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Cumulative Contextual Risk at Birth and Adolescent Substance Initiation: Peer Mediation Tests

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Abstract

Background: Children who experience multiple adversities, such as prenatal exposure to drugs and poverty, early in development are at increased risk for the early initiation of alcohol and cigarette use. However, studies that examine potentially malleable processes associated with substance use initiation in the context of exposure to cumulative stressors are scant. This study examined associations between cumulative contextual risk at birth and initiation of alcohol and cigarette use in adolescence, testing childhood peer marginalization and peer aggression and behavior problems as mediating mechanisms. Analyses further adjusted for fearfulness/inhibition and hyperactivity/distractibility to determine if the hypothesized mediating mechanisms were significant after accounting for temperamental characteristics associated with substance initiation. **Methods:** Participants were 6,190 adolescents from the Northern Finland Birth Cohort 1986 Study. Data were collected on cumulative contextual risk (parent reports), substance initiation (adolescent reports), childhood peer processes and behavior problems (teacher reports), and temperamental characteristics (teacher reports). Novel discrete-time survival mediation analysis was conducted to test the hypothesized mediating mechanisms. **Results:** Initial analyses showed that the associations between cumulative contextual risk and both alcohol and cigarette initiation were mediated by childhood peer processes and behavior problems; however, the indirect effects became statistically non-significant after adding the temperament variables, which themselves predicted substance initiation. **Conclusions:** Targeting peer processes may not be an effective way to interrupt pathways leading from early contextual risk to substance initiation. Instead, early screening and intervention efforts to delay substance initiation may need to be tailored to the individual temperamental characteristics of targeted participants.

Keywords: substance initiation; cumulative risk; peer; temperament

1. Introduction

Although declining, rates of adolescent alcohol use and cigarette smoking remain elevated worldwide, even among very young adolescents (Degenhardt et al., 2008; Johnston, O'Malley, Miech, Bachman, & Schulenberg, 2016). This is a concern because, compared to later onset, early-onset alcohol and cigarette use (around age 13 or younger) increases the risks for adverse consequences (Chen, Storr, & Anthony, 2008; Grant & Dawson, 1998). Identifying malleable risk processes leading toward early-onset alcohol and cigarette use among at-risk adolescents can guide screening and intervention efforts to delay substance initiation. However, analyses of such processes must account for potential confounds to distinguish causal factors from markers of risk. This study analyzed data from a large Finnish birth cohort to examine cumulative contextual risk at birth in relation to alcohol and cigarette initiation in adolescence, and tested childhood peer marginalization and peer aggression as mediating mechanisms, while accounting for general problem behaviors and adjusting for temperamental characteristics.

Early contextual risk factors, such as prenatal exposure to drugs (Richardson, Larkby, Goldschmidt, & Day, 2013), often co-occur with other risk factors in the environment, such as being born into poverty and from a teenage mother. According to the cumulative risk hypothesis (Rutter, 1979; Sameroff, Seifer, Zax, & Barocas, 1987), rather than the severity of any particular contextual risk factor, it is the presence of many such factors that increases the likelihood of difficulties among children. This approach assigns unit weighting to each indicator, represented as a dichotomous variable capturing the presence versus absence of risk. The indicators are then summed into a count variable that indexes the total number of equally weighted risks to quantify the overall burden of risk for each individual. The cumulative risk approach has the advantage of providing a parsimonious representation of co-occurring risks and has obtained considerable

support over the years (Evans, Li, & Whipple, 2013). An earlier analysis from the current project found that a measure of cumulative contextual risk at birth was a positive predictor of adolescent substance use (Mason et al., 2016), consistent with prior studies (Newcomb & Felix-Ortiz, 1992; Ostaszewski & Zimmerman, 2006). Whether such risk predicts alcohol and cigarette initiation is uncertain and the extent to which developmentally salient processes in childhood might mediate these long-term associations has not yet been examined. An important critique of the cumulative risk approach has been that the mechanisms of effects are understudied (Evans et al., 2013).

During the early elementary school years, peer interactions take on increased importance. Key developmental tasks for children during this time period involve learning how to develop and maintain positive peer relationships. However, difficulties with peer socialization, such as peer aggression and peer marginalization, have adverse consequences for children (Parker & Asher, 1987), including substance use (Hawkins, Catalano, & Miller, 1992). Children involved in aggression as perpetrators and/or victims are more likely, compared to children who are not so involved, to display a range of socio-emotional adjustment problems (Haynie et al., 2001; Kumpulainen et al., 1998). There is evidence that various contextual risk factors positively predict peer aggression (e.g., poverty and having a teenage mother; Nantel-Vivier, Pihl, Côté, & Tremblay, 2014; Romano, Tremblay, Boulerice, & Swisher, 2005) and that the number of contextual risks is associated positively with aggressive behavior (Stoddard, Zimmerman, & Bauermeister, 2012), consistent with the cumulative risk hypothesis. The majority of studies examining risk factors for peer marginalization have addressed psychological characteristics, such as cognitive deficits (Dodge, Lansford, Burks, Bates, & Pettit, 2003; Southam-Gerow & Kendall, 2002). Social context also plays a role in peer marginalization (Mikami, Lerner, & Lun, 2010), but the degree to which cumulative contextual risk at birth predicts children's experiences

of being marginalized from their peers is unclear. Moreover, whether peer aggression and peer marginalization, both of which have links with adolescent substance use (Moore et al., 2014; Sullivan, Farrell, & Klierer, 2006), might serve as mediating mechanisms linking cumulative contextual risk at birth with substance initiation is unknown.

Peer difficulties often co-occur with disruptive behavior problems in children (Powers, Bierman, & The Conduct Problems Prevention Research Group, 2013). Links between cumulative contextual risk and substance initiation may have less to do with peer aggression and peer marginalization than with behavior problems, consistent with the expectations of general deviance perspectives (e.g., Jessor & Jessor, 1977). Childhood behavior problems are predicted by contextual risks (January et al., 2017; Slopen, Koenen, & Kubzansky, 2014) and predict adolescent substance-related outcomes (Hawkins et al., 1992); thus, it is important for tests of peer mediation processes to consider childhood problem behavior as an alternative or additional mediating mechanism.

Temperament also is an important consideration (Cloninger, Svrakic, & Przybeck, 1993). Temperamental characteristics refer to relatively stable individual differences in reactivity and self-regulation (Rothbart, Derryberry, & Hershey, 2000). In the context of peer relationships, two dimensions of temperament can influence children's interactions with their peers: fearfulness/inhibition and hyperactivity/distractibility. Fearful/Inhibited temperament is a pattern of response in unfamiliar situations showing signs of distress, anxiety, or wariness. As these patterns of behavior become recognizable by peers, fearful/inhibited children tend to be rejected from social activities because they are not viewed as desired playmates (Rubin, Burgess, & Hastings, 2002). Hyperactivity/distractibility is characterized by high activity, low persistence, and high distractibility. Children displaying such behaviors can be easily frustrated when they

cannot reach their goals and tend to use aggressive strategies to overcome barriers (Berdan, Keane, & Calkins, 2008), which is viewed negatively by their peers (Nijmeijer, Minderaa, Buitelaar, Hartman, & Hoekstra, 2008).

The aforementioned temperamental characteristics not only are related to peer processes in childhood but also predict substance use in adolescence (Creemers et al., 2010; Wills & Dishion, 2004). Because temperamental characteristics may have broad consequences for peer relationships and substance involvement, it is uncertain how hypothesized developmental processes linking early cumulative contextual risk with adolescent substance initiation through childhood peer factors might change after adjustment for fearfulness/inhibition and hyperactivity/distractibility. If these characteristics represent confounding influences, then intervention efforts might be best directed toward early identification of temperamental risk with referrals to tailored substance use prevention programs (e.g., Palmgreen & Donohew, 2003).

This study used longitudinal data from the Northern Finland Birth Cohort 1986 (NFBC1986) to examine the association of cumulative contextual risk at birth with alcohol and cigarette initiation in adolescence. It was hypothesized that the number of contextual risk factors early in development would predict early-age substance use onset. Analyses also tested childhood peer aggression and peer marginalization as mediating mechanisms, while considering intervening effects through childhood behavior problems. Results were expected to show mediation through peer processes, even in the presence of a behavior problems pathway. However, observed mediation might reflect confounding due to temperamental characteristics; thus, analyses were extended to include fearfulness/inhibition and hyperactivity/distractibility as covariates. Peer mediation processes might be attenuated in the presence of the temperament variables. Finally, analyses included gender as a covariate (e.g., McEachern & Snyder, 2012).

2. Material and Methods

2.1 Data and Participants

The NFBC1986, a population-based study of individuals born during a one-year period in Finland, provided the data for this study. The original cohort included 9,432 children born alive, whose expected date of birth fell between July 1, 1985 and June 30, 1986. Details regarding the NFBC1986 data collection are available elsewhere (Hurtig et al., 2007; Järvelin, Hartikainen-Sorri, & Rantakallio, 1993; Miettunen et al., 2014). Current analyses used data collected at prenatal/birth, childhood, and adolescence. At the study's outset, mothers were provided a prenatal background questionnaire at their first antenatal visit to the local prenatal clinic (on average at the 12th gestational week), to be returned by their 24th gestational week. Midwives and/or medical staff at the prenatal clinics completed additional information on pregnancy and delivery. In 1993-1994, when children were 8 years old, a postal questionnaire regarding school behavior and performance was provided to each child's homeroom teacher in the spring of their first year of school (92% completion rate). In 2001-2002, participants were invited to a clinical examination, during which the 15-16 year olds filled in a questionnaire regarding eating habits, stress, sexual behavior, substance use and mental well-being (76% participation rate). Written informed consent was obtained from parents and assent from children. The NFBC1986 study was approved by the ethical committee of the Northern Ostrobothnia Hospital District.

The analysis sample included all consented youth with self-reported age of substance initiation data collected during adolescence (66% of live births at the study's outset), with one randomly selected child from each set of participating non-singletons. The analysis sample was 6,190 for alcohol initiation and 6,140 for cigarette initiation. Participants were 51% female and had an average age in adolescence of 16.0 (14.58 to 16.96) years. Attrition analyses showed that

fewer males (48% v. 51%; $X^2(1, N = 15622) = 9.72, p < .05$) and fewer children of mothers who smoked during pregnancy (16% v. 14%; $X^2(1, N = 13969) = 9.60, p < .05$) were retained.

2.2 Measures

The measures for this study were culled from a variety of established sources and instruments (e.g., Koivusilta, Rimpelä, & Rimpelä, 1999; World Health Organization, 1981), including the landmark NFBC1966 (Järvelin, Hartikainen-Sorri, & Rantakallio, 1993).

Cumulative contextual risk index. This study adopted the standard approach to measuring cumulative risk, which entails creating a count of dichotomized risk indicators (Evans et al., 2013). Advantages of this approach, compared to an individual risk factor approach, include improved measurement precision and validity, as well as enhanced statistical power (Evans et al., 2013). Based on prior project work (January et al., 2017; Mason et al., 2016), ten indicators comprised contextual risk during the prenatal/birth period: low birth weight, teenage mother, single mother, multiple unions, low maternal education, smoking while pregnant, drinking while pregnant, paternal alcohol use, economic exclusion, and material deprivation. As described in January et al. (2017), indicators were selected because they have been shown to be associated with problem behaviors in adolescence, including substance use (Fergusson et al., 1998; Hawkins et al., 1992), and have been used in previous cumulative risk studies. Each indicator was coded 1 to represent presence of the risk and 0 to represent absence of the risk. The index was computed as the sum of the ten dichotomous indicators (observed range = 0-6).

Low birth weight was coded 1 if the child was born weighing under 2,500 grams (Zegers-Hochschild et al., 2009). *Teenage mother* was coded 1 if the mother gave birth to the participant at age 19 or younger. *Single mother* was coded 1 if the mother was unmarried, widowed, divorced, or not cohabitating with a partner. *Multiple unions* was coded 1 if the mother had at

least one prior registered union, such as marriage or cohabitation. *Low maternal education* was coded 1 if the mother completed fewer than 9 years of comprehensive schooling (Grades 1-9). *Smoking while pregnant* was coded 1 if the mother smoked after the first trimester during pregnancy. *Drinking while pregnant* was coded 1 if the mother drank alcohol during pregnancy. *Paternal alcohol use* was coded 1 if the mother reported that the child's father had five or more alcoholic drinks per typical week. *Economic exclusion* was coded 1 if the highest occupational status of the adult member of household was either unskilled worker (manual labor), unemployed, or on disability pension. *Material deprivation* was coded 1 if the household had fewer than two of these four items: washing machine, telephone, flushing toilet, or indoor bathroom.

Substance initiation. Age of substance initiation data were collected with items from the adolescent self-report questionnaire. These items began with the stem, "At what age did you do the following things for the FIRST TIME . . .?," followed by text regarding a specific behavior, including "Smoked your first cigarette," capturing *cigarette initiation*. Responses to items with the text "Drank beer (one glass or more)," "Drank wine (one glass or more)," and "Drank spirits (one glass or more)" were combined into a measure of *alcohol initiation*. These questions used a response set of "Never," "11 years or under," "12 years," "13 years," "14 years," "15 years," or "16 years." Six dichotomous age variables (11 or under, 12, 13, 14, 15, and 16) were created for each substance to be used in survival analyses described below. Youth who had never initiated were coded as "0" on all six age variables. Youth who initiated at age 11 or younger were coded "1" on the 11 or under variable and missing on all subsequent age variables. Youth initiating at age 13, for example, were coded "0" on the 11 or under variable, "0" on the age 12 variable, "1" on the age 13 variable, and then missing on all subsequent age variables.

Childhood peer and problem behaviors. Selected items from the Children's Behavior Questionnaire (Rutter, 1967) completed by teachers with response options of "Doesn't Apply" (0), "Applies Somewhat" (1), and "Certainly Applies" (2) were used to create three behavior scales. Raw scores from two items ("Fights every so often or quarrels often with other children" and "Teases other children") were summed to create the *Peer Aggression* variable ($\alpha = .84$). Two additional items ("Other children don't particularly like him/her" and "Has tendency towards being alone, is quite seclusive") were summed to create the *Peer Marginalization* variable ($\alpha = .49$). *Behavior Problems* ($\alpha = .69$) were measured by summing the raw scores from three items ("Is often disobedient," "Lies often," and "Gets annoyed or behaves aggressively when corrected").

Temperamental characteristics. Two scales reflecting temperamental characteristics were developed using items from the same teacher questionnaire (Rutter, 1967) in childhood.

Fearfulness/Inhibition ($\alpha = .84$) was measured with the sum of five items ("Is often scared of new things or situations," "Is often worried," "Is passive, slack or apathetic," "Seems often low-spirited, unhappy, weepy or anguished," and "Child has tears in his/her eyes when coming to school or has refused to come into the school building"). Three items ("Child is restless, does not have patience to sit down for a long period of time," "Wiggles and is restless," and "Is not able to concentrate on anything for a longish period") were summed to measure *Hyperactivity/Distractibility* ($\alpha = .88$).

Child gender. Child gender was coded 1 for males and 0 for females.

2.3 Data Analyses

Structural equation modeling-based discrete-time survival mediation analysis (Fairchild, Abara, Gottschall, Tien, & Prinz, 2015) was conducted with maximum likelihood-robust (MLR)

estimation in Mplus 7.4 (Muthén & Muthén, 1998-2015). This model permits tests of mediating processes in relation to the timing of event occurrence, while handling censored observations.

The hypothesized mediation model depicted in Figure 1 was tested in two steps for each outcome independently. In step one (Model 1), cumulative contextual risk was specified as a predictor of substance initiation, controlling for youth's gender, with potential mediation through peer marginalization, peer aggression, and child behavior problems. In step two (Model 2), fearfulness/inhibition and hyperactivity/distractibility were added to the model as additional exogenous variables. Note that the models in these two steps are not nested and, therefore, were not compared statistically. Beta coefficients for the event history outcome indicate the degree to which a 1-unit increase in the predictor is estimated to increase or decrease the log odds of initiating alcohol or cigarette use; exponentiation of the coefficients provides a hazard odds ratio for the predictor. Tests of mediation were conducted using bias-corrected bootstrapped 95% confidence intervals of the estimated indirect effects, calculated using RMediation (Tofighi & MacKinnon, 2011). Missing data were handled using full-information maximum likelihood (FIML) estimation.

3. Results

3.1 Preliminary Analyses

Correlations among study variables are reported in Table 1. Variables had expected associations with one another, providing evidence for the convergent and discriminant validity of the measures. For example, cumulative contextual risk had negative associations with age of alcohol and cigarette initiation, indicating that a higher number of risks was associated with an earlier age of substance use onset, and positive associations with the measures of difficult temperament. Figure 2 displays a plot of the alcohol and cigarette hazard rates, which indicate

the risk of alcohol and cigarette initiation at each age for those who had not yet initiated at previous ages. Supplementary analyses tested the proportional hazards assumption by comparing a model that included proportionality constraints to one in which such constraints were removed. Results supported the proportionality assumption. The chi-square difference test between the two models was statistically non-significant for both alcohol ($X^2 = 10.57$, $df = 5$, $p > .05$) and cigarettes ($X^2 = 5.03$, $df = 5$, $p > .05$). The risk for initiation of both substances among those who had not yet initiated increased steadily during early adolescence up to around age 15, with a leveling off thereafter.

3.2 Discrete-Time Survival Mediation Models

Alcohol initiation. Table 2 presents results from the two alcohol initiation discrete-time survival mediation models. In Model 1, which excluded the temperament variables, cumulative contextual risk at birth was a significant positive predictor of peer marginalization and peer aggression, as well as behavior problems in childhood. In turn, peer marginalization was a significant negative predictor, and both peer aggression and behavior problems were significant positive predictors of alcohol initiation. As reported in Table 3, the indirect effects through the peer mediators were significant, even in the presence of a significant indirect effect through behavior problems. There was a persistent direct association of cumulative contextual risk with alcohol initiation, indicating that after accounting for the three mediating pathways, cumulative contextual risk was still associated with the alcohol outcome.

Turning to Model 2 (Table 2), both fearfulness/inhibition and hyperactivity/distractibility were significant positive predictors of peer marginalization, peer aggression, and behavior problems. Whereas fearfulness/inhibition had a significant negative association with alcohol initiation, hyperactivity/distractibility was unrelated to the outcome. Even though peer

marginalization and peer aggression remained significant predictors of alcohol initiation, none of the paths from cumulative contextual risk to the childhood peer and problem behavior variables were statistically significant. Correspondingly, the three indirect effects were statistically non-significant in this model (Table 3). The long-term direct association of cumulative contextual risk with alcohol initiation remained significant.

Cigarette initiation. Also reported in Table 2 are results from the two cigarette initiation models. In Model 1, there were significant paths from cumulative contextual risk to the peer aggression and marginalization variables as well as to child behavior problems, and from these three childhood variables to the adolescent outcome. All three indirect effects were significant (Table 3), and there was a significant persistent direct association of cumulative contextual risk with cigarette initiation.

After including fearfulness/inhibition and hyperactivity/distractibility in Model 2 (Table 2), the paths from cumulative contextual risk to peer marginalization, peer aggression, and behavior problems became non-significant. Peer marginalization was a significant negative predictor, whereas peer aggression was a significant positive predictor of the outcome. None of the indirect effects were significant (Table 3). Both temperament variables were significant positive predictors of the three childhood peer and problem behavior variables. Whereas fearfulness/inhibition had a significant negative association with cigarette initiation, hyperactivity/distractibility was a significant positive predictor of the outcome. The long-term direct association of cumulative contextual risk with cigarette initiation remained significant.

4. Discussion

Cumulative contextual risk increases children's vulnerability for adverse outcomes (Evans et al., 2013), including substance use (Mason et al., 2016; Newcomb & Felix-Ortiz, 1992;

Ostaszewski & Zimmerman, 2006). However, the potential mediating mechanisms and confounding influences that might play a role in these long-term associations have not been fully addressed. This study helped fill these gaps by testing peer socialization processes, including peer aggression and peer marginalization, as mediating mechanisms in the associations of cumulative contextual risk at birth with alcohol and cigarette initiation in adolescence in a large Finnish birth cohort. Peer processes were examined in conjunction with a child behavior problems pathway and adjustments were made for more stable temperamental characteristics. Results showed that cumulative contextual risk at birth predicted both alcohol and cigarette initiation. Although there was some evidence for mediation through peer processes and child behavior problems, indirect effects became non-significant after adjusting for temperament. Cumulative contextual risk remained a significant positive predictor of substance initiation.

Peer socialization takes on increased salience in childhood, and problems with peers can increase risk for adolescent substance use (Hawkins et al., 1992). Although neither peer aggression nor peer marginalization served as mediators in the final models, both of these variables remained significant predictors of alcohol and cigarette initiation. Interestingly, peer marginalization was a negative predictor of substance initiation. Substance use tends to be a social activity for adolescents (Graham, Marks, & Hansen, 1991). It is possible that children who were marginalized by their peers lacked access to social activities organized around substance involvement, at least up to mid-adolescence.

Although cumulative contextual risk at birth appeared to have broad consequences for subsequent peer interactions and behavior problems in initial analyses, these long-term associations (i.e., cumulative contextual risk to peer aggression, peer marginalization, and behavior problems) disappeared after controlling for fearfulness/inhibition and

hyperactivity/distractibility. This is an important finding, and it suggests that the overlap of temperament with cumulative contextual risk explains away at least some of the long-term consequences of risk exposure. Still, the associations of cumulative contextual risk with both alcohol and cigarette initiation remained, suggesting that either (1) additional confounding variables may have been omitted from the models or (2) other untested biological and/or psychosocial mediating mechanisms may be operating (e.g., compromised stress response due to early adversity; Shonkoff, Boyce, & McEwen, 2009).

The temperamental characteristics had broad associations with peer-related and behavioral problems (Rothbart, 2007), as well as with the substance use outcomes (Wills & Dishion, 2004). Interestingly, the association of fearfulness/inhibition with substance initiation was negative. Fearful/inhibited children may be introverted and lack access to adolescent friendship networks that are organized around substance use. Indeed, fearfulness/inhibition positively predicted peer marginalization, which negatively predicted substance initiation.

The large birth cohort, longitudinal design, novel survival mediation analyses, and Finnish context of this study are strengths. The context also raises questions about generalizability. Further research is needed to determine if the findings observed here will be reproduced in other country contexts. Age of substance use initiation was obtained retrospectively at ages 15/16, and these reports may have been biased (e.g., telescoping; Shillington, Woodruff, Clapp, & Lemus, 2012). Also, the temperament variables were obtained via teacher report in childhood using items from the same instrument from which the peer and behavior problems variables were culled. Teacher reports of child temperament are common (Moritz Rudasill, Rimm-Kaufman, Justice, & Pence, 2006; Smith & Prior, 1995), but subjective ratings from a single teacher at a single time point do not fully capture children's temperamental characteristics over

development. As is often the case with large-scale birth cohort studies that measure a breadth of variables in a sizable sample, steps were taken to avoid over-burdening participants and data collectors with lengthy assessments. As such, the primary constructs were measured with either small scales or single questionnaire items. Although there was evidence for construct validity of the measures, conceptual replications drawing on additional standardized measures are needed. Finally, certain effects were relatively small in magnitude. This is expected in light of the extended time frame of the study, and it is noteworthy that larger effects were observed for primary and more proximal predictors of the substance outcomes. Still, the practical significance of the effects is uncertain at this stage of research and may be small on their own without consideration of additional factors.

5. Conclusions

This study extends prior research that has given insufficient attention to potential mediating mechanisms and confounding influences in the long-term associations between cumulative contextual risk and substance initiation. Targeting peer processes may not be an effective way to interrupt pathways leading from early contextual risk to substance initiation. Instead, early screening and intervention efforts to delay substance initiation may need to be tailored to the individual temperament characteristics of targeted participants (Palmgreen & Donohew, 2003). Delaying the onset of substance use among at-risk youth holds promise for reducing their likelihood of experiencing adverse outcomes later in life.

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Table 1

Correlations, Means, and Standard Deviations of Study Variables

Variable	1	2	3	4	5	6	7	8	9
1. Male									
2. Cumulative contextual risk	-.03								
3. Fearfulness/Inhibition	.06*	.06*							
4. Hyperactivity/Distractibility	.26*	.07*	.22*						
5. Peer marginalization	.08*	.06*	.48*	.25*					
6. Peer aggression	.23*	.06*	.18*	.59*	.32*				
7. Behavior problems	.19*	.06*	.26*	.65*	.36*	.75*			
8. Age of alcohol initiation	-.09*	-.16*	.04*	-.10*	.03*	-.11*	-.09*		
9. Age of cigarette initiation	-.03*	-.07*	.05*	-.11*	.05*	-.11*	-.10*	.45*	
<i>Mean</i>	.49	.63	5.75	3.82	2.34	2.37	4.48	3.80	3.97
<i>Standard Deviation</i>	.50	.93	1.33	1.43	.69	.82	1.07	2.00	2.21
<i>N</i>	6,190	6,190	5,674	5,718	5,714	5,710	5,691	6,190	6,136

Note. * $p < .05$.

Table 2

Discrete-Time Survival Mediation Model Results for Alcohol and Cigarette Initiation

Outcome Predictor Variable	Age of Alcohol Initiation						Age of Cigarette Initiation					
	Model 1			Model 2			Model 1			Model 2		
	<i>b</i>	<i>S.E.</i>	β	<i>b</i>	<i>S.E.</i>	β	<i>b</i>	<i>S.E.</i>	β	<i>b</i>	<i>S.E.</i>	β
Substance Initiation												
Male	.170*	.035	.286	.163*	.036	.266	-.019	.036	-.088	-.039	.036	-.084
Cumulative contextual risk	.241*	.020	.755	.242*	.019	.735	.099*	.019	.466	.098*	.019	.392
Fearfulness/Inhibition	-	-	-	-.050*	.015	-.215	-	-	-	-.058*	.016	-.330
Hyperactivity/Distractibility	-	-	-	.029	.017	.134	-	-	-	.065*	.018	.401
Peer marginalization	-.184*	.029	-.429	-.142*	.032	-.322	-.205*	.030	-.669	-.157*	.033	-.469
Peer aggression	.116*	.035	.321	.099*	.035	.267	.159*	.036	.636	.126*	.037	.445
Behavior problems	.066*	.026	.238	.056	.029	.198	.065*	.027	.136	.037	.030	.171
Peer Aggression												
Male	.388*	.021	.236	.140*	.018	.085	.386*	.022	.469	.138*	.018	.084
Cumulative contextual risk	.058*	.013	.065	.015	.011	.017	.057*	.013	.069	.014	.011	.016
Fearfulness/Inhibition	-	-	-	.029*	.009	.048	-	-	-	.029*	.009	.047
Hyperactivity/Distractibility	-	-	-	.321*	.010	.557	-	-	-	.321*	.010	.558

Peer Marginalization

Male	.106*	.018	.076	.017	.016	.013	.106*	.018	.152	.015	.016	.011
Cumulative contextual risk	.043*	.010	.058	.015	.009	.021	.044*	.010	.063	.016	.009	.021
Fearfulness/Inhibition	-	-	-	.232*	.010	.445	-	-	-	.232*	.010	.444
Hyperactivity/Distractibility	-	-	-	.068*	.008	.141	-	-	-	.069*	.008	.142

Behavior Problems

Male	.411*	.028	.192	.047*	.020	.022	.408*	.028	.380	.043*	.021	.020
Cumulative contextual risk	.068*	.017	.059	.002	.013	.002	.067*	.017	.063	.002	.013	.002
Fearfulness/Inhibition	-	-	-	.097*	.013	.120	-	-	-	.096*	.013	.119
Hyperactivity/Distractibility	-	-	-	.460*	.014	.614	-	-	-	.461*	.014	.615

Fearfulness/Inhibition

Male	-	-	-	.155*	.035	.058	-	-	-	.158*	.035	.059
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Hyperactivity/Distractibility

Male	-	-	-	.761*	.037	.266	-	-	-	.760*	.037	.266
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Note. * $p < .05$; S.E. = standard error.

Table 3

Unstandardized Indirect Effects [95% Confidence Intervals] from the Discrete-Time Survival Mediation Models

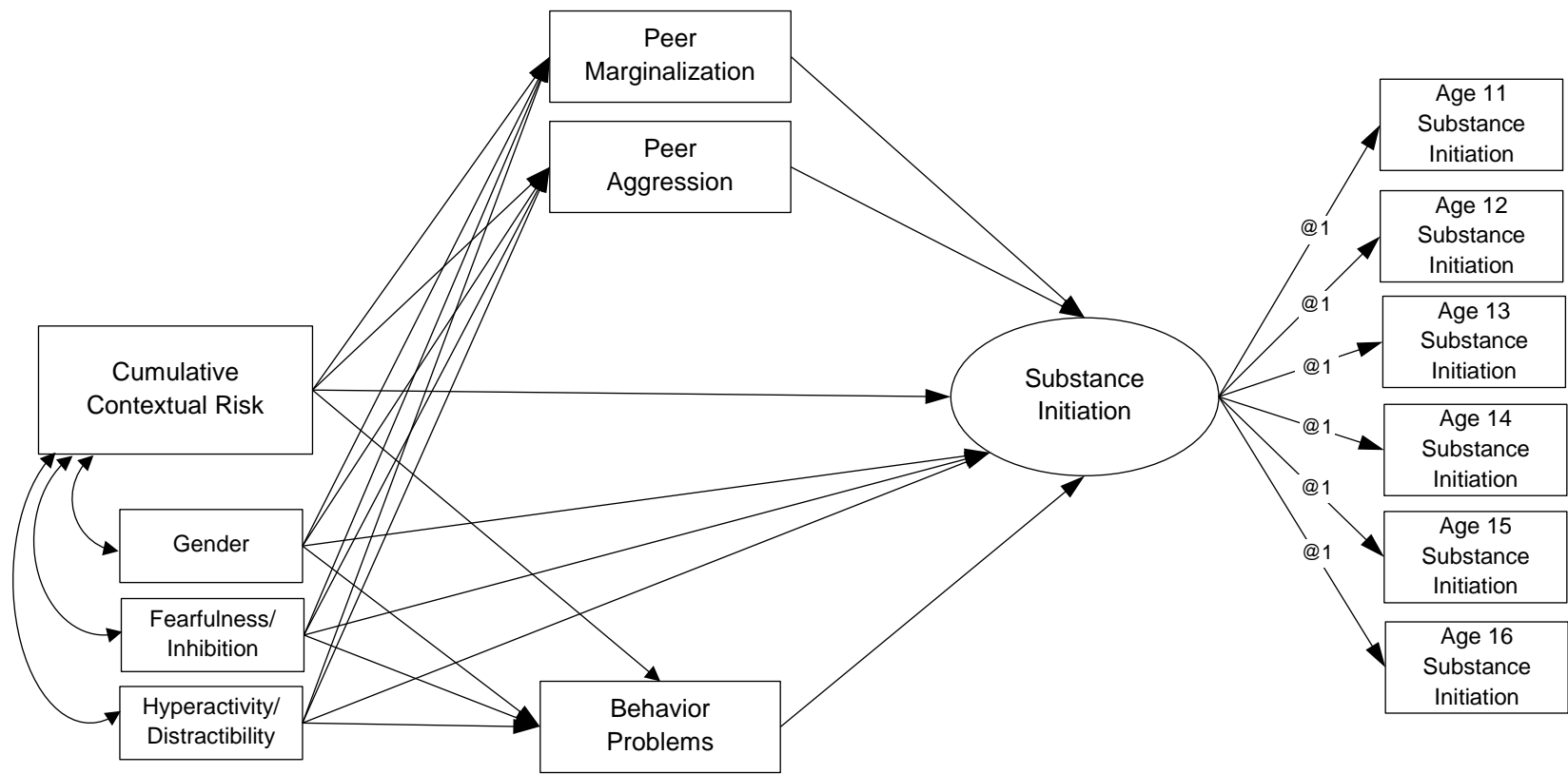
Mediator	Age of Alcohol Initiation		Age of Cigarette Initiation	
	Model 1	Model 2	Model 1	Model 2
Peer marginalization	-.008*	-.002	-.009*	-.003
	[-.013, -.004]	[-.005, 0]	[-.014, -.005]	[-.006, 0]
Peer aggression	.007*	.001	.009*	.002
	[.002, .012]	[-.001, .004]	[.004, .015]	[-.001, .005]
Behavior problems	.004*	0	.004*	0
	[.001, .009]	[-.002, .002]	[.001, .009]	[-.001, .001]

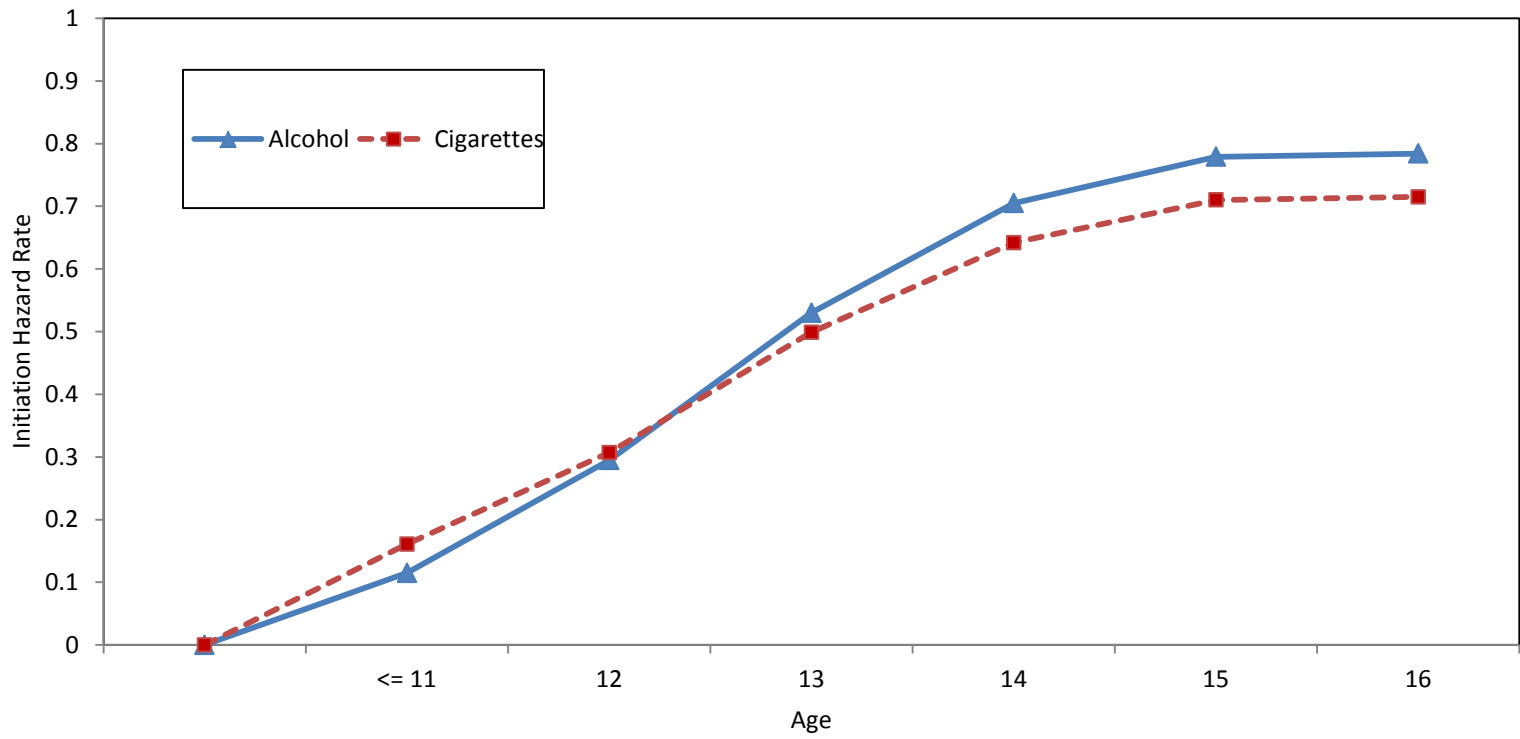
Note. * Confidence intervals that do not include zero are statistically significant.

Figure Captions

Figure 1. Hypothesized Discrete-Time Survival Mediation Model.

Figure 2. Hazard Rates for Alcohol and Cigarette Initiation by Age.





Highlights

- Cumulative contextual risk at birth predicted adolescent substance initiation
- Childhood peer aggression and marginalization served as mediators in initial analyses
- These mediation effects disappeared after adjusting for temperamental characteristics
- Screening and intervention for at-risk youth may need to be tailored to temperament

Contributors

W. Alex Mason and Jukka Savolainen contributed to formulation of the research question. W. Alex Mason, Gail L. Smith, and Mary B. Chmelka conducted the analyses. Jouko Miettunen and Marjo-Riitta Järvelin contributed to data collection and data management. With support from the grants, all authors provided substantive knowledge and expertise to the study reported herein and contributed to the writing.

Author Disclosures

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Contributors

W. Alex Mason and Jukka Savolainen contributed to formulation of the research question. W. Alex Mason, Gail L. Smith, and Mary B. Chmelka conducted the analyses. Jouko Miettunen and Marjo-Riitta Järvelin contributed to data collection and data management. With support from the grants, all authors provided substantive knowledge and expertise to the study reported herein and contributed to the writing.

Conflict of Interest

The authors have no conflicts of interest to declare.

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Conflict of Interest Statement

The authors have no conflicts of interest to declare.