

The Impacts of Sleep Deprivation on Adolescent Decisions Involving Risk Taking

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Abstract

This study examined the relationships among sleep behavior, self-regulation, and academic decision-making in a sample of 89 male adolescents (ages 14 - 18) recruited through online networks of former classmates from a single-gender elementary school in China. The survey included items designed to assess key constructs such as academic risk-taking, overconfidence, and self-regulation, adapted from validated behavioral frameworks. Measures included sleep habits, use of social media, study timing, confidence in academic performance, and impulsivity in decision-making. Multivariate analyses were conducted to determine the extent to which sleep behavior predicted decision-making and delayed discounting outcomes. Although not statistically significant, students who reported more average sleep per night tended to prefer larger, delayed rewards. A greater number of siblings was significantly associated with a preference for smaller, immediate rewards, suggesting potential environmental influences on impulsivity, $t(28.3) = -22.2$, $p = .034$, $\eta^2 = .565$. Interestingly, students who preferred immediate rewards were not necessarily overconfident in their academic abilities compared with peers who slept more, indicating that consistent sleep may support self-regulation despite sleep deprivation. The sleep variable was dichotomized at 6.5 hours, chosen based on prior adolescent sleep research identifying < 7 hours as suboptimal (Weaver et al., 2018). Age differences also emerged, with younger students more likely to feel well-rested only some of the time, while older students showed more balanced perceptions of restfulness, suggesting increased self-awareness with age. All procedures followed ethical guidelines; participation was anonymous, voluntary, and approved by a school administrator.

Keywords

Risk-Taking, Delay Discounting, Adolescent Brain, Sleep Deprivation, Brain Activity, Impulsivity, Neuroscience, Risk-Taking

1. Introduction

Adolescents' engagement in risk behaviors poses significant threats to health and safety, not only to others but to themselves. In 2017, 2364 adolescents aged 16 - 19 died in motor vehicle crashes, and over 300,000 were treated in emergency departments for crash-related injuries (National Academies of Sciences, Engineering, and Medicine, 2019). Alcohol consumption is a particularly salient factor in these fatalities, as approximately 19% of teen driver deaths involved blood alcohol concentrations at or above the legal limit of 0.08 g/dl. These statistics highlight the intersection between adolescent risk-taking and mortality, underscoring how impulsive decision-making and diminished self-regulation—whether due to substance use, sleep deprivation, or social influences—contribute to outcomes with life-threatening consequences.

According to the National Institute of Mental Health (NIMH), the brain, including the prefrontal cortex, continues to develop and mature into the mid-to-late 20 s. This delayed maturation is why adolescents may engage in more risk-taking behaviors and have less impulse control compared to adults, as the prefrontal cortex is not yet fully developed¹.

Adolescents who experience frequent sleep difficulties face substantially higher risks for engaging in substance-related and risky behaviors. Compared to peers without sleep problems, those reporting trouble sleeping once a week or more over the past year were up to 80% more likely to engage in regretted sexual activities and approximately 47% more likely to experience alcohol-related interpersonal problems or binge drink. Longitudinally, these risks increased, with sleep-troubled adolescents showing up to 92% higher likelihood of regretted sexual activity, 71% higher risk of alcohol-related interpersonal problems, 65% higher risk of binge drinking, and 57% higher risk of driving while intoxicated. These findings highlight the significant link between inadequate sleep and increased engagement in high-risk behaviors during adolescence (Wong et al., 2015).

Adolescence is marked by significant neurodevelopmental changes, particularly in the prefrontal cortex (PFC), which governs executive functions such as impulse control, risk assessment, and long-term decision-making (Arain et al., 2013; Steinberg, 2010). As the PFC matures later than subcortical reward-processing regions, such as the ventral striatum, a neural imbalance is created that predisposes adolescents to heightened reward sensitivity and risk-taking (Casey et al., 2008; Steinberg, 2010). Compounding this developmental vulnerability, insufficient sleep, reported by over 70% of high school students, exacerbates cognitive deficits and amplifies risk-taking behaviors (McKnight-Eily et al., 2011; Weaver et al., 2018).

Sleep deprivation disrupts functional connectivity between the dorsolateral prefrontal cortex (DLPFC), critical for cognitive control, and affective regions, such as the insula, which processes reward and emotional arousal (Telzer et al., 2013). This neural dysregulation may impair adolescents' ability to evaluate long-term consequences, leading to preferences for immediate rewards (delay discounting)

¹<https://www.nimh.nih.gov/health/publications/the-teen-brain-7-things-to-know>

and overconfidence in risky decisions (Libedinsky et al., 2013; O'Brien & Mindell, 2005). Research indicates that for every hour of sleep lost, an adolescent's risk of obesity increases substantially, with chronic sleep restriction in adolescence identified as a key risk factor for excess weight and related health consequences (Owens et al., 2014). Additionally, adolescents' physical and financial ease of access to energy-dense, low-nutrient foods exacerbates risk-taking behavior, thereby increasing obesity prevalence among youth (WHO Regional Office for Europe, 2024).

These findings align with recent work emphasizing the cognitive and emotional costs of chronic sleep restriction. A 2024 study by de Bruin and van Run found that adolescents averaging fewer than seven hours of sleep showed a 23% increase in impulsive decision-making scores relative to peers sleeping eight or more hours. Similarly, Beattie et al. (2016) demonstrated that insufficient sleep predicts poorer metacognitive accuracy (students' ability to judge their own performance), closely related to the overconfidence construct examined here. Together, these new findings reinforce the present study's interpretation that reduced sleep compromises prefrontal control, amplifies emotional reactivity, and increases susceptibility to risk-taking behaviors in school contexts.

Neuroimaging studies have demonstrated that poor sleep quality correlates with reduced DLPFC activation during cognitive tasks and heightened insula reactivity during reward processing, effectively tilting the balance toward affective-driven choices (Telzer et al., 2013). These findings align with dual-system models of adolescent neurodevelopment, wherein delayed PFC maturation and accelerated limbic system development increase susceptibility to risk-taking (Casey et al., 2008). For example, sleep-deprived adolescents exhibit 1.43 times greater odds of engaging in risky behaviors, including substance use and unsafe sexual practices, compared to well-rested peers (McKnight-Eily et al., 2011; Short & Weber, 2018). Even modest sleep deficits impair effort discounting, the willingness to exert cognitive effort for rewards, though their impact on delay discounting remains debated (Libedinsky et al., 2013; Reynolds & Schiffbauer, 2004).

Electroencephalography (EEG) research further demonstrates the unique neural vulnerabilities adolescents face under sleep deprivation. In adults, sleep loss typically produces elevated alpha power (8 - 12 Hz) during wakefulness, particularly with eyes open, reflecting cortical idling and reduced attentional readiness. By contrast, adolescents show a significant decrease in alpha power under both eyes-open and eyes-closed conditions, with reductions observed across most EEG channels (Campbell et al., 2022). This decrease is interpreted as evidence of incomplete recuperation from sleep loss, manifesting in greater daytime sleepiness and impaired vigilance. Importantly, the adolescent EEG response diverges from that of adults, suggesting that the developing brain may have distinct or less efficient compensatory mechanisms. These developmental patterns are consistent with broader processes of synaptic pruning and cortical reorganization occurring during adolescence, and they may underlie the heightened susceptibility of youth to risk-taking behaviors when sleep-deprived.

Research using event-related potentials (ERPs) has shown that children exhibit greater delay discounting than adults, choosing immediate rewards more often and displaying distinct neural markers of immature decision-making. In one study, children demonstrated longer P2 latency during early evaluation phases, smaller N2 amplitudes over frontal regions (indicating weaker cognitive control), and larger amplitudes when making final decisions—suggesting they exert greater neural effort to reach a choice (Zhou et al., 2012). These ERP components are critical indicators of attention allocation and self-regulatory processing, both of which are vulnerable to disruption under sleep deprivation. Further ERP research comparing adolescents to adults has revealed that impulsive choices in adolescents are closely tied to how their brains process delayed outcomes. Specifically, adolescents exhibited a weaker feedback-related negativity (FRN) response when anticipating delayed rewards, suggesting that their brains assign lower subjective value to future outcomes compared to those of adults (Yeung et al., 2018). This diminished neural signal was directly linked to greater impulsivity in behavior, as measured by a delay discounting task. These results support the idea that adolescents are not only behaviorally but also neurologically biased toward immediate gratification, a tendency that could be heightened under sleep deprivation, which is known to impair prefrontal functioning and reward valuation systems.

Choice Behavior

Researchers often assess risk-taking behaviors in controlled laboratory settings to better understand how people make decisions under uncertainty. One widely used method is the Iowa Gambling Task (IGT), a psychological test designed to simulate real-life scenarios involving risk, uncertainty, and delayed gratification. In the IGT, participants are presented with four virtual decks of cards labeled A, B, C, and D. Each time a card is selected, it results in a monetary reward, but some selections also include penalties. Decks A and B are considered *disadvantageous*; they offer larger, less frequent rewards but lead to greater long-term losses. In contrast, decks C and D are *advantageous*; these decks provide smaller, more consistent rewards and fewer losses, resulting in better long-term gains.

Participants are not told the rules in advance and must learn through trial and error, using feedback from wins and losses to guide their choices. Interestingly, research on decision-making in both humans and non-human primates suggests that early in learning or in simple tasks, individuals may engage in probability matching, distributing their choices in proportion to the likelihood of reward rather than consistently selecting the most rewarding option. Over time, with extended experience or in more complex tasks, maximizing behavior, consistently choosing the option with the highest long-term payoff, tends to emerge. This shift from probability matching to maximizing highlights the dynamic nature of decision-making and the role of experience in shaping adaptive choice strategies. Over time, most individuals learn to favor the advantageous decks, gradually shifting away from the risky ones. This process reflects the ability to prioritize long-term outcomes over short-term gratification.

The IGT is commonly used to assess decision-making abilities in both healthy individuals and clinical populations, such as those with brain injuries, substance use disorders, or psychiatric conditions. It also offers insights into the neural mechanisms of decision-making, particularly the role of the ventromedial prefrontal cortex (VMPFC), a brain region critical for evaluating risk and reward. Overall, the IGT helps researchers better understand how people adapt their choices based on experience, and how this process can be disrupted by cognitive or emotional impairments (Bechara et al., 1994).

A landmark study by Bechara, Damasio, Damasio, and Anderson investigated how damage to the ventromedial prefrontal cortex (VMPFC) affects decision-making. Their research introduced the above-mentioned Iowa Gambling Task (IGT) as a tool to simulate real-life decisions involving uncertainty, risk, and future consequences. The study found that individuals with VMPFC damage consistently made poor decisions on the IGT, favoring card decks that offered high immediate rewards but led to greater long-term losses. Despite intellectually understanding the risks involved, these patients failed to adjust their behavior over time, unlike healthy participants who gradually learned to avoid the disadvantageous decks.

The findings suggest that the VMPFC is crucial not just for logical reasoning but for integrating emotional signals and future consequences into the decision-making process. This paper provided strong evidence that impairments in this brain region result in an insensitivity to future consequences, helping to explain why patients with such damage often struggle with risky behavior and poor judgment in real-world scenarios (Bechara et al., 1994).

Animal Risk Taking and Sleep Deprivation

Animal studies exploring the relationship between sleep deprivation, reward processing, and risk-taking behaviors have revealed important insights into the neurobiological mechanisms underlying decision making. In rodents, tasks such as the Rodent Gambling Task or probability discounting paradigms assess risk-related choices by manipulating reward probabilities and magnitudes, often resulting in rats adapting strategies like maximizing or frequency matching (Rivalan et al., 2009; PMC7838799; PMC9220963). Sleep deprivation, however, has produced mixed effects: short periods of deprivation may not have a clear effect on risk preferences, while more prolonged or chronic loss of sleep can increase the tendency for disadvantageous, riskier choices (PMC7838799; Rivalan et al., 2009).

In non-human primates, especially rhesus macaques, single-unit recording studies have identified robust neural encoding of risk/reward computations within the insular cortex during risky decision-making tasks (McCoy & Platt, 2005; PMC3378365). These studies show that, under certain conditions, macaques display persistent risk-seeking behavior, preferring probabilistic large rewards over guaranteed smaller ones, even when it may not maximize expected value, possibly reflecting reward system dynamics and contextual cues specific to non-verbal learning (McCoy & Platt, 2005; Hayden & Platt, 2007). Such animal findings underscore the complexity of biological and experiential factors, including

sleep, that shape the neural and behavioral foundations of risky decision making.

Delayed Sleep-Wake Phase Disorder (DSWPD) is a prevalent circadian rhythm disorder among adolescents, characterized by a significant delay in the sleep-wake cycle. Prevalence estimates for DSWPD in adolescents range from 1% to 16%, with variations based on diagnostic criteria and population studied. A study by [Sivertsen et al. \(2013\)](#) reported a prevalence of 3.3% among Norwegian adolescents, with higher rates observed in older age groups and females. This disorder often co-occurs with insomnia, with over half of adolescents with DSWPD also meeting the criteria for insomnia.

The neural underpinnings of delayed sleep onset in adolescents are complex and involve developmental changes in brain regions responsible for circadian regulation. Adolescence is marked by a shift in the timing of melatonin secretion, the hormone that signals sleep onset, leading to a later sleep-wake cycle. This shift is thought to be driven by changes in the suprachiasmatic nucleus (SCN) of the hypothalamus, which regulates the circadian rhythm. Additionally, the prefrontal cortex, which is involved in executive functions such as decision-making and impulse control, undergoes significant development during adolescence. Sleep deprivation and circadian misalignment can impair the functioning of the prefrontal cortex, leading to difficulties in regulating sleep patterns and increased vulnerability to mood disorders and cognitive deficits. Furthermore, the interaction between the circadian system and the sleep-wake homeostatic system becomes more pronounced during adolescence. The homeostatic drive for sleep increases with prolonged wakefulness, but the delayed circadian rhythm can make it difficult for adolescents to fall asleep at conventional times, leading to insufficient sleep and associated negative outcomes ([Narala et al., 2024](#)).

Despite these advances in understanding the influencers of risky decisions, most research relies on laboratory-based tasks or small samples, neglecting real-world academic risk-taking (e.g., procrastination, cheating) and overconfidence in self-assessment. Furthermore, the interplay between sleep duration, grade level, and age in moderating risk profiles remains poorly understood. This study addresses these gaps by examining how self-reported sleep duration and quality relate to academic risk-taking, delay discounting, and overconfidence in a large sample of high school students. By integrating neuroscientific frameworks on PFC development with behavioral sleep research, this investigation aims to clarify how sleep deprivation interacts with adolescent neurobiology to shape decision-making, a critical step for designing targeted interventions to mitigate risk.

Research on delayed sleep onset prevalence in adolescents has revealed important insights. For example, a large population-based study in Norway (the [ung@hordaland](#) study) examined over 10,000 adolescents aged 16 - 18 and found that 3.3% met criteria for Delayed Sleep Phase Syndrome (DSPS), a condition characterized by delayed sleep onset and difficulty waking at conventional times ([Sivertsen et al., 2013](#)). The prevalence was notably higher in girls (3.7%) than in boys (2.7%), and more than half of those with DSPS also experienced clinical in-

somnia. Furthermore, adolescents with DSPS showed significantly higher rates of school non-attendance, highlighting the real-world academic impact of delayed sleep onset.

Multiple studies suggest that adolescent males are particularly prone to impulsive and risky decision-making, more so than their female counterparts. For example, research on sleep deprivation and risk behavior found that while men's risk-taking behavior remained steady under sleep loss, women's risk-taking significantly decreased (Mather & Lighthall, 2012). This gender divergence suggests that males may be more neurologically or behaviorally predisposed to risk tolerance, even under cognitive fatigue. Additionally, delay discounting studies report that males often display greater preference for immediate rewards and higher sensation-seeking behavior, contributing to a higher prevalence of risk-based decision-making during adolescence (Joseph et al., 2016). Given these trends and the goal of minimizing variability due to gender in cognitive and behavioral outcomes, the current study focuses exclusively on a male adolescent population to better isolate the effects of sleep deprivation on impulsive decision-making.

2. Methods

Participants and Recruitment

Data were collected via an anonymous online survey distributed through email and social media networks to former classmates from the researcher's elementary school in China. A total of 405 students were invited to participate, yielding 89 valid responses (response rate \approx 22%). The sample included male adolescents aged 14 - 18 who were enrolled in various high schools across China at the time of data collection. Participation was voluntary and uncompensated.

Measures and Variables

The survey contained items designed to assess key constructs related to academic decision-making, risk-taking, and self-regulation. Core variables included self-reported sleep duration, perceived restfulness, impulsivity, and confidence in academic performance. Representative items included: "How often do you take risks in academic settings?" (academic risk-taking), "Have you ever been certain you would do well on a test but scored lower than expected?" (overconfidence), and "How often do you prioritize short-term enjoyment over long-term responsibilities?" (self-regulation). Items were conceptually adapted from validated self-regulation and adolescent risk-taking frameworks (Steinberg, 2010; Duckworth & Seligman, 2005), while new items were created to reflect the academic context. Sleep duration was dichotomized at 6.5 hours based on prior adolescent sleep research identifying $<$ 7 hours as suboptimal (Weaver et al., 2018), though future analyses may treat sleep as a continuous variable to reduce information loss.

Power and Sensitivity Analysis

A sensitivity analysis was conducted to evaluate whether the sample size ($N = 89$) provided adequate statistical power. Assuming $\alpha = .05$ and desired power ($1 - \beta$) = .80, the study was powered to detect a minimum standardized mean differ-

ence of Cohen's $d \approx 0.60$ for two-tailed independent-sample t-tests—equivalent to a medium-to-large effect size. For one-way ANOVA designs, the corresponding effect size thresholds ranged from $f = 0.30$ to 0.38 , depending on the number of groups. These values indicate that the study was sufficiently sensitive to detect moderate or large effects but underpowered for smaller effects (e.g., $d < 0.30$). Therefore, nonsignificant findings for small associations should be interpreted cautiously, and replication with larger samples is recommended. (Power estimates derived using G*Power 3.1.)

Ethical Considerations

This study was conducted in accordance with institutional and ethical research standards. Although China does not have an institutional review board (IRB) system identical to that of the United States, administrative permission to conduct the study was obtained from a school administrator. The research involved no interventions or sensitive personal data collection and was limited to anonymous, voluntary online survey responses.

Before beginning the survey, participants were presented with an introductory screen outlining the study's purpose, approximate duration, and their right to withdraw at any time without consequence. This screen functioned as an informed consent form: only individuals who actively clicked the "Begin Survey" link were able to proceed, indicating voluntary participation. No personally identifiable information (e.g., names, emails, or IP addresses) was collected. Data were stored securely and analyzed in aggregate form to ensure participant confidentiality.

Participants were all high school students aged 14 - 18 who were recruited through online networks of former classmates from the researcher's elementary school. They happened to be minors due to the age range of the population being studied, but no parental data were collected, and all participation occurred independently through online access.

Research Questions

The present study seeks to address several research questions concerning individual differences in risk-taking and decision-making, exploring the relationships between sleep, social media usage, extracurricular involvement, sibling number, and self-reported restfulness. First, does the amount of sleep individuals receive significantly impact their preference for delayed discounting? Specifically, are there observable differences in how people weigh immediate versus delayed rewards as a function of hours slept, or are such preferences invariant to sleep patterns? Second, is the frequency of academic risk-taking behaviors influenced by daily social media usage and weekly participation in extracurricular activities, or do these factors have minimal effect on such behaviors? Third, are there significant differences in short-term and long-term decision-making preferences that can be attributed to the number of siblings a person has and their age, or are these preferences independent of these demographic characteristics? Fourth, does recent risk-taking activity vary according to how well-rested participants feel and

the frequency with which they report pulling all-nighters, or are such risk-taking tendencies not associated with self-reported sleep quality? Finally, does the frequency of risk-taking behavior differ meaningfully across age groups, or is risk-taking relatively constant regardless of age? These research questions are designed to test the null hypotheses that no significant differences exist for each variable combination, as opposed to the alternative hypotheses suggesting that significant differences may exist. This framing enables a systematic investigation of the nuanced roles that sleep, social environment, and personal characteristics play in risk-related decision-making. The following are formal hypotheses that have spawned from these more general research questions:

Hypotheses

Hypothesis 1:

H1₀: There are no significant differences in individuals' delayed discounting preferences based on their hours of sleep.

H1₁: There are significant differences in individuals' delayed discounting preferences based on their hours of sleep.

Hypothesis 2:

H2₀: There are no significant differences in the frequency of academic risk-taking behavior as a function of daily social media usage hours and weekly hours spent in extracurricular activities.

Hypothesis

H2₁: There are significant differences in the frequency of academic risk-taking behavior as a function of daily social media usage hours and weekly hours spent in extracurricular activities.

Hypothesis 3:

H3₀: There are no significant differences in weekly extracurricular activities as a function of getting 6.5 hours of sleep or less each night.

H3₁: There are significant differences in weekly extracurricular activities as a function of getting 6.5 hours of sleep or less each night.

Hypothesis 4:

H4₀: There are no significant differences in reported overconfidence in test performance and reward preference as a function of age.

H4₁: There is a significant difference in reported overconfidence in perceived test performance and reward preference as a function of age. Specifically, older students will have a greater ability to self-regulate on self-capabilities and conservative reward preference.

Hypothesis 5:

H5₀: There are no significant differences in reported reward preference (delayed discounting) and number of siblings.

H5₁: There is a significant difference in reported reward preference and number of siblings. Those having more siblings will be more likely to choose a short-term reward over a delayed, larger reward due to a learned competition for resources.

Methods

Data were collected via an online survey (Google Survey) distributed through email to all students in grades 9 to 12, resulting in a sample of 89 respondents. The final sample included 89 male students (age $\bar{x} = 15.8$, s.d. = 1.49). Standardized measures assessed self-reported information related to reward preference, sleep patterns, risk-taking, social media use, and hours spent on extracurricular activities.

3. Results

An independent sample t-test was conducted to determine whether there was a significant difference in individuals' delayed discounting preferences based on their hours of sleep (hypothesis 1). No significant difference was found ($t(86) = 2.12$, $p = 0.149$). Even so, those reporting a preference for a larger reward in a month reported a greater number of hours of reported sleep with less variability in the number of hours of sleep compared to those reporting to "prefer a small reward today" ($X = 6.50$, s.d. 1.23; $X = 5.75$, s.d. = 1.59). See **Figure 1**.

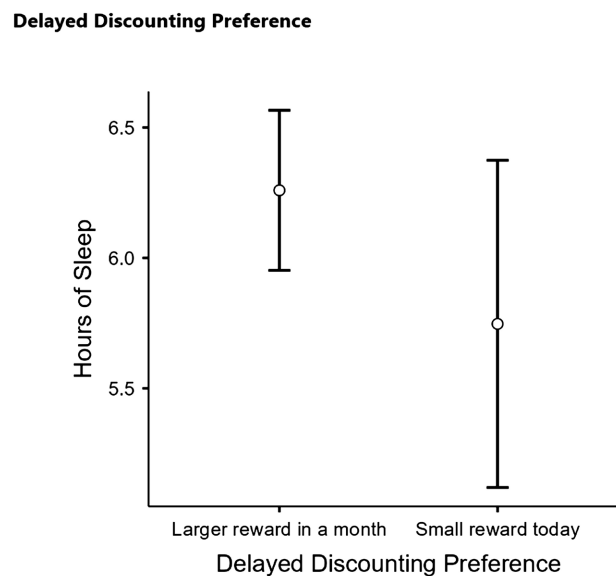


Figure 1. Delay discounting preference and average reported hours asleep. Although not significant, delay discounting preferences differed as a function of the amount of reported sleep. Students who reported having more average sleep per night were more likely to report a preference for a larger, delayed reward.

To determine if there is a relationship between reported daily social media use and academic risk-taking (hypothesis 2), an ANOVA was conducted. No significant differences in the frequency of academic risk-taking behavior as a function of daily social media usage hours, $F(4,84) = 0.922$, $p = 0.456$. No significant difference was found in reported frequency of academic risk-taking and weekly extracurricular hours $F(4,83) = 1.14$, $p = 0.341$.

Siblings and Reward Preference

Independent samples t-tests revealed a significant difference in delay discounting based on the number of siblings. Students with more siblings were more likely

to choose the smaller immediate reward. A Welch's t-test corrected for unequal group variance showed that there was a significant difference in reward preference with the number of reported siblings, $t(28.3) -2.22$, $p = 0.034$, $\eta^2 = 0.565$. This suggests household competition may influence preference for immediate rewards. See **Figure 2**.

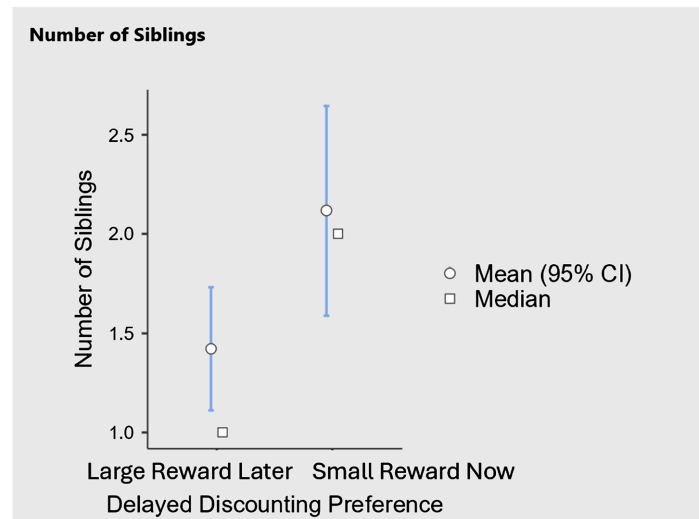


Figure 2. A significant difference in reward preference was found with the reported number of siblings. Those with more siblings were significantly more likely to choose a short-term, immediate reward over a larger, delayed reward.

Age, Overconfidence, and Reward Preference

To determine the extent to which reward preference (small reward now versus larger reward later) and overconfidence on test performance have on age, an ANOVA was run. A small, but significant interaction was found ($F = 2.40$, $p = .024$, $\eta^2 = 0.195$). Upperclassmen who report rarely seeking a short-term, small reward gain are less likely to report feeling overconfident in their test performance (See **Figure 3**).

Short-term vs Long-term Choices * Overconfident Test Performance

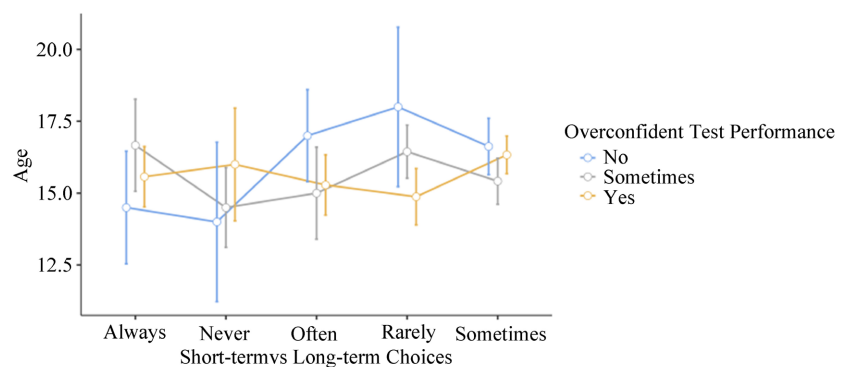


Figure 3. A significant interaction between reported overconfidence on test performance and reward preference was found by age.

Hypothesis 3 was tested using an independent samples t-test, which found that getting less than 6.5 hours of sleep each night has a significant impact on reported duration of daily extracurricular activities ($t(86) -3.00, p = .004, \eta^2 = -0.794$). Individuals reporting 6.5 hours of sleep or less still managed to engage in extracurricular activities for a longer duration than those who reported sleeping more than 6.5 hours. This suggests that, although more sleep deprived, students with a consistent routine have a greater regulatory mechanism. This is also evidenced in delayed discounting choice, as students preferring a small immediate reward were less likely to engage in structured extracurricular activities (Figure 4).

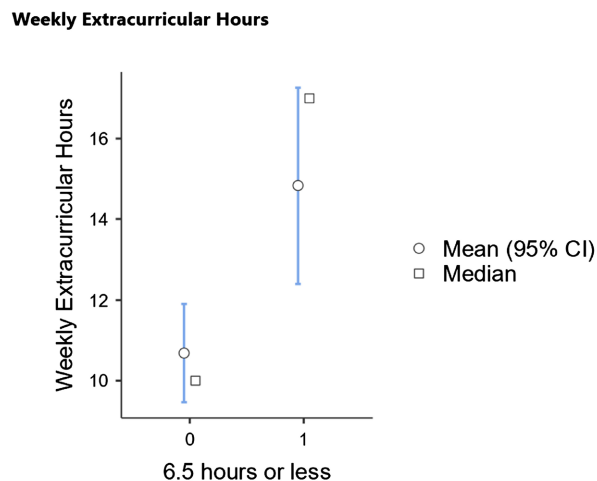


Figure 4. Those reporting more than 6.5 hours of nightly sleep spent significantly more hours per week on extracurricular activities. This suggests that, even though more hours were spent actively engaging in routine extracurricular activities, these students can regulate their routines to include sufficient sleep.

There was also a small but significant difference found in reported feelings of being rested by age $F(2, 85) = 3.50, p = 0.034, \eta^2 = 0.076$. Younger students were more likely to report feeling well rested only some of the time, as compared to older students, who rated being rested and not rested at about the same frequency. See Figure 5.

An ANOVA was conducted to examine the effect of daily social media usage on impulsive regret when sleep-deprived. Results revealed a significant main effect, $F(2, 85) = 3.12, p = 0.049, \eta^2 = 0.068$, suggesting that the number of hours spent on social media per day was associated with differences in regret following impulsive decision-making when lacking sleep. Post hoc Tukey's HSD test indicated that students who reported using social media heavily and also experiencing impulsive regret when sleep-deprived ("yes") scored higher on regret compared to those who reported without such experiences, though this comparison only approached statistical significance (mean difference = 1.392, SE = 0.655, $t(85) = 2.13, p = 0.091$). Differences between the "no" and "sometimes" groups (mean difference = 0.541, SE = 0.653, $p = 0.687$), as well as between the "sometimes" and "yes" groups (mean difference = 0.852, SE = 0.436, $p = 0.130$), were not statistically significant.

These results suggest a trend in which heavier social media use may be linked to heightened impulsive regret under conditions of sleep deprivation, though the effect appears modest, and post hoc comparisons did not reach levels of significance (Figure 6).

Feel Well-Rested

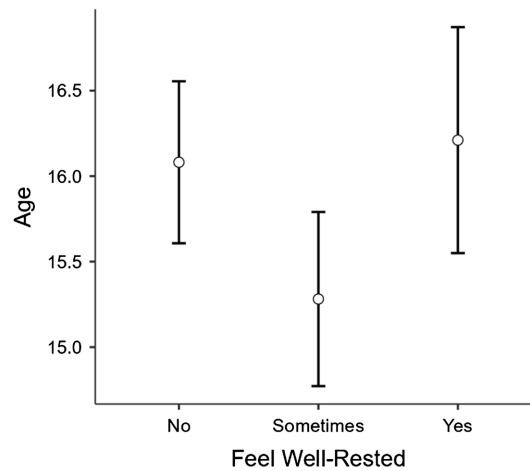


Figure 5. Younger students were more likely to report only sometimes feeling well-rested compared to older students, who were more decisive on how rested they typically feel.

Estimated Marginal Means

Impulsive Regret When Sleep-Deprived

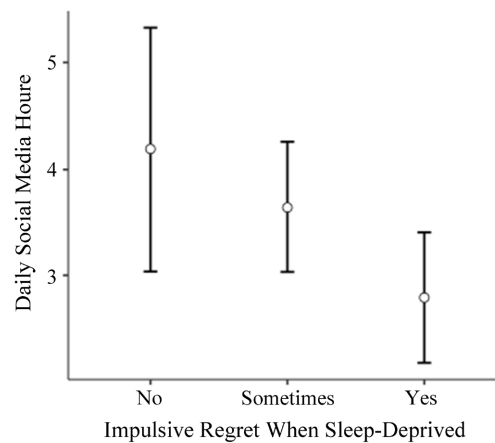


Figure 6. Students with lower daily social media hours were more likely to report “yes” to impulsive regret under sleep-deprived conditions.

4. Discussion

Taken together, the findings of this study suggest a complex but meaningful relationship between sleep duration, social media use, and self-regulation among male

adolescents. Specifically, individuals who exhibit stronger self-regulatory behaviors, such as reduced social media use, were more likely to report impulsive regret when sleep-deprived, indicating greater self-awareness and behavioral monitoring. These results underscore how self-regulation not only influences media consumption habits but also impacts emotional responses and risk-prone decision-making under sleep deprivation. Additionally, engagement in extracurricular activities was positively associated with healthier sleep patterns and delayed discounting, reinforcing the idea that structured routines support regulatory development. This interconnectedness highlights sleep and self-regulation as key modulators of adolescent risk behavior, with important implications for behavioral interventions and educational policy. The results of this study underscore the nuanced impact of sleep deprivation on adolescent risk-taking and decision-making processes. Drawing upon dual-systems models of neurodevelopment, our findings indicate that sleep loss compromises cognitive control mechanisms while amplifying reward sensitivity, thereby fostering a bias toward affect-driven, short-term choices.

Consistent with prior literature, insufficient sleep appears to disrupt functional connectivity between the dorsolateral prefrontal cortex, which is critical for executive regulation, and affective regions, such as the insula, which are instrumental in reward processing. This neural dysregulation impairs adolescents' abilities to delay gratification and evaluate long-term consequences, which correlates with increased rates of risky behaviors, including substance use and unsafe sexual practices, as identified in previous epidemiological studies (McKnight-Eily et al., 2011; Telzer et al., 2013; Short & Weber, 2018). Neuroimaging evidence and ERP data further support a mechanistic link, showing reduced DLPFC activation and greater insula reactivity during cognitive and reward-based tasks under conditions of poor sleep, leading to a tilt toward immediate reward selection.

The behavioral findings are consistent with these neural mechanisms. Delay discounting preferences were found to be related not only to sleep duration but also to familial and demographic factors; specifically, adolescents with more siblings were more likely to opt for immediate rewards, which suggests that competition within the household may further reinforce short-term reward seeking. Intriguingly, a significant interaction emerged between age and self-reported overconfidence in test performance, such that older students exhibited more self-regulation and less overconfidence, supporting developmental models that implicate age-related improvements in executive function.

Extracurricular engagement also showed important associations with sleep habits, as students reporting longer sleep durations participated more actively in extracurricular activities, potentially reflecting better time management or enhanced cognitive stamina. Finally, the data revealed a feedback loop in which sleep deprivation, risk-prone decision-making, and environmental factors such as overuse of social media converge to heighten vulnerability to negative health outcomes, including taking academic or health-related risks.

The results of daily social media hours versus impulsive regret when sleep-de-

prived suggest that social media use may influence impulsive regret when sleep-deprived, with lighter users showing a trend toward greater regret compared to heavier users. Individuals with higher daily social media use were more likely to report “sometimes” or “no” to experiencing impulsive regret when sleep-deprived, possibly reflecting reduced self-awareness or diminished clarity in evaluating their own behaviors and emotions. This pattern suggests that heavier social media engagement may blur perceptions of consequence and self-reflection, thereby masking the recognition of poor decision-making under sleep loss.

Taken together, these results reinforce the importance of both sleep and self-regulation as modulators of adolescent risk behavior and can provide tangible applications for educators, parents, and policymakers seeking to mitigate high-risk decision-making in youth. By highlighting the intertwined roles of sleep, neurodevelopment, and environmental context, this study points toward targeted interventions that promote restorative sleep habits and support healthy decision-making trajectories in adolescence.

Building on the broader findings of this study, one notable pattern emerged regarding sibling dynamics and reward preference. The significant association between the number of siblings and delay discounting highlights the potential influence of family structure on adolescents’ motivational and decision-making processes. Adolescents with more siblings demonstrated a stronger preference for immediate rewards, suggesting that growing up in larger families may foster behaviors oriented toward short-term gain. This tendency can be understood through theories of resource competition and parental investment, which propose that as the number of children in a household increases, individual access to parental attention, time, and material support diminishes. Shukla, Rai, and Kaur (2016) observed that students with more siblings often show lower academic achievement due to divided parental resources, while Blake (1989) similarly found that larger family size negatively correlates with educational attainment. Extending these findings, the current study suggests that similar dynamics may shape reward-related decision-making. The observed preference for immediate rewards could reflect an adaptive response to environments characterized by resource scarcity, where acting quickly yields more reliable outcomes.

Limitations and Future Directions

The findings of this study, while providing preliminary support for the relationship between sleep and adolescent decision-making, are subject to several limitations that should be addressed in future research.

First, the cross-sectional design prevents any inference of causality between sleep deprivation and decision-making; longitudinal or experimental studies are needed to determine directionality. Second, the sample consisted exclusively of 89 male students from high school, which limits generalizability to other populations and educational settings. Future work should replicate these findings with coeducational and more socioeconomically diverse samples to strengthen external validity.

Furthermore, the reliance on self-reported data for sleep duration, social media usage, and risk-taking behaviors introduces potential for reporting biases and inaccuracies. Future research could employ more objective measures, such as actigraphy or wearable sleep monitors, to provide a more accurate assessment of sleep patterns. Data pulled directly from devices like Apple Watches or similar technologies could allow researchers to examine both sleep duration and sleep quality, reducing the limitations associated with recall-based reporting.

Finally, the absence of multiple measurement waves or repeated observations limits interpretation of within-person variability. Future longitudinal and experimental studies, ideally integrating neurocognitive measures and validated scales of self-control and risk-taking, are needed to clarify how chronic versus acute sleep loss differentially influences adolescent decision-making.

The simplified, self-report measure of delayed discounting also stands as a limitation, as it lacks the nuanced, trial-based assessment provided by established paradigms like the Iowa Gambling Task (IGT). Incorporating behavioral tasks such as the IGT in future research would allow for more robust and ecologically valid evaluations of impulsivity, reward processing, and risk-taking. Additionally, previous work using gambling paradigms in animal models, including rats, pigs, and macaques, has demonstrated how sleep deprivation affects reward-based decision-making, providing a valuable comparative framework for future human studies.

Despite the study's significant findings, it is important to acknowledge that the primary hypothesis linking sleep deprivation directly to risk-prone decision-making did not reach statistical significance. Several factors may account for this null result. First, restricted variability in sleep duration among participants could have limited the ability to detect meaningful differences. Second, the sample size may have constrained statistical power, reducing sensitivity to small but theoretically important effects. Third, reliance on self-report measures of sleep and decision-making introduces the possibility of measurement error, which may obscure true associations. Importantly, null findings still provide valuable insights by highlighting the boundaries of generalizability and suggesting areas for methodological refinement in future research. These results encourage careful consideration of how individual differences, environmental context, and assessment methods shape observed relationships, reinforcing the notion that transparent reporting of non-significant outcomes contributes to cumulative.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix A: Survey Questions

What is your current grade level?

(Options: 9th, 10th, 11th, 12th)

On average, how many hours of sleep do you get on school nights?

(Options: Less than 4, 4 - 5, 6 - 7, 8+)

Do you feel well-rested when you wake up for school?

(Options: Yes, No, Sometimes)

How often do you pull all-nighters or sleep less than 4 hours before an exam or major assignment?

(Options: Never, Rarely, Sometimes, Often)

On a scale of 1 - 5, how confident are you in your ability to make good decisions when tired?

Have you ever been certain you would do well on a test but scored lower than expected?

(Options: Yes, No, Sometimes)

How often do you take risks in academic settings (e.g., guessing on tests, procrastinating, under-preparing)?

(Options: Never, Rarely, Sometimes, Often, Very Often)

Given the choice, would you prefer a small reward today (e.g., \$ 10) or a larger reward in a month (e.g., \$ 25)?

(Delayed Discounting)

How often do you prioritize short-term enjoyment (e.g., video games, TV) over long-term responsibilities (e.g., studying, homework)?

(Options: Always, Often, Sometimes, Rarely, Never)

If you had an important exam in two weeks, how likely are you to start studying in advance vs. the night before?

(Options: Advance, Night before, Some advance but mostly night before)

Do you feel that getting more sleep would improve your ability to make better decisions?

(Options: Yes, No, Maybe)

Have you ever made an impulsive decision (e.g., texting in class, skipping homework) that you later regretted, especially when sleep-deprived?

(Options: Yes, No, Sometimes)

If your school started later, do you think it would help you make better decisions throughout the day?

(Options: Yes, No, Unsure)

What is your intended major or area of focus?

(Options: STEM, Business, Arts/Humanities, Social Sciences, Undecided)

On average, how many hours per day do you spend on social media?

How many hours per week do you spend on extracurricular activities (sports, clubs, volunteering, jobs, etc.)?

When was the last time you engaged in a risky activity (e.g., driving fast, procrastinating before a major test, skipping an assignment, impulsive decision)?

(Options: Within the past week, Within the past month, Within the past six months, More than six months ago)

How many siblings do you have?

What is your current age?