Sleep and Impulsivity in Adolescents

**Background/Scientific Premise**

Adolescence is a crucial developmental period involving emotional and behavioral regulation. Defined as the period of time between childhood and adulthood, adolescence is bookended by the start of puberty and encompasses major neurocognitive and social development.1 As a whole, this era is accompanied by many physical and emotional changes.

Sleep is an especially important aspect of this developmental process, with less sleep being linked with poorer cognitive performance and emotional regulation alongside associated brain structural correlates.2 Despite the importance of adequate sleep, US adolescents tend to get significantly less sleep than recommended.3 Furthermore, sleep duration is generally lower in the adolescent period compared to both childhood and early/emerging adulthood.4

Sleep and sleep difficulty are complex constructs that extend beyond sleep duration. As one of the most common sleep disorders in adolescents, insomnia is an especially pertinent manifestation.5 Difficulties initiating and maintaining sleep (DIMS) describe a range of sleep disturbances that may affect an adolescent’s functioning and development.

Impulsivity is a similarly complex entity. As described by Mackillop et al., impulsivity can be conceptualized in three ways. First, *delay discounting* reflects the tendency for one’s preference for smaller, sooner rewards over larger, later rewards. Second, *impulsive action* reflects difficulties inhibiting motor responses. Third, *impulsive tendencies* represents impulsivity as a personality feature.6 The UPPS-P further fractionates impulsivity into five facets. The first pair, positive and negative urgency, can be defined as tendencies to act rashly in the setting of positive and negative affective states, respectively. The third facet, lack of premeditation, is acting without considering consequences. The fourth, lack of perseverance, involves difficulties persisting through boring tasks. The last, sensation seeking, is a tendency to engage in stimulating experiences. 7,8 These frameworks do not exist independently, nor are they mutually exclusive. Subcomponents may interact to represent a more comprehensive model of impulsivity.9

The importance of sleep for impulse control is supported.10 While adolescence generally is a period of increased risk-taking behavior, poor sleep is specifically implicated in behavioral dysregulation, including poor impulse control.11 Cross-sectionally, impulsivity has been linked to insomnia severity.12 Urgency has been associated with difficulty initiating and maintaining sleep, while lack of perseverance has been related to insomnia-related interference with daytime function.13

It is possible that a reciprocal relationship exists between impulsive behavior and sleep difficulties, although longitudinal data would provide more robust support and permit investigation of directionality.14 A bidirectional relationship would suggest a negative cycle in which poor impulse control might worsen sleep and poor sleep might increase impulsivity.

However, to my knowledge, no study has looked at the longitudinal, bidirectional association between the multiple dimensions of impulsivity and components of sleep difficulty during the period of later childhood into adolescence. In this study, I intend to utilize data from a large longitudinal study, the Adolescent Brain Cognitive Development (ABCD) study, to examine this relationship.

**Research question(s) being asked, with hypotheses being tested (not relevant for qualitative research or history of medicine research)**

Hypothesis 1: Negative and positive urgency and lack of perseverance are facets of impulsivity that will be negatively correlated with sleep over time. While aroused mental states may interfere with sleep, heightened urgency may translate into action. Leaving bed or staying in bed while engaging in distracting activities (e.g., screentime) may link to lack of perseverance and impair sleep initiation. Sleep, especially its initiation, is not an intrinsically stimulating activity. Thus, we hypothesize that specific impulsivity features will be associated with sleep difficulties, especially initiation.

Hypothesis 2: Sleep initiation will be primarily affected by impulsive behavior. Much of impulsivity involves conscious decision-making. Thus, we hypothesize that impulsivity will exert a larger influence on tendencies to initiate and transition into sleep.

**Specific Aims of the Study**

To determine the longitudinal relation between facets of impulsive behavior and components of sleep health in childhood to adolescence.

**Methods you will use, including a proposed statistical analysis plan**

Data:

This study will use data from the longitudinal Adolescent Brain Cognitive Development (ABCD) study. A more detailed overview of the study can be found on the study website and in various publications. In summary, the data are collected from 21 sites around the United States, including over 11,000 children recruited between ages 9-10 with an annual follow-up for at least 10 years. This study will use the 5.1 data release, which includes 7 timepoints (baseline, 6-month, 1-year, 18-month, 2-year, 30-month, and 3-year follow-up).15 In this study, participants without sociodemographic information or sleep disturbance and impulsivity measures will be excluded.

Analysis:

In the first part of the analytic approach, the five metrics of the UPPS-P will be entered into Random-Intercept Cross-Lagged Panel Models (RI-CLPMs) along with the Difficulty Initiating and Maintaining Sleep (DIMS) scale, which includes sleep duration. These models will allow us to examine the significance of the bidirectional relationship between sleep difficulty and the five facets of impulsivity: negative urgency, lack of premeditation, lack of perseverance, sensation seeking, and positive urgency.8 The Random-Intercept variant of the Cross-Lagged Panel Model was chosen based off of prior literature suggesting that CLPMs do not adequately delineate within-person and between-person variance.16,17 RI-CLPMs have been explicitly suggested for use with the ABCD study data as a way of more appropriately capturing variance that may occur within an individual over time or between two people at a given time point.

In the second part of the analysis, we will break down the broader category of sleep difficulty and explore their associations with facets of impulsivity. The DIMS scale will be separated into three categories: sleep duration, difficulty initiating sleep, and difficulty maintaining sleep. These measures will be inputted as nodes into a network analysis, in which the strength of the association between each node will be estimated. This allows us to determine the underlying relationship between these variables. Specifically, we will look at the strength of association between components of sleep difficulty and the impulsivity factors affected by sleep difficulty broadly defined. These contemporaneous networks will be complemented by temporal networks that track the development of these trends over time.

**Expected results, and potential challenges/ limitations**

Results:

First, I expect to find a reciprocal, longitudinal association between positive/negative urgency and lack of perseverance that increases over time. This finding will demonstrate the hypothesized negative cycle of sleep problems and impulsive behavior. Second, I expect to find that sleep initiation (longer) and sleep duration (shorter) will be strongly associated with the relevant facets of impulsivity (higher) identified in the first part.

Limitations:

There are several notable study limitations. First, that the sleep metrics are self-reported by parents. Future studies may improve in this aspect by directly, objectively observing sleep behavior. Second, although potential sociodemographic covariates were included, external factors like significant life events that may affect temporal relationships were not. Third, the facets of impulsivity examined in this study represents self-reported components of a complex, multifactorial construct. The five facets of impulsivity defined in the UPPS-P test look at impulsive behavior as a personality trait while it has also been described in terms of motor impulsivity and delay-discounting. 6,7,9

**Statement of scientific impact and relevance for communities of interest, including patients**

Sleep is a fundamental component of health, especially during the pivotal developmental periods of childhood and adolescence. Adolescents often engage in impulsive behavior as regulatory parts of the brain develops. These results should provide valuable insight into the nature of the interplay between these two aspects of adolescent health. The longitudinal analysis allows for examination of relationships over time while accounting for between-subject variance.

Neither sleep quality nor impulsivity are complete descriptions by themselves. Sleep problems have various components, as does impulsive behavior. This study aims to explore the facets within these complex constructs. The better we understand the specific factors at play, the better we are able to address them.

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