



# The role of family conflict in mediating impulsivity to early substance exposure among preteens

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## ABSTRACT

**Objectives:** Preadolescence substance exposure, which increases the risk of regular substance use, has been a public health concern. Although studies found that impulsivity is a predisposing factor of early substance exposure, the pathways through which impulsivity is associated with early substance exposure remain unclear. This study examined how family conflict mediates this association among U.S. preteens as family environment plays an essential role in pre-adolescent development.

**Methods:** Respondents (N = 11,800, 9–10 years old) from the Adolescent Brain Cognitive Development (ABCD) Study Release 2.01 (July 2019) were included in this study. Generalized structural equation modeling was performed to investigate the mediation effects of family conflict on the associations between childhood impulsivity and early exposure to alcohol and tobacco use, controlling for covariates based on the Problem Behavior Theory.

**Results:** Pre-adolescents with high impulsivity levels ( $\geq 90^{\text{th}}$  percentile) were more likely to report early alcohol and tobacco exposure (total effect: ORs = 1.49 and 1.70, respectively), where 4.13% and 12.41% of the associations, respectively, were mediated by family conflict (indirect effect: ORs = 1.02 and 1.07; Sobel test  $ps$  = 0.022 and 0.005, respectively).

**Conclusions:** Family conflict mediates the associations between childhood impulsivity and early substance exposure among preteens, with higher impulsivity leading to more severe family conflicts that are, in turn, associated with a higher likelihood of early substance exposure. To prevent preteens with high impulsivity level from early use of substances, interventions may focus on reducing family conflicts such as parenting counseling that guides parents to strengthen conflict-resolution skills and create a stable home environment for preteens.

## 1. Introduction

Childhood substance exposure has been a public health concern in the U.S. The most commonly used substances among children and adolescents include alcohol and tobacco (DeBeck et al., 2016; Golub et al., 2007; Johnston, O'Malley, & Bachman, 2003). The increasing prevalence of substance use among U.S. adolescents is alarming, with 78.4% having consumed alcohol and 42.5% having used illicit drugs by late adolescence (17–18 years old). In particular, 20.4% of high school students have used any tobacco products in lifetime (Arrazola, Kuiper, & Dube, 2014; Swendsen et al., 2012). The effects of early substance exposure among adolescents could be devastating (Chen & Jacobson, 2012; Odgers et al., 2008; Swahn & Bossarte, 2007). For example, early

alcohol exposure in adolescents is associated with adulthood alcohol dependence, mental health problems, and delayed brain development (Johnston et al., 2003). Similarly, early onset of tobacco consumption is associated with delinquent behaviors and the increased likelihood of substance use disorders later in life (Odgers et al., 2008). Early substance exposure among preteens contributes to the risks for low self-esteem, substance dependence, suicide attempts, and poor health outcomes, as well as low life quality in adulthood (Odgers et al., 2008; Swahn & Bossarte, 2007).

Widely considered as a predisposing psychological factor, impulsivity has been linked to early substance onset and development of substance use (Moeller & Dougherty, 2002; Verdejo-García, Lawrence, & Clark, 2008; Vitaro et al., 1998). Impulsivity is defined as a tendency

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to respond erratically to stimulus without considering the positive/negative consequences of the behavior (Moeller, Barratt, & Dougherty, 2001). Impulsivity is a psychological multidimensional construct with four sub-traits including lack of premeditation, lack of perseverance, sensation seeking, and urgency, as defined by Whiteside and colleagues (Whiteside & Lynam, 2001). Impulsivity was found to be linked to drinking, smoking, and substance dependence (Adams et al., 2012). Previous studies also established that different sub-traits of impulsivity play different roles on the pathways of developing substance use problems (Keough, Zimbardo, & Boyd, 1999; Shin, Chung, & Jeon, 2013). For example, lack of premeditation—the tendency to react without planning or without considering the potential consequences—was found to be associated with binge drinking, alcohol dependence, smoking, and nicotine dependence (Carlson, Johnson, & Jacobs, 2010; Kale, Stautz, & Cooper, 2018; Verdejo-García et al., 2007). Lack of perseverance refers to the inability to keep working on a repetitive or boring task until finishing it, which has been shown to have indecisive associations with drinking and smoking behaviors (Fischer & Smith, 2008; Magid & Colder, 2007; Verdejo-García et al., 2007). Similarly, sensation seeking, another sub-trait of impulsivity, reflects the tendency to attempt a novel or thrilling experience, potentially leading to the onset of substance use during childhood. In addition, high level of sensation seeking among children may influence them to choose friends with similar behaviors and therefore increases their risks of substance use through peer influence (Donohew et al., 1999). The last sub-trait of impulsivity is urgency, the tendency to act and follow up on impulsive motivations, which was previously found to be associated with substance use during both childhood and adolescence (Pang et al., 2014; Smith & Cyders, 2016).

Although the association between impulsivity and the increased likelihood of early substance exposure has been found among children and adolescents, the mechanism responsible for such associations remains unclear (Vergés et al., 2019). Identifying important factors that link impulsivity to early onset of substance use could inform the development of preventive interventions to disrupt the mediating processes, subsequently reducing the risk of early substance use among preteens. In this study, we examined the role of family conflict, one of the potential mediating factors, in influencing the effect of impulsivity on early substance exposure among preteens.

Family conflict, an environmental stressor that contributes to poor social support in a family environment (Cummings & Davies, 2010; Elam et al., 2016), is associated with the increased likelihood of early substance exposure among adolescents, due to externalizing problems attributed from family conflict and the use of substances as a maladjusted coping method (Skeer et al., 2009, 2011). In addition, genetic studies have found that high-level pre-adolescence impulsivity could adversely stress the family environment and increase family conflicts due to the lack of planning and negative urgency (Elam et al., 2016; Wang & Chassin, 2018), where impulsivity prompts poor self-regulation in childhood and subsequently leads to negative parenting and family conflict (Brody and Ge, 2001). Such stress in turn heightens the likelihood of substance use among children and adolescents. Thus, family conflicts may serve as a risk factor for preteens to experiment substance use due to poor support and lack of coping strategies in a chaotic family environment (Foxcroft & Lowe, 1995). However, no studies have investigated whether and to what extent family conflicts mediate the associations between impulsivity and early substance exposure among preteens. This study fills in the literature gaps by testing two hypotheses: 1) impulsivity is a predisposing factor for increasing the likelihood of early substance exposure; and 2) family conflict mediates the aforementioned relationship.

## 2. Methods

### 2.1. Data and study sample

This study used the Adolescent Brain Cognitive Development (ABCD)

Study Release 2.01 data (July 2019) for analysis (Auchter et al., 2018). The ABCD Study, an on-going multi-site longitudinal study, is the largest brain development and adolescent health study in the U.S. (Auchter et al., 2018). It has recruited over ten thousand children aged between 9 and 10 years old ( $N = 11,875$  at the baseline) nationwide and follows these children and their families for 10 years until young adulthood (Auchter et al., 2018). During the baseline onsite visit, participants underwent comprehensive assessments of health, brain development, specimens, psychological testing, and family environment (Auchter et al., 2018). One goal of the ABCD Study is to understand the relationship between psychological factors and substance use (Jernigan & Brown, 2018).

The current study included 11,852 respondents with complete information with regard to variables of interest. A small number of children ( $n = 52$ ) who initiated use of heavier substances (e.g., marijuana, cocaine, heroin, etc.) other than alcohol and tobacco at the baseline interview (aged 9–10 years) were excluded from our analysis due to the fact that these children are at higher risk for substance use compared to the general child population. We finally obtained a study sample with 11,800 participants for analysis. The Institutional Review Board approval was not required at Indiana University due to the centralized approval from the University of California, San Diego and the public availability of the ABCD Study data.

### 2.2. Conceptual framework

Problem Behavior Theory (PBT), a commonly adopted psychosocial conceptual framework for explaining problematic behaviors for children and adolescents, including delinquent or norm-violative actions (Donovan, Jessor, & Costa, 1991; Jessor, 1968; Jessor & Jessor, 1977), was used as the framework to guide covariate selection for mediation analysis. One iteration of the PBT discerns that a problem behavior is determined by three constructs including predisposing system (e.g., sex, race/ethnicity), perceived-environment system (e.g., parent(s) education level, family rules on substance use), and behavior system (e.g., preteen's prosocial behavior) (Donovan et al., 1991). With these three conceptual systems, the conceptual framework is the balance of proneness and control that determine the problem behavior. In this study, early substance exposure is the problem behavior and the three PBT constructs guided the selection of control variables.

### 2.3. Variables, measures, and mediation relationship

This study examined how family conflict mediates the association between impulsivity and early substance exposure among U.S. preteens. The conceptual model of the mediation relationship was shown in Fig. 1. Detailed variables and their measures are described below.

#### 2.3.1. Outcome variables: early substance exposure

Early substance exposure among preteens was measured by two outcome variables: early exposure to alcohol and early exposure to tobacco, which were respectively defined as “had ever tried a sip of alcohol such as beer, wine, or liquor at any time in one's life” and “had ever tried a puff from tobacco or electronic cigarette or vape pens, or e-hookah at any time in one's life.” Both outcome variables were coded as binary (yes/no). We selected these two outcomes based on the following reasons. First, alcohol and tobacco are the most consumed substances among adolescents (DeBeck et al., 2016; Golub et al., 2007; Johnston et al., 2003). Understanding the underlying mechanisms of early substance exposure among children (in particular, preteens age 9–12) is essential to delay or reduce the likelihood of developing regular substance use during adolescence. Second, early alcohol and tobacco use onset is associated with increased substance use problems later in life. For example, Lin and colleagues indicated that the early onset of commonly used substances such as alcohol and tobacco during adolescence led to cannabis and opioid use initiation and reinitiation in

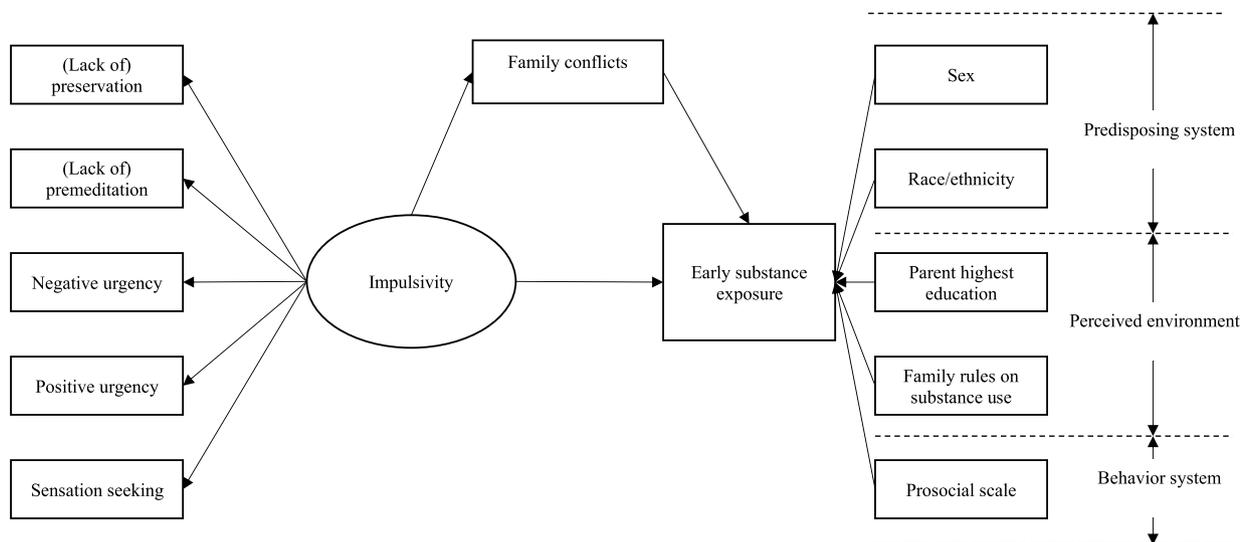


Fig. 1. The Conceptual Model of the Mediation Relationship.

adulthood (Arterberry et al., 2017; Lin, Jester, & Buu, 2016). Identifying important factors that link impulsivity to early alcohol and tobacco exposure could inform preventive interventions to disrupt the process. Notably, we used “had ever tried a sip of alcohol” to measure early alcohol exposure because studies have shown that sipping or tasting alcohol in childhood is associated with alcohol drinking in adolescence (Donovan & Molina, 2011). In addition, the likelihood of childhood sipping of alcohol are higher among those with poorer behavioral self-regulation—one important characteristic of impulsivity (Jackson et al., 2013).

### 2.3.2. Main predictor: impulsivity

Impulsivity is not a single trait but a personality that contains multi-dimensional sub-traits including lack of premeditation, lack of perseverance, sensation seeking, and urgency (Whiteside & Lynam, 2001). During the baseline visit, participants’ impulsivity was assessed by an impulsivity scale questionnaire. Based on the youth version UPPS-P impulsive behavior scale (Zapolski, Stairs, Settles, Combs, & Smith, 2010), the ABCD Study developed a shorter version of the UPPS-P impulsive behavior scale for children. Due to the unobservability of impulsivity and in order to measure different weight (i.e., factor loading) of the five dimensions of impulsivity (including negative urgency, positive urgency, lack of perseverance, lack of planning, and sensation seeking; all are continuous) (Barch et al., 2018), this study created a latent variable to infer impulsivity by adopting the items from the ABCD version’s UPPS-P. Based on the five dimensions, we created a continuous latent variable to represent impulsivity in our study. In a pilot study, the ABCD Study’s impulsivity scale shows robust internal consistency to measure impulsivity among participants (Barch et al., 2018).

### 2.3.3. Mediator: family conflict

Family conflict served as the mediator in this study. Family conflict is an environmental stressor that contributes to poor social support in a family environment (Cummings & Davies, 2010; Elam et al., 2016). In this study, family conflict was measured using the Family Conflict subscale of the Family Environment Scale (see Appendix A for detailed items), a 9-item categorical assessment within the family adopted by the ABCD Study (Hoffman et al., 2019). The total score of these nine items (ranged 0–9) was then dichotomized into a binary variable, using the 90th percentile of the total score among the study participants as the cutoff, where the 90th percentile corresponded to the total family conflict score = 5. Such a strict cutoff was chosen due to the skewness of the

total score distribution, where participants with  $\geq 90$ th percentile family conflict scores were coded as having high levels of family conflicts. Additional analyses (results available upon request) found that this cutoff significantly differentiated participants with high- and low-level family conflicts on all variables of interest. We also conducted sensitivity analysis that used 75th percentile (family conflict score  $\geq 3$ ), 80th percentile (family conflict score  $\geq 4$ ), 90th percentile (family conflict score  $\geq 5$ ), and 95th percentile (family conflict score  $\geq 6$ ) as the cutoffs, where the results (available upon request) support the robustness of our study findings.

### 2.3.4. Covariates

Covariate selection was guided by the three PBT constructs including 1) the predisposing system: sex (male/female) and race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanics, and others); 2) the perceived-environment system: parent(s)’ highest education levels (less than high school, high school or GED equivalents, some colleges, college or higher) and having family rules on alcohol use (yes/no) and/or tobacco use (yes/no); and 3) the behavior system: a prosocial scale (continuous variable; the higher the score, the more prosocial behaviors one is engaged in).

## 2.4. Analytical approach

Descriptive statistics including frequencies and percentages were computed for binary and categorical variables. Means and standard deviations were reported for continuous variables including the impulsivity scores and family conflict score. Chi-square tests (for categorical variables) and t-tests (for continuous variables) were conducted to examine differences in each variable between respondents who had ever tried alcohol and/or tobacco. Two sets of generalized structural equation modeling (GSEM) were performed to investigate the pathways of impulsivity to early alcohol and tobacco use initiation, respectively, through family conflicts among preteens (Emsley & Liu, 2013). Fig. 1 depicts the mediation relationship and GSEM. To measure children’s impulsivity, we constructed a continuous latent variable to infer impulsivity based on the UPPS-P impulsive behavior scale. We reported the direct effect, indirect effect, and total effect from each model and calculated the proportion of total effect mediated by family conflicts. We also conducted Sobel test for the significance of the indirect/mediation effect, under the linear assumption. Root mean squared error of approximation (RMSEA) and standardized root mean squared residual (SRMR) were computed to test the goodness-of-fit of the model. Under

**Table 1**  
Descriptive analysis of the study sample by early alcohol and tobacco exposure.

| Variables                               | Never had a sip of alcohol | Had a sip of alcohol | p-value | Never had a puff of tobacco | Had a puff of tobacco | p-value | Overall           |
|---|----------------------------|----------------------|---------|-----------------------------|-----------------------|---------|-------------------|
|   | n = 9,166 (77.68%)         | n = 2,634 (22.32%)   |         | n = 11,725 (99.32%)         | n = 75 (0.68%)        |         | n = 11,800 (100%) |
| 1. Impulsivity                          |                            |                      |         |                             |                       |         |                   |
| (Lack of) preservation <sup>a</sup>     | 6.97 (2.28)                | 7.22 (2.25)          | <0.01** | 7.02 (2.27)                 | 7.99 (2.94)           | <0.01** | 7.03 (2.27)       |
| (Lack of) premeditation <sup>a</sup>    | 7.59 (2.41)                | 8.15 (2.36)          | <0.01** | 7.71 (2.40)                 | 8.77 (2.97)           | <0.01** | 7.72 (2.41)       |
| Negative urgency <sup>a</sup>           | 8.37 (2.69)                | 8.80 (2.55)          | <0.01** | 8.46 (2.67)                 | 9.29 (2.89)           | <0.01** | 8.47 (2.67)       |
| Positive urgency <sup>a</sup>           | 7.92 (2.98)                | 8.15 (2.95)          | <0.01** | 7.97 (2.97)                 | 9.00 (3.33)           | <0.01** | 7.97 (2.98)       |
| Sensation seeking <sup>a</sup>          | 9.60 (2.71)                | 10.26 (2.66)         | <0.01** | 9.75 (2.71)                 | 9.99 (2.79)           | 0.45    | 9.75 (2.71)       |
| 2. Family conflict                      |                            |                      |         |                             |                       |         |                   |
| High-level family conflict <sup>b</sup> | 1,094 (11.94%)             | 391 (14.85%)         | <0.01** | 1,463 (12.48%)              | 22 (29.33%)           | <0.01** | 1,485 (12.58%)    |
| 3. Predisposing system                  |                            |                      |         |                             |                       |         |                   |
| Sex                                     |                            |                      | <0.01** |                             |                       | <0.21*  |                   |
| Male                                    | 4,669 (50.94%)             | 1,474 (55.96%)       |         | 6,094 (51.97%)              | 49 (65.33%)           |         | 6,143 (52.06%)    |
| Female                                  | 4,497 (49.06%)             | 1,160 (44.04%)       |         | 5,631 (48.03%)              | 26 (34.67%)           |         | 5,657 (47.94%)    |
| Race/ethnicity                          |                            |                      | <0.01** |                             |                       | 0.07    |                   |
| Non-Hispanic white                      | 4,866 (53.09%)             | 1,825 (69.29%)       |         | 6,646 (56.68%)              | 45 (60.00%)           |         | 6,691 (56.70%)    |
| Non-Hispanic black                      | 1,638 (17.87%)             | 204 (7.74%)          |         | 1,828 (15.59%)              | 14 (18.67%)           |         | 1,842 (15.61%)    |
| Hispanic                                | 1,942 (21.19%)             | 442 (16.78%)         |         | 2,377 (20.27%)              | 7 (9.33%)             |         | 2,384 (20.20%)    |
| Other                                   | 720 (7.86%)                | 163 (6.19%)          |         | 874 (7.45%)                 | 9 (12.00%)            |         | 883 (7.48%)       |
| 4. Perceived-environment system         |                            |                      |         |                             |                       |         |                   |
| Parent highest education                |                            |                      | <0.01** |                             |                       | <0.01** |                   |
| Less than high school                   | 704 (7.68%)                | 76 (2.89%)           |         | 776 (6.62%)                 | 4 (5.33%)             |         | 780 (6.61%)       |
| High school degree/GED                  | 1,049 (11.44%)             | 196 (7.44%)          |         | 1,232 (10.51%)              | 13 (17.33%)           |         | 1,245 (10.55%)    |
| Some college education                  | 2,837 (30.95%)             | 628 (23.84%)         |         | 3,429 (29.25%)              | 36 (48.00%)           |         | 3,465 (29.36%)    |
| College degree or higher                | 4,576 (49.92%)             | 1,734 (65.83%)       |         | 6,288(53.63%)               | 22 (29.33%)           |         | 6,310 (53.47%)    |
| Family rule on alcohol use              | 7,242 (79.01%)             | 1,823 (69.21%)       | <0.01** |                             |                       | –       | 9,065 (76.82%)    |
| Family rule on tobacco use              |                            |                      | –       | 9,599 (81.87%)              | 61 (81.33%)           | 0.91    |                   |
| 5. Behavior system                      |                            |                      |         |                             |                       |         |                   |
| Prosocial behavior scale <sup>a</sup>   | 5.04 (1.14)                | 4.93 (1.13)          | <0.01** | 5.02 (1.13)                 | 4.44 (1.53)           | <0.01** | 5.02 (1.14)       |

\* $p < 0.05$ ; \*\* $p < 0.01$ .

Data source: Adolescent Brain Cognitive Development (ABCD) Study (Release 2.01).

Total n = 11,800.

<sup>a</sup>Presented as mean and standard deviation.

<sup>b</sup>Measured as  $\geq$  the 90th percentile of total family conflict score (or total family conflict score  $\geq 5$ ).

<sup>c</sup>Means and standard deviation were reported for continuous variable; t-tests were conducted to test group difference.

<sup>d</sup>Counts and percentages were reported for categorical variables; chi-square tests were conducted to test group difference.

**Table 2**

The mediation effect of family conflicts on impulsivity to early alcohol exposure among preteens from generalized structural equation modeling results.

| Variable  | Factor Loading | S.E.          |
|---|----------------|---------------|
| <b>Measurement model</b>  |                |               |
| <b>Impulsivity</b>  |                |               |
| (Lack of) preservation  | 1              | (constrained) |
| (Lack of) premeditation   | 1.26**         | 0.05          |
| Negative urgency  | 2.53**         | 0.10          |
| Positive urgency  | 3.17**         | 0.14          |
| Sensation seeking   | 0.95**         | 0.06          |
|   | Odds Ratio     | 95% C.I.      |
| <b>Mediation model<sup>a</sup> (dependent variable: high-level family conflict<sup>b</sup>)</b> |                |               |
| Impulsivity   | 1.11 **        | (1.10, 1.13)  |
| <b>Structural model (dependent variable: ever had a sip of alcohol)</b>                         |                |               |
| Impulsivity   | 1.47**         | (1.34, 1.60)  |
| High-level family conflict <sup>b</sup>   | 1.17*          | (1.02, 1.33)  |
| <b>Predisposing system:</b>   |                |               |
| Sex: male   | 1.15**         | (1.05, 1.26)  |
| <b>Race/ethnicity</b>   |                |               |
| Non-Hispanic White  | –              | –             |
| Non-Hispanic Black  | 0.42**         | (0.36, 0.49)  |
| Hispanic  | 0.78**         | (0.68, 0.88)  |
| Other   | 0.65**         | (0.55, 0.79)  |
| <b>Perceived-environment system:</b>  |                |               |
| <b>Parent highest education level</b>   |                |               |
| Less than high school   | –              | –             |
| High school degree or GED   | 1.79**         | (1.38, 2.31)  |
| Some college education  | 1.76**         | (1.36, 2.27)  |
| College degree or higher  | 2.70**         | (2.09, 3.50)  |
| Family rule on alcohol use  | 0.70**         | (0.63, 0.77)  |
| <b>Behavior system:</b>   |                |               |
| Prosocial scale   | 0.96           | (0.93, 1.00)  |

\**p* < 0.05; \*\**p* < 0.01.

Data source: Adolescent Brain Cognitive Development (ABCD) Study (Release 2.01).

Total *n* = 11,800.

S.E. = standard error; C.I. = confidence interval.

<sup>a</sup> The mediation model controlled for the same covariates as in the structural model; results were omitted in this table.

<sup>b</sup> Measured as  $\geq$  the 90th percentile of total family conflict score (or total family conflict score  $\geq$  5).

the linear assumption, RMSEA and SRMR were computed for the complete GSEM (Clouston, Manganello, & Richards, 2016). All analyses were performed using Stata 16.

**3. Results**

Table 1 shows the descriptive statistics for the study sample. Early alcohol exposure was more prevalent than early tobacco exposure (22.32% vs. 0.68%) among preteens. Preteens who had sipped alcohol and had used tobacco had similar impulsivity profiles. Compared with preteens who had never sipped alcohol, those who had sipped had higher mean scores in four out of five impulsivity sub-traits, were less likely to have family rules on alcohol use and scored lower on prosocial behavior scale. Similarly, compared to preteens who had not used tobacco, those had used, on average, scored higher on all impulsivity sub-traits but lower on the prosocial behavior scale.

Tables 2 and 3 show the GSEM results regarding early alcohol and tobacco exposure, respectively. Both models constructed the latent variable—impulsivity—based on the UPPS-P impulsive behavior scale, where we constrained the factor loading of the lack of preservation sub-trait at 1 for GSEM model identification. All sub-traits significantly represented impulsivity, where positive urgency represented impulsivity the most (factor loadings: 3.17 [alcohol model] and 3.21 [tobacco model], both *ps* < 0.01). In both mediation models, impulsivity was significantly associated with having high-level family conflicts (ORs =

**Table 3**

The mediation effect of family conflicts on impulsivity to early tobacco exposure among preteens from generalized structural equation modeling results.

| Variable  | Factor Loading | S.E.          |
|---|----------------|---------------|
| <b>Measurement model</b>  |                |               |
| <b>Impulsivity</b>  |                |               |
| (Lack of) preservation  | 1              | (constrained) |
| (Lack of) premeditation   | 1.26**         | 0.53          |
| Negative urgency  | 2.54**         | 0.11          |
| Positive urgency  | 3.21**         | 0.13          |
| Sensation seeking   | 0.94**         | 0.06          |
|   | Odds Ratio     | 95% C.I.      |
| <b>Mediation model<sup>a</sup> (dependent variable: high-level family conflict<sup>b</sup>)</b> |                |               |
| Impulsivity   | 1.11**         | (1.11, 1.12)  |
| <b>Structural model (dependent variable: ever had a puff of tobacco)</b>                        |                |               |
| Impulsivity   | 1.59*          | (1.06, 2.41)  |
| High-level family conflict <sup>b</sup>   | 1.84*          | (1.07, 3.16)  |
| <b>Predisposing system:</b>   |                |               |
| Sex: male   | 1.41           | (0.87, 2.30)  |
| <b>Race/ethnicity</b>   |                |               |
| Non-Hispanic White  | –              | –             |
| Non-Hispanic Black  | 0.65           | (0.34, 1.24)  |
| Hispanic  | 0.31**         | (0.13, 0.71)  |
| Other   | 1.17           | (0.56, 2.44)  |
| <b>Perceived-environment system:</b>  |                |               |
| <b>Parent highest education level</b>   |                |               |
| Less than high school   | –              | –             |
| High school degree or GED   | 1.53           | (0.49, 4.80)  |
| Some college education  | 1.35           | (0.46, 3.94)  |
| College degree or higher  | 0.42           | (0.14, 1.31)  |
| Family rule on tobacco use  | 0.89           | (0.49, 1.61)  |
| <b>Behavior system:</b>   |                |               |
| Prosocial scale   | 0.76**         | (0.64, 0.90)  |

\**p* < 0.05; \*\**p* < 0.01.

Data source: Adolescent Brain Cognitive Development (ABCD) Study (Release 2.01).

Total *n* = 11,800.

S.E. = standard error; C.I. = confidence interval.

<sup>a</sup> The mediation model controlled for the same covariates as in the structural model; results were omitted in this table.

<sup>b</sup> Measured as  $\geq$  the 90th percentile of total family conflict score (or total family conflict score  $\geq$  5).

**Table 4**

Mediation effect of family conflicts on the association between impulsivity and early substance exposure.

|                            | Direct effect <sup>a</sup>    | Indirect effect <sup>b</sup>  | Total effect <sup>c</sup>     | Mediated proportion by family conflicts <sup>d</sup> | <i>p</i> -value <sup>e</sup> |
|----------------------------|-------------------------------|-------------------------------|-------------------------------|--|------------------------------|
| Ever had a sip of alcohol  | $\beta = 0.38$<br>(OR = 1.47) | $\beta = 0.02$<br>(OR = 1.02) | $\beta = 0.40$<br>(OR = 1.49) | 4.13%  | 0.022                        |
| Ever had a puff of tobacco | $\beta = 0.46$<br>(OR = 1.59) | $\beta = 0.07$<br>(OR = 1.07) | $\beta = 0.53$<br>(OR = 1.70) | 12.41%   | 0.005                        |

Data source: Adolescent Brain Cognitive Development (ABCD) Study (Release 2.01).

<sup>a</sup> Impulsivity to substance use initiation.

<sup>b</sup> Impulsivity to substance use initiation via family conflict.

<sup>c</sup> Sum of direct and indirect effects.

<sup>d</sup> Indirect effect  $\beta$  divided by total effect  $\beta$ .

<sup>e</sup> Based on Sobel test for the significance of the mediation effect.

1.11 in both alcohol and tobacco models, both *ps* < 0.01). In the structural models, significant associations were found between impulsivity and early exposure to both substances (OR = 1.47, *p* < 0.01 [alcohol model] and OR = 1.59, *p* < 0.05 [tobacco model]), and between family conflicts and early exposure to both substances (OR =

1.17, [alcohol model], and  $OR = 1.84$ , [tobacco model], both  $ps < 0.05$ ). GSEM demonstrated that the associations between impulsivity and early alcohol and tobacco exposure were mediated by family conflicts (mediated proportion = 4.13%, Sobel test  $p = 0.022$  [alcohol model]; and mediated proportion = 12.41%, Sobel test  $p = 0.005$  [tobacco model]; see details in Table 4). The test of the overall model fit with the linear assumption (Clouston et al., 2016) showed that  $RMSEA = 0.088$  and  $SRMR = 0.06$  for both alcohol and tobacco models, indicating a reasonable model fit for our GSEM (Hooper, Coughlan, & Mullen, 2008; Kline, 2015) (Appendix A).

#### 4. Discussion

This study filled the knowledge gap by investigating the mediating effects of family conflict on the association between impulsivity and early exposure to substances including alcohol and tobacco using data from the nationwide ABCD Study. Disentangling the pathway through which impulsivity and early substance exposure are associated and studying to what extent this association is mediated by family conflicts will guide future interventions aiming to reduce or delay substance exposure among preteens with impulsive behaviors. Such efforts may further reduce the likelihood of later development of regular use of substances and substance use disorders in adulthood.

Previous studies have shown that impulsivity is significantly associated with substance use among children, adolescents, and young adults (Dawe, Gullo, & Loxton, 2004; Kale et al., 2018; Khurana et al., 2013; Verdejo-García et al., 2007, 2008; Von Diemen et al., 2008). This study further demonstrated such association with early alcohol and tobacco exposure among a large sample of the preteen population in the U. S. Early exposure to substances such as alcohol and tobacco is a major risk for continuing substance use and abuse, low self-esteem, suicide attempts, poor health outcomes, and low quality of life (Odgers et al., 2008; Shortt et al., 2007; Swahn & Bossarte, 2007; Wolitzky-Taylor et al., 2017). Parents, educators, and therapists are encouraged to take precautions of substance use prevention among preteens with high-level impulsivity.

The results support the research hypothesis that the association between impulsivity and early substance exposure was mediated by family conflict. Based on our findings and supported by previous studies, children's impulsivity may be associated with more family conflicts (Elam et al., 2016), and consequently high-level family conflicts could reinforce children's desires to seek substances as an escape from the worsening situation (Skeer et al., 2009). While family environment has a noteworthy impact on children's substance-seeking behaviors (Kumpfer, Alvarado, & Whiteside, 2003), the evidence of mediating effects from family conflict indicates that comprehensive family-based interventions (e.g., the Fatherhood, Relationship, and Marriage Education [FRAME] intervention (Wadsworth et al., 2011)) could potentially reduce the level of family conflicts and may, in turn, prevent early substance use among preteens (Kumpfer et al., 2003). In addition, we found that various sub-traits had differential representativeness of impulsivity. For example, both negative and positive urgency had greater representativeness of children's impulsivity compared to sensation seeking. Therefore, when designing family-based interventions, efforts should focus on these two sub-traits of impulsivity. This study also found that family conflicts had a greater mediating effect on the associations between impulsivity and early tobacco exposure (mediation proportion = 12.41%) than that to alcohol (mediation proportion = 4.13%) among preteens. The differential mediation effect indicated that the effect of strategies to mitigate the impact of impulsivity on early exposure to different substances may be substance specific. For example, as previously stated, our study indicates that interventions through reducing family conflicts could prevent early exposure to both alcohol and tobacco, and could be notably effective for early tobacco use.

This study also revealed a few notable factors associated with early

alcohol and tobacco exposure among preteens. Consistent with previous findings, we found that having a family rule on alcohol use was associated with a lower likelihood of early alcohol exposure (White & Halliwell, 2010). However, the association between having a family rule on tobacco use and preteens' tobacco exposure was not observed. In addition, prosocial behaviors were significantly associated with a lower likelihood of early tobacco exposure, indicating that preteens' engaging in more prosocial behaviors (e.g., helping others) is a protective factor against early tobacco use (Zucker et al., 2018). Such association, however, was not found in early alcohol exposure among preteens. In summary, different emphases are needed to prevent early exposure to different substances (i.e., tobacco and alcohol) among preteens.

There are several limitations to this study. First, as this study was based on the ABCD Study baseline data, there was no timestamp to identify the temporal sequence of substance use initiation and therefore causality was not inferred. After the baseline visit, the ABCD Study follows participants over time and collects longitudinal data on substance use behaviors. With the prospective data collection, further studies are expected to have a clearer view of the pathway of substance use initiation. Second, this research was conceptualized with the assumption that impulsivity is a predisposing factor. However, family conflict may have reciprocal feedback to impulsivity (El-Sheikh & Erath, 2011). Future studies may examine the bidirectional association between the two. Third, the ABCD Study data contain self-reported questions, which is subject to recall errors and bias. Future releases of ABCD data corresponding to biomarkers or other objective measures may facilitate further validation of the current findings. Fourth, Stata 16 does not generate model fit statistics (e.g.,  $RMSEA$ ) for GSEM. As a result, we reported the model fit indicators computed using the standard SEM along with the linear assumption instead. Nevertheless, Clouston and colleagues have proved this method to be valid (Clouston et al., 2016). Despite these limitations, this study contributes to the extant literature by examining the important mediation relationship among preteens using data from the large-scale nationwide ABCD Study.

#### 5. Conclusions

Our findings indicate that impulsivity is associated with early alcohol and tobacco exposure among preteens, and these associations are mediated by family conflict. To prevent preteens with high impulsivity level from early substance exposure, interventions to reduce family conflict such as parenting counseling that guides parents to strengthen conflict-resolution skills and create a stable home environment for preteens are recommended. Future releases of longitudinal data from the ABCD Study will provide an invaluable opportunity to expand the current study which was based on cross-sectional data to investigate the underlying mechanisms with a developmental perspective.

#### 6. Author agreement

This manuscript has been submitted solely to *Addictive Behaviors* and it has not been previously published, either in whole or in part, nor have the findings been posted online. All authors (Z Wang, A Buu, DK Lohrmann, PC Shih, and HC Lin) had full access to all aspects of the research, contributed significantly to the work, and agreed to submit this manuscript to *Addictive Behaviors*. All of the authors have no conflict of interest to disclose.

#### CRedit authorship contribution statement

**Zhi Wang:** Conceptualization, Data curation, Formal analysis, Investigation, Writing - original draft. **Anne Buu:** Conceptualization, Writing - review & editing. **David K. Lohrmann:** Conceptualization, Writing - review & editing. **Patrick C. Shih:** Conceptualization, Writing - review & editing. **Hsien-Chang Lin:** Conceptualization, Supervision, Writing - original draft.

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U01DA041174, U24DA041123, U24DA041147, U01DA041093, and U01DA041025. A full list of supporters is available at <https://abcdstudy.org/federalpartners.html>. A listing of participating sites and a complete listing of the study investigators can be found at [https://abcdstudy.org/Consortium\\_Members.pdf](https://abcdstudy.org/Consortium_Members.pdf). ABCD consortium investigators designed and implemented the study and/or provided data but did not necessarily participate in analysis or writing of this report. This manuscript reflects the views of the authors and may not reflect the opinions or views of the NIH or ABCD consortium investigators. The ABCD data repository grows and changes over time. The ABCD data used in this report came from <https://doi.org/10.15154/1503209>.

## Appendix A. The Family Conflict Subscale of the Family Environment Scale Adopted by the ABCD Study

| Item | Content  | Response       |
|------|--|----------------|
| 1    | We fight a lot in our family.  | Yes (1)/No (0) |
| 2    | Family members rarely become openly angry.   | Yes (1)/No (0) |
| 3    | Family members sometimes get so angry they throw things.                                       | Yes (1)/No (0) |
| 4    | Family members hardly ever lose their tempers.   | Yes (1)/No (0) |
| 5    | Family members often criticize each other.   | Yes (1)/No (0) |
| 6    | Family members sometimes hit each other.   | Yes (1)/No (0) |
| 7    | If there's a disagreement in our family, we try hard to smooth things over and keep the peace. | Yes (1)/No (0) |
| 8    | Family members often try to one-up or outdo each other.  | Yes (1)/No (0) |
| 9    | In our family, we believe you don't ever get anywhere by raising your voice.                   | Yes (1)/No (0) |

Source: The ABCD Study (Hoffman et al., 2019).

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