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Fighting Off Tiredness: Subjective Perceptions of Sleep Impact Offending Behavior in Adolescence and Young Adulthood

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Brown, Colleen Joan

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Fighting Off Tiredness: Subjective Perceptions of Sleep Impact Offending Behavior in  
Adolescence and Young Adulthood

THESIS

submitted in partial satisfaction of the requirements  
for the degree of

MASTER OF ARTS

in Social Ecology

by

Colleen Joan Brown

Thesis Committee:  
Professor Elizabeth Cauffman, Chair  
Professor Chuansheng Chen  
Associate Professor Angela Lukowski

2021



## **DEDICATION**

To

My partner, Adam and daughter, Elle

in recognition of their love, support, and endless silliness.

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## **ABSTRACT OF THE THESIS**

Fighting Off Tiredness: Subjective Perceptions of Sleep Impact Offending Behavior in Adolescence and Young Adulthood

by

Colleen Joan Brown

Master of Arts in Social Ecology

University of California, Irvine, 2021

Professor Elizabeth Cauffman, Chair

There are profound consequences when developing youth do not get adequate sleep. In particular, sleep-deprived adolescents may be more likely to engage in offending behavior. While there is a documented association between the number of hours youth sleep and their likelihood of offending, it is unclear how youths' subjective perceptions of their own sleep contribute to offending. Further, scholars have yet to rigorously examine the relation between sleep problems and offending in young adulthood, a developmental stage in which sleep may play a critical role. Using a sample of 1,216 justice-involved male youth from the Crossroads Study, this study uses longitudinal methods to examine the relation between changes in subjective perceptions of sleep and changes in offending behavior from ages 13 to 24. Results indicate that increases in sleep problems are associated with increases in offending, particularly violent offending, regardless of youth age. Implications for juvenile and young adult justice policies are discussed.



## Introduction

There are serious consequences when adolescents do not get adequate sleep. Although it is often thought that the need for sleep decreases from childhood to adolescence, developmental science suggests that this is not the case (Carskadon, 2011). Current research recommends that adolescents sleep between nine and ten hours each night, but many teens only sleep seven hours or fewer (Wheaton et al., 2018; Kansagra, 2020). In fact, approximately 40% of adolescents experience sleep problems, and nearly 20% are considered chronically sleep-deprived (Paiva, Gaspar, & Matos, 2015). There are developmental factors that contribute to inadequate sleep across this period, and frequent poor sleep may result in long-term consequences for physical health, mental health, and behavior (Owens, 2014). One of the most serious consequences is an increased likelihood of offending behavior.

As demonstrated by the “age-crime curve,” individuals are more likely to commit crimes during adolescence than during any other developmental period, with criminal behavior peaking during adolescence and declining thereafter (Farrington, 1986; Tremblay & Nagin, 2005). Sleep deficits may contribute to the association between age and crime. Researchers often observe correlations between poor sleep and crime during adolescence (Pieters et al., 2015), and there is evidence to suggest that sleep problems drive changes in behavior, rather than the reverse (Telzer et al., 2013). In particular, longitudinal analyses have linked sleep duration to offending behavior, with fewer hours of sleep predicting greater levels of offending (e.g., Clinkinbeard et al., 2011).

Additionally, sleep *quality* and disturbances may be unique predictors of offending (Stone, Cuella, Miller-Loncar, LaGasse, & Lester, 2015). Many studies of adolescent sleep

focus solely on the numbers of hours slept, but this may obscure a broader, more meaningful picture (Lewandowski, Toliver-Sokol, & Palermo, 2011). An individual's subjective perception of their own sleep has been demonstrated to impact many important domains, such as cognitive functioning, over and above objective measures of sleep (Draganich & Erdal, 2014), highlighting the importance of the personal *feeling* of a good night's rest. Some evidence suggests that it may also influence offending behavior. Studies of community (Meijer et al., 2010) and incarcerated samples (Ireland & Culpin, 2006) have linked adolescent sleep quality to aggression, and in some cases, this rises to the level of delinquency. In other words, when adolescents subjectively feel like they have poor sleep, this may have behavioral consequences.

Though sleep has been established as an important factor for healthy adolescent development, there is comparatively little research on sleep during the transition to adulthood and how it may affect offending behavior. Young adults (aged 18-25) may struggle to get adequate sleep as they navigate the responsibilities of adulthood, such as full-time employment, starting a family, or establishing financial independence (Millman, 2015). Neuroimaging studies suggest that the brains of young adults may be more like adolescents than older adults (Larsen & Luna, 2018), and studies have demonstrated that the need for sleep remains high during this developmental period, with young adults needing the same nine to ten hours as adolescents (Carskadon, 2011; Zitting et al., 2018). Poor sleep may be especially salient for justice-involved young adults. Youth who have been in contact with the justice system are more likely to be exposed to risk factors for poor sleep, such as exposure to violence, and they may face additional barriers to economic stability, or enter parenthood at a younger age (Wolff & Shi, 2012; Khurana & Gavazzi,

2010). Finally, because young adults account for nearly 25% of all arrests despite making up less than 10% of the population (Pirius, 2019), there is a great need to examine the impact of sleep problems on their offending behavior.

In order to address gaps in developmental literature, this study aims to examine the relation between sleep and offending across adolescence and young adulthood. First, a brief review of biological and social changes that impact sleep across these developmental phases is provided. The importance of subjective measures of sleep as compared to more objective measures is also highlighted. Then, the extant literature on the link between sleep and different types of antisocial behavior across development is discussed. Taken together, poor sleep across adolescence and young adulthood may contribute to an increased likelihood of offending.

### **Developmental Changes and Sleep**

Prominent biological changes occur during adolescence that make it more difficult for teens to get sufficient sleep than younger children. Prior research has established that adolescents begin producing melatonin, the hormone that helps to induce sleep, later in the day than school-aged children (Carskadon, Wolfson, Acebo, Tzischinsky, & Seifer, 1998; Carskadon, 2011). This is accompanied by a shift in juveniles' circadian rhythms, and correspondingly, their preferred bedtime: teenagers do not start to feel sleepy until later in the night (Andrade, Benedito-Silva, Domenice, Arnhold, & Menna-Barreto, 1993). Recent evidence suggests that this trend continues well into young adulthood, only stabilizing around age 30 (Kuula et al., 2019). This delayed phase preference, however, is not accompanied by a later awakening time. Middle and high schools still have early morning start times, resulting in a compressed window of time for sleep (Carskadon et al., 1998;

Iglowstein, Jenni, Molinari, & Largo, 2003). Similarly, young adults entering the workforce may struggle to adjust to rigid 9-to-5 schedules; 1 in 5 young adults experience short sleep duration (Steptoe, Peacey, & Wardle, 2006).

Adolescents' and young adults' increased autonomy to make their own decisions may also negatively impact sleep. For instance, frequent technology use, especially at night, may lead to decreased sleep duration. Arora and colleagues (2014) found that technology use of any kind was associated with shorter sleep during early adolescence, and these habits often carry over into young adulthood, where they continue to disrupt sleep (Owens, 2014). A majority of young people also choose to drink caffeinated sodas, energy drinks, and/or coffee (Ludden & Wolfson, 2010), which is inversely related to hours slept, and positively associated with falling asleep during the day (Calamaro, Mason, & Ratcliffe, 2009). Although increased autonomy is a positive hallmark of adolescence and the transition to adulthood, youth may inevitably make decisions, such as prioritizing socialization, that lead to fewer hours of sleep.

### **Sleep and Offending**

When youth do not get adequate sleep, this may result in an increased risk for offending. For instance, one longitudinal study found that limited hours in bed and poor sleep quality among adolescents were unique predictors of offending behavior over time, and that this was especially true for boys (Meijer et al., 2010). Similarly, Clinkinbeard and colleagues (2011) found that youth who slept seven hours or fewer per night were more likely to commit property crimes, such as theft or vandalism, and youth who slept five hours or fewer were more likely to engage in violent behavior. These patterns suggest that

the negative outcomes associated with sleep may exist on a continuum, and that greater sleep deficits may produce exponentially more harmful effects.

Sleep may also be related to juvenile offending above and beyond more traditional factors associated with deviance. Backman and colleagues (2015) found that persistent problems or disturbances in sleep predicted both violent and property crimes among juveniles, and this was true even after controlling for psychopathic traits and level of parental monitoring. In other instances, sleep issues may help explain the link between traditional risk factors and criminal behavior. In a study of middle school-aged youth, sleep problems mediated the relation between victimization and delinquency, excluding aggression (Sosnowski, Kliewer, & Lepore, 2016). Moreover, among Latino youth, sleep problems were found to partially mediate the association between community violence exposure and subsequent offending (Rubens, Fite, Cooley, & Canter, 2014). The results of these studies have potentially meaningful treatment implications for delinquent youth, because tackling sleep problems may be an easier first step than attempting to eliminate other risk factors for crime, such as violence exposure. In other words, if certain risk factors for offending cannot be contained, perhaps the magnitude of their negative impact can be reduced instead.

Although sleep is important for both adolescents and young adults (and virtually all age groups), the effect of sleep on behavior may differ developmentally. Findings from a longitudinal study indicated that insufficient sleep duration and delayed sleep onset (i.e., going to bed or falling asleep late) were directly related to delinquency during adolescence, but short sleep duration failed to account for offending in emerging and later adulthood (Peach & Gaultney, 2013). Sleep duration was, however, related to impulsivity and

increased sensation-seeking during adulthood, which were in turn related to more offending. Because impulsivity and sensation-seeking gradually decline across adolescence and young adulthood, it may be that sleep is especially important for adolescent delinquency, as teens are already developmentally vulnerable to elevated levels of impulsive, risky behavior.

Finally, although the number of hours a young person sleeps is undoubtedly important, it is just as critical to consider their subjective perceptions of their sleep. Though hours of sleep and subjective quality of sleep are sometimes used interchangeably (i.e., eight hours of sleep is “good” or “sufficient” sleep), the two concepts are not always so closely aligned. In fact, mounting evidence suggests that subjective measures of sleep are a more important determinant of functioning than sleep duration. In a meta-analysis examining the effects of sleep on adolescents’ academic performance, Dewald and colleagues (2010) found that subjective reports of “feeling tired” were more strongly associated with performance than sleep duration (Dewald et al., 2010). Similarly, among young adults, subjective sleep quality has been found to be a stronger predictor of physical and mental health than number of hours slept (Pilcher, Ginter, & Sadowsky, 1997). Likewise, subjective sleep quality, but *not* sleep duration, has been found to impact cortisol stress responses, and this appears to be especially true among men (Bassett et al., 2015). Because subjective perceptions of sleep may be just as important (or perhaps more important) than the number of hours a person sleeps in understanding individuals’ behavior, it is critical to examine the relation between subjective perceptions of sleep and offending.

## **Present Study**

Building on prior research that examined the relation between sleep problems and offending across childhood and adolescence (Thomas, Monahan, Lukowski, & Cauffman, 2015), this study aims to track the impact of subjective perceptions of sleep on antisocial behavior from adolescence to young adulthood in a high-risk sample. In order to assess the nuanced relation between sleep and offending, a within-individual model was used to test the person-level association between changes in subjective sleep and changes in offending over time. In other words, as perceptions of sleep fluctuate over time, this model allows me to examine if there is an increased likelihood of offending behavior following a shift in sleep quality.

## **Method**

### **Participants**

The sample is comprised of 1,216 male youth from the Crossroads Study, aged 13-17 years ( $M = 15.3$ ,  $SD = 1.3$ ) at the time of their first arrest, who were recruited from three sites: Orange County, California ( $n = 532$ ); Philadelphia, Pennsylvania ( $n = 533$ ); and Jefferson Parish, Louisiana ( $n = 151$ ). The sample is racially and ethnically diverse, with approximately 47% of youth self-identifying as Latino, 38% as Black/African American, and 15% as White, which is also reflective of the disproportional number of minority youth who come into contact with the juvenile justice system. Participants were followed for seven years, and due to the study's accelerated longitudinal design, participants in this study range in age from 13 to 24.

### **Procedure**

The study procedures were approved by the Institutional Review Board (IRB) at all three sites. A Privacy Certificate issued by the Department of Justice protects participants' identities and responses from subpoenas, court orders, or any other type of involuntary disclosure. Prior to conducting interviews, signed parental consent and youth assent were obtained from all participants. At every interview, youth were informed about what participation would entail and were told that participation was voluntary. Participants were interviewed within 6 weeks after the disposition hearing for their first arrest (baseline). Follow-up interviews were then conducted biannually for the first three years, annually for the next two years, and then two years later at a seven-year follow up. Interviews were conducted in person with a trained research assistant using a secure, computer-administered program and typically lasted 2-3 hours. Participants were paid for each interview, with increased payment amounts at each time point to encourage study retention. Out of the 1,216 youth who joined the study and completed the baseline interview, 94% completed the 12-month interview, 93% completed the 24-month interview, 91% completed the 36-month interview, 89% completed the 48-month interview, 85% completed the 60-month interview, and 76% completed the 84-month interview.

## **Measures**

**Subjective Perceptions of Sleep.** A scale was created for this study to specifically measure participants' subjective perception of their own sleep using three items from the Revised Child Anxiety and Depression Scale (RCADS; Chorpita & Daleiden, 2000). Participants were asked how much they agreed with statements on a four-point Likert Scale, ranging from 1 ("Strongly Disagree") to 4 ("Strongly Agree"). The average score of



three items<sup>1</sup> related to participants' perceptions of their sleep quality ("I have trouble sleeping"), daytime functioning ("I am tired a lot"), and sleep disturbances ("I worry when I go to bed at night") was used to calculate a subjective sleep score at all timepoints. Internal consistency (average  $\alpha$ : 0.66,  $\alpha$  range: 0.55-0.78), while low for the earliest waves of data collection, is consistent with other well-established measures of sleep quality (e.g., Magee et al, 2008; Spira et al., 2012) particularly among adolescents (see review by Ji & Liu, 2016).

**Offending.** The 24-item Self-Report of Offending scale (SRO; Huizinga, Esbensen, & Wieher, 1991), which assesses antisocial and illegal behavior, was administered at every time point. Specifically, participants reported on whether they had engaged in different illegal behaviors (e.g., "purposely destroyed or damaged property that did not belong to you"; "sold marijuana") "ever" (asked at baseline only), over "the last 6 months" (baseline through the 36-month interview), over "the last 12 months" (48-month and 60-month interview), and over "the last 24 months" (84-month interview). Youth responded to each item with a "yes" (= 1) or "no" (= 0). A variety of offending score was calculated using a count of the total number of types of illegal behavior that the youth reported engaging in. In order to examine specific types of offenses, the items were also broken down into five subtypes, including violent offenses (10 items, e.g., armed robbery, murder), fighting (a single dichotomous item, excluding other violence items), violent offenses excluding fighting (the remaining 9 items from violent offenses), property offenses (8 items, e.g., petty theft, vandalism), and drug offenses (2 items, selling marijuana or other illicit drugs).

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<sup>1</sup> A single-item indicator ("I have trouble sleeping") was also considered, but the three-item scale was ultimately chosen for its significant correlation with an established measure of sleep quality that was only used during one study timepoint.

Fighting was included as its own item because it may be less indicative of a “serious” violent offender, particularly among developing youth (Ray et al., 2016). All outcomes for offending subtypes were dichotomized in order to account for positively skewed distributions (see Table 3).

## **Covariates**

**Internalizing Symptoms.** Because sleep quality is highly correlated with anxiety disorders (Roth et al., 2006), participants’ score on the Generalized Anxiety Disorder (GAD) subscale of the RCADS (Chorpita & Daleiden, 2000) was used to control for mental health disturbances to clarify the unique relationship between sleep quality and offending outside of these factors. Participants were asked how much they agreed with statements on a four-point Likert Scale, ranging from 1 (“Strongly Disagree”) to 4 (“Strongly Agree”). These were measured at baseline and during all follow-up interviews (average  $\alpha = .84$ , range = .81 to .87). None of the items overlapped with items used for the subjective perceptions of sleep scale.

**Substance Use.** Substance use is linked to sleep disturbances (Angarita, Emadi, Hodges, & Morgan, 2016), especially considering that individuals may use substances to either induce sleep or counteract exhaustion brought on by lack of sleep. Therefore, participants’ responses to the Substance Use/Abuse Inventory (Chassin et al., 1991) regarding alcohol, marijuana, and cigarettes were used as covariates to adjust for the potential interference of substance use in sleep quality. Items asked youth to state the frequency with which they used each substance during the recall period, using a 9-point scale that ranged from “Not at all” to “Every day.” Substance use was measured at baseline and all follow-up interviews.

**Exposure to Violence.** Because violence exposure is a strong predictor of offending, participants' level of violence exposure was assessed by a modified version of the Exposure to Violence Inventory (ETV; Selner-O'Hagan, Kindlon, Buka, Raudenbush, & Earls, 1998). Using items that capture direct victimization (e.g., "Have you been beaten up or attacked?"), witnessing violence (e.g., "Have you seen someone else being chased where you thought they might be seriously hurt?"), and exposure to death (e.g., "Has anyone close to you tried to kill him/herself?") during the recall period, youth responded to each item with a "yes" (= 1) or "no" (= 0). A variety score was calculated to assess the number of types of violence participants experienced (higher scores indicating more exposure).

### **Analytic Plan**

All analyses were conducted in Stata Version 16.1 (StataCorp, 2019). First, data were transformed to align by age, rather than interview timepoint. This allowed me to examine the effect of subjective sleep on offending as a function of age. I then utilized fixed-effects within-individual change models in which time-varying sleep problems were used to predict concurrent offending. Specifically, I examined general offending, and then examined offending outcomes by subtype: violent offenses (first all violent offenses, then fighting only, and finally violent offenses other than fighting), property and theft offenses, and drug offenses. Outcomes were not lagged in the models as I expected the predictor and outcome to be closely temporally related (i.e., sleep is more likely to be associated with next-day offending than next-year offending). This model also adjusted for concurrent symptoms of anxiety, exposure to violence, and substance use, as these variables were thought to confound the association between sleep problems and offending. Importantly, fixed-effects models use participants as their own controls, which automatically controls

for all time-invariant characteristics of the individual (e.g., race, personality traits, parental education), even including factors that are not measured (Allison, 2009; Firebaugh et al., 2013). Finally, to examine whether the nature of the association between sleep problems and offending changes across adolescence and the transition to adulthood, I included product terms (i.e., interactions) between sleep problems and age in additional models.

### **Missing Data**

Analyses were conducted to determine whether having missing data was associated with any of the study variables by using binary logistic regressions. Missing data was slightly more likely among youth who reported more offending ( $p < .001$ ) and experienced more violence exposure ( $p < .001$ ), who drank less alcohol ( $p < .001$ ) and used less marijuana ( $p < .001$ ), and who had slightly higher subjective perceptions of sleep. Having missing data was not associated with internalizing symptoms of anxiety ( $p = 0.06$ ) Missing data due to participant attrition in within-individual models has been found to be less problematic than between-individual models (Hill et al., 2017), and it is thus unlikely that missing data impacted the final analyses.

## **Results**

### **Main Effects of Sleep on Different Types of Offending**

In order to closely examine how changes in subjective perceptions of sleep were related to offending behavior, a series of fixed-effects regressions were conducted. Without including covariates, subjective perceptions of sleep were significantly and positively correlated with all types of offending. The correlation matrix can be found in Table 1, and descriptive statistics for

**TABLE 1. Correlations between Subjective Sleep and Offending Outcomes Collapsing Across Ages**

	1	2	3	4	5	6	7
<b>1. Sleep Quality</b>	-						
<b>2. General Offending</b>	0.21	-					
<b>3. Violent Offending</b>	0.16	0.81	-				
<b>4. Fighting Only</b>	0.14	0.75	0.86	-			
<b>5. Violent Offending - no fighting</b>	0.11	0.57	0.78	0.35	-		
<b>6. Property Offenses</b>	0.16	0.81	0.50	0.49	0.31	-	
<b>7. Drug Offenses</b>	0.14	0.70	0.41	0.40	0.27	0.48	-

\*\*\*All correlations are significant at  $p < .001$

all study variables can be found in Tables 2 and 3. Full results from the within-individual fixed-effects regression models, which were used to examine how changes in individuals' sleep problems was related to changes in their own offending behavior, are provided in Table 4. In addition to all time-invariant factors of the individual, all fixed-effects models included time-varying anxiety, substance use, and exposure to violence as covariates.

**General Offending.** Using fixed-effects Poisson regression, our first model indicated that increases in sleep problems were associated with small, concurrent increases in overall offending ( $b = 0.08, p = 0.003$ ). Subsequent models investigated subtypes of offending.

**Violent Offending.** A fixed-effects binary logistic regression similarly indicated that increases in sleep problems were related to concurrent changes in overall violent offending ( $b = 0.23, p = 0.01$ ). In order to probe the significant effect of sleep on violent behavior, I then analyzed "fighting" and "serious violent offenses" separately. A binary logistic fixed-effects regression indicated that changes in sleep problems were positively associated with

**TABLE 2. Means and Standard Deviations of Key Predictors and Outcomes by Age**

		Age 13	Age 14	Age 15	Age 16	Age 17	Age 18	Age 19	Age 20	Age 21	Age 22	Age 23	Age 24
		<i>n</i> = 136	<i>n</i> = 326	<i>n</i> = 615	<i>n</i> = 892	<i>n</i> = 1115	<i>n</i> = 1087	<i>n</i> = 949	<i>n</i> = 829	<i>n</i> = 643	<i>n</i> = 423	<i>n</i> = 257	<i>n</i> = 206
<b>Subjective Sleep</b>	<i>M</i>	1.61	1.62	1.60	1.61	1.66	1.65	1.63	1.72	1.69	1.69	1.63	1.73
	<i>(SD)</i>	(0.59)	(0.63)	(0.58)	(0.58)	(0.62)	(0.63)	(0.61)	(0.68)	(0.67)	(0.69)	(0.62)	(0.68)
<b>Anxiety</b>	<i>M</i>	4.93	4.73	4.77	4.68	4.91	4.63	4.52	4.74	4.80	4.49	4.61	4.68
	<i>(SD)</i>	(3.71)	(3.54)	(3.58)	(3.67)	(3.91)	(3.73)	(3.69)	(3.80)	(4.10)	(3.90)	(3.53)	(3.87)
<b>ETV</b>	<i>M</i>	0.74	1.00	0.94	0.89	0.84	0.68	0.62	0.62	0.51	0.63	0.80	0.60
	<i>(SD)</i>	(1.25)	(1.60)	(1.58)	(1.62)	(1.51)	(1.49)	(1.39)	(1.40)	(1.27)	(1.41)	(1.64)	(1.33)
<b>Alcohol</b>	<i>M</i>	0.29	0.71	1.02	1.33	1.59	1.85	2.01	2.36	3.23	3.55	3.90	4.50
	<i>(SD)</i>	(1.10)	(1.62)	(1.73)	(2.07)	(2.19)	(2.27)	(2.35)	(2.39)	(2.43)	(2.40)	(2.46)	(2.36)
<b>Marijuana</b>	<i>M</i>	0.62	1.39	1.89	2.07	2.25	2.57	2.78	3.13	3.45	3.67	4.56	4.03
	<i>(SD)</i>	(1.84)	(2.51)	(2.88)	(3.02)	(3.08)	(3.27)	(3.31)	(3.41)	(3.43)	(3.49)	(3.49)	(3.36)
<b>Cigarettes</b>	<i>M</i>	0.26	0.90	1.10	1.33	1.83	2.04	2.17	2.45	2.60	2.77	3.23	3.32
	<i>(SD)</i>	(1.06)	(2.28)	(2.43)	(2.63)	(3.01)	(3.13)	(3.25)	(3.33)	(3.28)	(3.28)	(3.23)	(3.33)

**TABLE 3. Percent of Youth at Each Age Who Endorsed at Least One Offending Item By Subtype of Offending**

	Age 13	Age 14	Age 15	Age 16	Age 17	Age 18	Age 19	Age 20	Age 21	Age 22	Age 23	Age 24
	<i>n</i> = 136	<i>n</i> = 326	<i>n</i> = 615	<i>n</i> = 892	<i>n</i> = 1115	<i>n</i> = 1087	<i>n</i> = 949	<i>n</i> = 829	<i>n</i> = 643	<i>n</i> = 423	<i>n</i> = 257	<i>n</i> = 206
<b>General SRO (all offenses)</b>	62%	59%	55%	48%	43%	37%	33.5%	37%	39%	37.5%	43%	39%
<b>Violent SRO</b>	49%	46%	41%	34.5%	28%	24%	18%	18%	17.5%	19.5%	21.5%	14%
<b>Fighting</b>	46%	46%	40.5%	34.5%	28%	22%	18%	17%	16%	19%	20%	20%
<b>Serious Violent SRO</b>	8%	11%	11%	11.5%	9.5%	7.5%	5%	5.5%	5%	7%	8.5%	7%
<b>Property SRO</b>	29%	29%	27%	22%	20.5%	13%	12%	12%	13%	11%	13%	13%
<b>Drug SRO</b>	4%	9%	14%	13%	14.5%	12.5%	13.5%	14%	12%	14%	14%	15%

changes in the likelihood of fighting ( $b = 0.25, p = 0.01$ ). Namely, when youth experienced worse sleep, this was related to a greater likelihood of engaging in fighting. However, changes in sleep were not associated with serious violent offending (violence other than fighting;  $b = 0.09, p = 0.47$ ).

**Property Offenses and Theft.** A binary logistic fixed-effects regression indicated that changes in sleep were only marginally associated with property offenses ( $b = 0.07, p = 0.07$ ).<sup>2</sup>

**Drug Offenses.** Finally, changes in sleep were not associated with drug offending ( $b = 0.05, p = 0.61$ ).

### **Interactions**

The effect of changes in subjective perceptions of sleep on offending did not vary as a function of age for overall offending or any subtypes of offending. In other words, an increase in sleep problems was associated with increased fighting, and this is equally true for adolescents and young adults. Additionally, changes in sleep problems did not appear to predict other types of crime, regardless of age.

### **Discussion**

It has been well-documented that sleep is an important determinant of behavior among developing youth, and this extends to offending behavior. Prior research has demonstrated an increased likelihood of adolescent offending following too few hours of

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<sup>2</sup> Data were also analyzed with a single-item indicator of sleep (“I have trouble sleeping”) and main effects were consistent with the three-item scale. However, the single-item indicator significantly predicted property offenses ( $p = .01$ ).



**TABLE 4. Within-Individual Associations Between Changes in Sleep Problems and Changes in Offending**

	General SRO		Violent SRO – all types		Fighting Only	
<b>Main Effects Model</b>	b	95% CI	b	95% CI	b	95% CI
<b>Sleep Problems</b>	0.08**	[0.03, 0.13]	0.23**	[0.07, 0.39]	0.25**	[0.07, 0.42]
<b>Internalizing</b>	0.02***	[0.01, 0.02]	0.00	[-0.02, 0.03]	-0.01	[-0.04, 0.01]
<b>Age</b>	-	[-0.54, -0.31]	-1.25***	[-1.57, -0.91]	-1.23***	[-1.56, -0.89]
	0.43***					
<b>Age<sup>2</sup></b>	0.01***	[0.01, 0.01]	0.02***	[0.02, 0.04]	0.03***	[0.02, 0.04]
<b>Alcohol</b>	0.05***	[0.04, 0.07]	0.12***	[0.07, 0.16]	0.12***	[0.07, 0.17]
<b>Marijuana</b>	0.08***	[0.07, 0.09]	0.08***	[0.05, 0.11]	0.07***	[0.03, 0.10]
<b>Cigarettes</b>	0.03***	[0.02, 0.04]	0.04**	[0.01, 0.08]	0.05**	[0.01, 0.08]
<b>Exposure to Violence</b>	0.19***	[0.17, 0.20]	0.46***	[0.40, 0.52]	0.38***	[0.32, 0.45]
<b>Interaction Model</b>	b	95% CI	b	95% CI	b	95% CI
<b>Sleep Problems by age</b>	0.07	[-0.09, 0.24]	-0.11	[-0.64, 0.41]	-0.29	[-0.85, 0.27]
<b>Sleep Problems by age<sup>2</sup></b>	-0.00	[-0.01, 0.00]	0.00	[-0.01, 0.02]	0.01	[-0.01, 0.02]
	Violent SRO – no fighting		Property SRO		Drug SRO	
<b>Main Effects Model</b>	b	95% CI	b	95% CI	b	95% CI
<b>Sleep Problems</b>	0.09	[-0.16, 0.34]	0.17	[-0.02, 0.35]	0.05	[-0.16, 0.27]
<b>Internalizing</b>	0.03	[-0.02, 0.07]	0.06***	[0.02, 0.09]	0.00	[-0.03, 0.04]
<b>Age</b>	-0.36	[-0.91, 0.18]	-1.76***	[-2.16, -1.36]	0.28	[-0.19, 0.74]
<b>Age<sup>2</sup></b>	0.01	[-0.01, 0.02]	0.04***	[0.03, 0.05]	-0.01	[-0.02, 0.00]
<b>Alcohol</b>	0.11**	[0.04, 0.18]	0.13***	[0.08, 0.18]	0.07*	[0.01, 0.12]
<b>Marijuana</b>	0.07**	[0.02, 0.12]	0.12***	[0.09, 0.16]	0.23***	[0.19, 0.26]
<b>Cigarettes</b>	-0.04	[-0.09, 0.01]	0.07***	[0.01, 0.11]	0.08***	[0.04, 0.12]
<b>Exposure to Violence</b>	0.47***	[0.39, 0.54]	0.36***	[0.29, 0.42]	0.33***	[0.28, 0.40]
<b>Interaction Model</b>	b	95% CI	b	95% CI	b	95% CI
<b>Sleep Problems by age</b>	2.58	[-4.91, 10.08]	0.01	[-0.56, 0.58]	0.62	[-0.10, 1.34]
<b>Sleep Problems by age<sup>2</sup></b>	0.00	[-0.02, 0.03]	0.00	[-0.01, 0.02]	-0.02	[-0.03, 0.00]

\* $p < .05$  \*\* $p < .01$  \*\*\* $p < .001$

sleep, and our results suggest that subjective sleep may also plays an important role in certain types of offending behavior. Though sleep problems did not impact all types of crime in the current study, when youth reported poor sleep, they were more likely to report getting into fights. Critically, this holds true for both adolescents and young adults, suggesting that youth remain vulnerable to the effects of poor sleep as they transition to adulthood.

First, it is noteworthy that subjective sleep is related to fighting, but not other types of crime. While other types of crimes are strongly related to more traditional risk factors for offending, such as internalizing problems, substance use, and violence exposure, something about sleep appears to uniquely contribute to fighting. Research has shown that sleep-deprived individuals have trouble recognizing facial cues for certain nuanced emotions, while retaining the ability to recognize more primal emotions, such as fear and anger (Killgore et al., 2017). When youth experience poor sleep, they may indeed misinterpret or overinterpret certain facial cues (i.e., heightened threat perception) and react more aggressively. In other words, although subjective sleep quality might not contribute to elevated levels of crime in general, perhaps it impacts the way individuals react to other people and their surroundings. Additionally, sleep problems have been linked to difficulties with impulse control and subsequent risk-taking (Wong et al., 2010). Poor sleep may make it difficult for youth to control their behavior, resulting in rash actions that carry serious consequences. Though there are multiple potential pathways in which sleep might influence offending behavior, the spontaneous nature of fighting suggests that it may be related to individuals' reactivity. Nevertheless, it will be important

for future research to examine the potential mechanisms underlying the relation between sleep and violent behavior.

Second, although sleep was not related to “serious” violent offending, it was related to the most common type of violent offending (i.e., fighting). Acts of serious violence are unquestionably devastating, but they are also rare, while simple assault (fighting without a weapon) accounts for almost two-thirds of all violent crime (Morgan & Truman, 2020). This is also reflected in our sample, which is comprised of youth who generally did not engage in serious violence over a seven-year period. On one hand, I may not have had sufficient variability in the sample to detect an effect of sleep on serious violent behavior. On the other hand, the findings also suggest that these youth are not otherwise violent people – when they get into fights as a result of poor sleep, they are becoming involved in violence that likely could have been avoided. Nearly 40% of all violent crimes are committed by individuals under the age of 30 (Morgan & Truman, 2020), and addressing sleep quality may be a key factor for reducing violence in these age groups.

This study is not without limitations. One of the advantages of utilizing a fixed-effects model is the ability to examine within-individual change while automatically controlling for all time-stable effects, producing less biased results. However, because all time-stable effects are included in a single term, it is not possible to isolate the effects of specific time-stable factors, such as race. Accordingly, these models do not allow me to examine if the relation between sleep and offending is different among different groups. Future studies should consider the specific impact of race and socioeconomic status when investigating the effect of subjective sleep quality on offending, given that both of those factors have been associated with poor sleep quality (Mezick et al., 2008; Fuller-Rowell et

al., 2017). It is also important to acknowledge that our measure of subjective perceptions of sleep is not an established measure in the field and may underestimate the impact of sleep for certain types of offending (i.e., low internal consistency at earlier interview waves). Nevertheless, the significant association between sleep and one of the most common forms of offending presents important treatment implications for reducing fighting.

Despite these limitations, the findings of this study further our knowledge on offending behavior, and especially violent behavior. Specifically, offending is influenced by a complex combination of individual and contextual factors, and developing solutions to reduce offending may ultimately require a complex approach. However, subjective sleep problems are easy to recognize, and many empirically validated treatments are readily available (e.g., Peterman et al., 2016; Pagel & Parnes, 2001). Because sleep problems are prevalent among adolescents and young adults, and given that sleep quality is linked to increased fighting regardless of age in our study, sleep interventions are likely to have very broad applications. Justice system authorities are thus encouraged to both assess sleep problems in developing youth, and to provide resources (perhaps even rehabilitative “sanctions”) to help improve sleep. Even brief mindfulness-based interventions, which could be included as part of the therapeutic terms of probation, have effectively improved sleep quality (Rusch et al., 2019). By enhancing the sleep quality of system-impacted youth, we can potentially reduce pathways toward violent behavior.

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