial behavior.

Accordingly, the primary hypothesis for this study is that both deficient and excessive sleep duration will be positively associated with self-reported arrest. Such an investigation is important for at least two reasons. First, given the negative effects that arrest has on subsequent behavioral outcomes among juveniles as revealed through prior research, it is important to examine all possible predictors of arrest in order to better inform policy and advance research. Second, because prior research has not considered the association between sleep and arrest, our understanding of the potential link between sleep and antisocial behavior that rises to the level of formal intervention by the justice system is currently unclear.

Data and Method

Data

Data for the current study come from the 2018 Florida Youth Substance Abuse Survey (FYSAS). The FYSAS is an annual survey that assesses current drug use and abuse, delinquent behaviors, peer associations, family and social involvement, school involvement, neighborhood characteristics, and other social characteristics. The sampling procedure for the FYSAS is a two-stage cluster design, stratified by county. The first stage involves the random selection of middle and high schools from the 67 counties in Florida. Schools for special education, adults, and correctional populations were excluded. The second stage of sampling involved the random selection of classrooms within the selected middle and high schools.

While some schools involved in the FYSAS used active consent, passive consent was used by most schools. Passive consent is a procedure where students were given consent notifications and told to give it to their parents, and the parents were then able to provide notification if they did not wish for their child to be a participant. Overall, 79,697 students (38,631 middle school and 41,066 high school students) were invited to participate. The total number of students who actually participated in the 2018 survey was 58,193 (a participation rate of 73%). Out of the 58,193 participants, 3,582 were removed using a series of validation tests,[2] resulting in a sample size of 54,611. Data missing on the study variables were addressed using multiple imputation (see below). For additional information on the 2018 FYSAS, including its methods and key findings, refer to the 2018 FYSAS State Report.[3] For each of the study variables, the descriptive statistics for the non-imputed data, the valid sample size before imputation, and the proportion of cases with data missing are presented in Table 1.

Measures

Self-reported arrest. The dependent variable, *Self-reported arrest*, is a dichotomous measure representing whether a participant had been arrested in the previous 12 months. Specifically, the question asked, "How many times in the past year (12 months) have you been arrested?" Answer choices originally available to the participants ranged from a minimum of "Never" to a maximum of "40+ times." However, due to the low number of respondents choosing more than "1 or 2 times," the responses were collapsed. The final coding of this variable was dichotomous, with those reporting one or more arrests coded as 1.

Table 1. Descriptive Statistics.

Variables	*N*	Mean/%	*SD*	Min.	Max.	Missing
Dependent variable						
Self-reported arrest						
Yes[a]	49,360	2.18%	—	0	1	9.62%
Independent variables						
Sleep duration (categorical)						
4 or fewer hours[b]	47,374	8.53%	—	0	1	13.25%
5 hours[b]	47,374	9.23%	—	0	1	13.25%
6 hours[b]	47,374	16.76%	—	0	1	13.25%
7 hours[b]	47,374	22.29%	—	0	1	13.25%
10 or more hours[b]	47,374	6.25%	—	0	1	13.25%
Sleep duration (dichotomous)						
Fewer than 8 hours[c]	47,374	56.82%	—	0	1	13.25%
Sleep duration (ordinal)	47,374	3.07	1.61	0	6	13.25%
Covariates						
Grade level	54,611	8.58	1.92	6	12	0.00%
Sex						
Male[d]	53,794	48.73%	—	0	1	1.50%
Race/ethnicity						
Black[e]	54,085	17.55%	—	0	1	0.96%
Hispanic[e]	54,085	24.16%	—	0	1	0.96%
Other race[e]	54,085	13.34%	—	0	1	0.96%
Low self-control	50,718	1.02	0.66	0	3	7.13%
Neighborhood disorder	48,994	0.43	0.61	0	3	10.29%
Parental control	50,054	2.22	0.72	0	3	8.34%
History of gang membership						
Yes[f]	49,584	3.97%	—	0	1	9.21%
Family drug use						
Yes[g]	48,922	34.66%	—	0	1	10.42%

Note. $N = 54{,}611$. *N* = valid non-missing sample size before multiple imputation. SD = standard deviation.
[a]Reference is no self-reported arrest.
[b]Reference is 8 or 9 hours.
[c]Reference is 8 or more hours.
[d]Reference is female.
[e]Reference is White.
[f]Reference is no history of gang membership.
[g]Reference is no family drug use.

Sleep duration. The main independent variable for this study, *Sleep duration*, is a measure of the respondents' sleep duration obtained on an average school night. This variable was originally ordinal in nature, with responses including

"4 or fewer hours," "5 hours," "6 hours," "7 hours," "8 hours," "9 hours," and "10 or more hours." For the main set of analyses, sleep duration was recoded into a categorical variable, and both "8 hours" and "9 hours" are combined into a single category that is used as the reference because these encompass the recommended sleep duration for adolescents (Hirshkowitz et al., 2015). Importantly, this approach allows for an examination into the non-linear effect of sleep (e.g., Mears et al., 2020).[4] In this sample, 8.53% reported 4 or fewer hours, 9.23% reported 5 hours, 16.76% reported 6 hours, 22.29% reported 7 hours, 36.94% reported 8 or 9 hours, and 6.25% reported 10 or more hours of sleep.

For supplementary analyses, two additional measures of sleep duration are modeled as outcomes. The first is a dichotomous measure of sleep duration like that appearing in some past research (McKnight-Eily et al., 2011), with 8 or more hours coded as 0 and fewer than 8 hours coded as 1. In this sample, 56.82% reported fewer than 8 hours of sleep. The second measure is the original ordinal measure of sleep ("4 or fewer hours" = 0, "5 hours" = 1, "6 hours" = 2, "7 hours" = 3, "8 hours" = 4, "9 hours" = 5, and "10 or more hours" = 6). The ordinal measure of sleep has a mean of 3.07 with a standard deviation of 1.61.

Covariates. *Grade level* is a proxy for age and ranges from 6 to 12, with a mean of 8.58. A quadratic term for grade level also is included in the analyses to capture non-linearity. *Sex* is a dichotomous variable with male respondents coded as 1. In this sample, 48.73% of participants indicated they were male. Additionally, *Race/ethnicity* is represented by a mutually exclusive categorical variable (i.e., White, Black, Hispanic, and Other race), with White as the reference category. The sample is comprised of 44.95% Whites, 17.55% Blacks, 24.16% Hispanics, and 13.34% youth categorized as Other race.

Low self-control is an average of six items from the Grasmick et al. (1993) self-control scale ($\alpha = .79$) and includes items such as, "I often do whatever brings me pleasure here and now, even at the cost of some distant goal" and "Excitement and adventure are more important to me than security." This measure utilizes two items each for impulsivity, risk-seeking, and anger from the Grasmick et al. (1993) scale (see Meldrum et al., 2020). The response options for these six items were "Strongly disagree" (=0), "Disagree" (=1), "Agree" (=2), and "Strongly agree" (=3). The mean of this variable is 1.02. The variable *Neighborhood disorder* is an average of four items on the FYSAS. The respondents were asked, "How much do each of the following statements describe your neighborhood?" followed by answer choices for "crime and/or drug selling," "fights," "lots of empty or abandoned buildings," and "lots of graffiti." The answer choices included "NO!" (=0), "no" (=1), "yes" (=2), and "YES!" (=3). This four-item measure had good internal

reliability ($\alpha = .83$), with a mean score of 0.43. This measure has also been used by researchers employing FYSAS data (e.g., Meldrum et al., 2018).

To measure *Parental control*, an average of seven items was calculated. Specifically, respondents were asked, (1) "When I am not at home, one of my parents knows where I am and who I am with," (2) "If you drank some beer, wine or liquor (for example, vodka, whiskey, or gin) without your parents' permission, would you be caught by your parents?" (3) "If you carried a handgun without your parents' permission, would you be caught by your parents?" (4) "If you skipped school, would you be caught by your parents?" (5) "Would your parents know if you did not come home on time?" (6) "The rules in my family are clear," and (7) "My family has clear rules about alcohol and drug use." The four response options for this measure mirror those of neighborhood disorder (i.e., "NO!" to "YES!"). This seven-item measure demonstrated good internal reliability ($\alpha = .86$) and has a mean of 2.22.

History of gang membership is a single-item measure reflecting responses to a question that asked, "Have you ever belonged a gang?" Answer choices for this item were "No" (= 0) and "Yes" (= 1). In this sample, 3.97% answered that they have belonged to a gang at some point in their life.[5] Finally, *Family drug use* is a single item drawn from a question that asked, "Has anyone in your family ever had a severe alcohol or drug problem?" Answer choices were "No" (= 0) and "Yes" (= 1). Out of the sample, 34.66% indicated that someone in their family has had a severe substance use problem. This item serves a proxy for family dysfunction, which has been associated with poor sleep among adolescents (Chang et al., 2019).

Analytic Plan

Stata 16.1 was used to estimate all models. As shown in Table 1, there is missingness on nearly all of the study variables, and the use of listwise deletion would result in a loss of 11,746 observations, or 21.5% of the sample. Little's (1988) test revealed that the data are not missing completely at random; accordingly, the data were imputed using multiple imputation with chained equations (MICE) and 20 imputations (White et al., 2011). All of the study variables were included in the imputation model; however, following best practices, only cases with no missingness on the dependent variable were retained for use in the analyses. The final imputed sample contains 49,360 cases.

Given the dichotomous nature of the dependent variable, binary logistic regression is used in the current study. The first model will examine the bivariate relationship between sleep duration and self-reported arrest using the categorical measure of sleep discussed above. Following this, covariates will be introduced in a series of stepwise logistic regressions. Model 2 will add

grade, sex, and race/ethnicity as covariates, and Model 3 will add low self-control, neighborhood disorder, parental control, gang membership, and family drug use. This full model will reveal whether sleep duration exhibits statistically significant effects on the likelihood of arrest, even when theoretically relevant covariates that might confound the association are included. Finally, supplementary analyses will be presented that substitute the categorical measure of sleep duration for the dichotomous and ordinal measures. To account for the non-independence of students nested within the same schools, all models use cluster-robust standard errors, with the school identification number used as the clustering variable.

Results

Table 2. Logistic Regressions Predicting Self-Reported Arrest, Categorical Sleep Duration Measure.

	Model 1		Model 2		Model 3	
Variables	*b* (RSE)	*OR*	*b* (RSE)	*OR*	*b* (RSE)	*OR*
Independent variable						
4 or fewer hours[a]	1.487*** (0.097)	4.426	1.357*** (0.103)	3.885	0.348** (0.116)	1.416
5 hours[a]	0.911*** (0.107)	2.486	0.835*** (0.111)	2.306	0.225* (0.114)	1.252
6 hours[a]	0.529*** (0.104)	1.698	0.450*** (0.106)	1.568	0.074 (0.106)	1.077
7 hours[a]	0.155 (0.106)	1.168	0.086 (0.109)	1.090	–0.122 (0.112)	0.886
10 or more hours[a]	0.354* (0.144)	1.425	0.410** (0.144)	1.507	0.221 (0.153)	1.248
Covariates						
Grade level	—	—	1.250*** (0.197)	3.492	1.032*** (0.204)	2.808
Grade level[2]	—	—	–0.067*** (0.011)	0.936	–0.054*** (0.011)	0.947
Male[b]	—	—	0.579*** (0.062)	1.785	0.425*** (0.067)	1.529
Black[c]	—	—	0.813*** (0.088)	2.256	0.515*** (0.090)	1.673
Hispanic[c]	—	—	0.313** (0.091)	1.367	0.127 (0.097)	1.135
Other race[c]	—	—	0.250* (0.108)	1.283	0.073 (0.114)	1.076
Low self-control	—	—	—	—	0.438*** (0.050)	1.550
Neighborhood disorder	—	—	—	—	0.603*** (0.045)	1.828
Parental control	—	—	—	—	–0.727*** (0.042)	0.483

(continued)

Table 2. (continued)

Variables	Model 1		Model 2		Model 3	
	b (RSE)	*OR*	*b* (RSE)	*OR*	*b* (RSE)	*OR*
History of gang membership[d]	—	—	—	—	1.787*** (0.087)	5.974
Family drug use[e]	—	—	—	—	0.336*** (0.071)	1.399
Intercept	–4.270*** (.074)	0.014	–10.438*** (0.863)	0.000	–8.906*** (0.911)	0.000
Model *F* test	61.55***		54.09***		140.06***	
FMI	0.097		0.094		0.107	
RVI	0.089		0.050		0.048	

Notes. $N = 49{,}360$. *b* = unstandardized logistic regression coefficient. RSE = robust standard error (adjusted for clustering within 685 schools); OR = odds ratio; FMI = highest fraction of missing information; RVI = average relative increase in variance.
[a]Reference is 8 or 9 hours.
[b]Reference is female.
[c]Reference is White.
[d]Reference is no history of gang membership.
[e]Reference is no family drug use.
*$p < .05$, **$p < .01$, ***$p < .001$ (two-tailed).

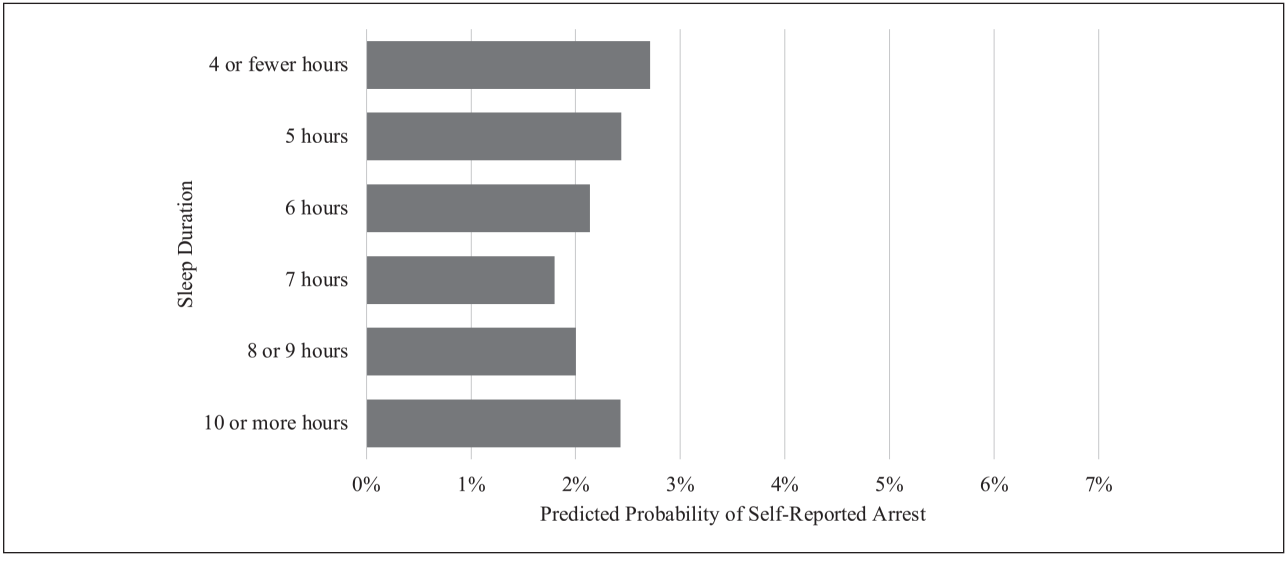

Figure 1. Predicted probabilities of self-reported arrest by sleep duration.
Note. Predicted probabilities are calculated using the coefficients presented in Model 3 of Table 2. Probabilities are calculated as average adjusted predictions (AAPs).

Supplementary Analyses

Researchers have argued against the use of continuous and dichotomous measures of sleep duration due to the potential for the inability to consider non-linear effects (e.g., Mears et al., 2020; Meldrum & Restivo, 2014). While the primary models for the current study shown in Table 2 included the categorical indicator of sleep duration, supplementary analyses were conducted to assess whether substantial differences in the association between sleep duration and self-reported arrest were observed using alternative measurement strategies for sleep duration. Model 1 of Table 3 replaces the categorical sleep duration variable with the dichotomous measure of sleep duration. Model 2 replaces the dichotomous indicator of sleep duration with the ordinal measure.

Table 3. Logistic Regressions Predicting Self-Reported Arrest, Dichotomous and Ordinal Sleep Duration Measures.

	Model 1		Model 2	
Variables	*b* (RSE)	*OR*	*b* (RSE)	*OR*
Independent variables				
Fewer than 8 hours[a]	0.070 (0.078)	1.073	—	—
Sleep duration (ordinal)	—	—	–0.060** (0.022)	0.942
Covariates				
Grade level	1.003*** (0.203)	2.726	0.979*** (0.203)	2.662
Grade level^2	–0.052*** (0.011)	0.949	–0.051*** (0.011)	0.950
Male[b]	0.411*** (0.066)	1.509	0.418*** (0.067)	1.519
Black[c]	0.520*** (0.090)	1.681	0.522*** (0.090)	1.685
Hispanic[c]	0.126 (0.097)	1.134	0.124 (0.097)	1.132
Other race[c]	0.094 (0.114)	1.098	0.088 (0.114)	1.092
Low self-control	0.441*** (0.050)	1.555	0.436*** (0.050)	1.546
Neighborhood disorder	0.608*** (0.044)	1.838	0.605*** (0.044)	1.831
Parental control	–0.774*** (0.040)	0.461	–0.750*** (0.040)	0.473
History of gang membership[d]	1.812*** (0.087)	6.125	1.803*** (0.087)	6.067
Family drug use[e]	0.341*** (0.071)	1.407	0.332*** (0.071)	1.394
Intercept	–8.669*** (0.909)	0.000	–8.359*** (0.919)	0.000
Model *F* test	190.92***		190.00***	
FMI	0.085		0.083	
RVI	0.028		0.027	

Note. $N = 49{,}360$. *b* = unstandardized logistic regression coefficient. RSE = robust standard error (adjusted for clustering within 685 schools). OR = odds ratio; FMI = highest fraction of missing information; RVI = average relative increase in variance.

[a]Reference is 8 or more hours.

[b]Reference is female.

[c]Reference is White.

[d]Reference is no history of gang membership.

[e]Reference is no family drug use.

**$p < .01$, ***$p < .001$ (two-tailed).

Notes

1. While the arrest risk for male juveniles is higher than the arrest risk for female juveniles, females are becoming increasingly active in delinquent acts as juveniles (see Sela-Shayovitz, 2016).
2. The FYSAS includes five validations tests. Two tests examine exaggerated behavior, one test asks about the use of a fictitious drug, "Derbisol," one test examines inconsistencies with reported drug use, and a final check requires at least 25% of the survey to be completed.
3. https://www.myflfamilies.com/service-programs/samh/prevention/fysas/2018/docs/2018%20FYSAS%20State%20Report.pdf
4. Due to the 2018 FYSAS having the upper limit of sleep duration as "10 or more hours," the ability to assess nonlinearity toward the upper-extreme of sleep duration is somewhat limited for this study. In other words, while there may have been participants that reported 11 or 12 hours of sleep at night, they are treated, analytically, like those who reported 10 hours of sleep.
5. The item used for gang membership may reflect that the individual is currently in a gang, but it is also possible that they were part of a gang in the past but are no longer a member.
6. While the FYSAS does not have a measure for SES, it does contain items for both maternal and paternal education. However, there is a significant amount of data missing on these items as well as a "Don't know" response option which more than 27% of participants selected.

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