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Cumulative contextual risk at birth in relation to adolescent substance use, conduct problems, and risky sex: General and specific predictive associations in a Finnish birth cohort

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Abstract

Background—Research indicates that risk factors cluster in the most vulnerable youth, increasing their susceptibility for adverse developmental outcomes. However, most studies of cumulative risk are cross-sectional or short-term longitudinal, and have been based on data from the United States or the United Kingdom. Using data from the Northern Finland Birth Cohort 1986 Study (NFBC1986), we examined cumulative contextual risk (CCR) at birth as a predictor of adolescent substance use and co-occurring conduct problems and risky sex to determine the degree to which CCR predicts specific outcomes over-and-above its effect on general problem behavior, while testing for moderation of associations by gender.

Methods—Analyses of survey data from 6963 participants of the NFBC1986 followed from the prenatal/birth period into adolescence were conducted using structural equation modeling.

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Results—CCR had long-term positive associations with first-order substance use, conduct problems, and risky sex factors, and, in a separate analysis, with a second-order general problem behavior factor. Further analyses showed that there was a positive specific effect of CCR on risky sex, over-and-above general problem behavior, for girls only.

Conclusions—This study, conducted within the Finnish context, showed that CCR at birth had long-term general and specific predictive associations with substance use and co-occurring problem behaviors in adolescence; effects on risky sex were stronger for girls. Results are consistent with the hypothesis that early exposure to CCR can have lasting adverse consequences, suggesting the need for early identification and intervention efforts for vulnerable children.

Keywords

Cumulative contextual risk; Substance use; Conduct problems; Risky sex; Adolescence

1. Introduction

The most vulnerable youth are those who experience multiple contextual risks, such as poverty and prenatal alcohol exposure, during early development. Research conducted within the cumulative risk (Rutter, 1979; Sameroff, Seifer, Zax, & Barocas, 1987) and adverse childhood experiences (Felitti et al., 1998) traditions indicates that the accumulation of risk factors increases the likelihood of problem outcomes (Evans, Li, & Whipple, 2013), including substance use (Ostaszewski & Zimmerman, 2006) and co-occurring problem behaviors (Mitchell, Whitesell, Spicer, Beals, & Kaufman, 2007; Stoddard et al., 2013). Although basic relationships between cumulative contextual risk (CCR) and problem outcomes have been documented, there are gaps in knowledge. Most studies have been conducted in the United States (US) or the United Kingdom (UK), and have been cross-sectional or short-term longitudinal. The degree to which CCR confers vulnerability for youth within different macro-societal contexts is relatively unknown, and the long-term consequences of such risk are poorly understood. Moreover, multivariate analyses that account for associations of substance use with other problem behaviors are rare, as are tests of gender differences. The degree to which CCR in early development has general and/or specific associations with correlated problem behaviors in adolescence, and whether gender moderates these associations, has yet to be determined. The current study addresses these gaps, examining CCR at birth in relation to adolescent substance use, conduct problems, and risky sexual behavior via analyses of data from the Northern Finland Birth Cohort 1986.

Contextual risks do not occur in isolation, but tend to cluster in vulnerable families. Research has shown that CCR, traditionally operationalized as a count of the number of dichotomized contextual risk factors present at a particular time point, increases children's likelihood of experiencing multiple problem outcomes (Appleyard, Egeland, van Dulmen, & Sroufe, 2005; Sameroff, Bartko, Baldwin, & Seifer, 1998; Sameroff et al., 1987). Much of this research has focused on the academic and psychosocial functioning of younger children (Evans et al., 2013). During adolescence, however, substance use begins to emerge (Johnston, O'Malley, Bachman, & Schulenberg, 2014), and co-occurring problem behaviors, including conduct problems and risky sex, increase (Mason et al., 2010; Windle, 2000). Selected studies have documented links between CCR and adolescent substance use

(Newcomb & Felix-Ortiz, 1992; Ostaszewski & Zimmerman, 2006), as well as conduct problems (Mitchell et al., 2007; Stoddard et al., 2013; van der Laan, Veenstra, Bogaerts, Verhulst, & Ormel, 2010) and risky sex (Price & Hyde, 2009; Small & Luster, 1994). However, it remains to be determined if CCR in early development has long-term consequences for adolescent substance use and co-occurring problem behaviors. For example, long-term effects might result from direct genetic influences or epigenetic processes, such as the modification of gene expression related to individuals' stress response resulting from early exposure to prenatal and postnatal stressors (National Scientific Council on the Developing Child, 2010).

A prominent explanation for the co-occurrence of adolescent substance use with other problem behaviors is that such co-occurrence is due to a common latent factor, typically conceptualized as a general problem behavior syndrome (Jessor & Jessor, 1977) or common liability (Vanyukov et al., 2012). Research has shown that the correlations among adolescent problem behaviors are captured to a large extent, but not wholly, by a general problem behavior factor (Donovan & Jessor, 1985; Donovan, Jessor, & Costa, 1988). However, analyses of CCR have not accounted for the correlations among multiple behaviors. Thus, it is unknown if CCR primarily has effects on general problem behavior or if it might also have specific effects on particular outcomes. For example, early adversity in the form of CCR might lead to accelerated pubertal development (Belsky, Houts, & Fearon, 2010), which is associated with earlier initiation of sexual activity and sex-risk behavior (Savolainen et al., 2015). These processes could result in a specific effect from early CCR to adolescent risky sex, over-and-above heightened risk for general problem behavior.

Few studies have evaluated whether gender moderates the association between CCR and adolescent problem behaviors. There is some evidence that cumulative risk increases the likelihood of aggression more in boys than girls (Ribeaud & Eisner, 2010). However, other studies have indicated a relative lack of support for gender differences in the associations between cumulative risk and substance use (Griffin, Scheier, Botvin, & Diaz, 2000) and externalizing problems (Gerard & Buehler, 2004). Additional tests of gender differences are needed.

Little is known about the effects of CCR in national contexts outside of the US and the UK. The consequences of CCR might vary across countries. The current study examines the general and specific effects of CCR at birth in relation to substance use and co-occurring problem behaviors in adolescence using data on a birth cohort from Northern Finland. As a Nordic welfare state, Finland represents a unique context, due to generous and comprehensive systems of collective social support and protection available. Such policy arrangements might attenuate well-established CCR effects reported in the literature from US and UK studies. Alternatively, if these effects are similar in Finland, the results would suggest that CCR effects represent general developmental processes.

2. Method

2.1. Participants and procedures

Participants were from the Northern Finland Birth Cohort 1986 (NFBC1986), a population-based study of individuals born during a one-year period in the two northernmost provinces of Finland. The original NFBC1986 cohort included 9432 children born alive, whose expected date of birth fell between July 1, 1985 and June 30, 1986 (98.5% of all deliveries taking place in the target location). Details about data collection are available elsewhere (Hurtig et al., 2007; Järvelin, Hartikainen-Sorri, & Rantakallio, 1993).

The current analyses use data collected during the prenatal/birth period and middle adolescence. A prenatal background questionnaire of mothers was distributed at their first antenatal visit to the local prenatal clinic (on average at the 12th gestational week) and returned by their 24th gestational week. A second pregnancy questionnaire was completed by midwives at mother's last antenatal visit to the clinic, or during the first home visit by the midwife after delivery. Additional information on pregnancy and delivery was completed by midwives and/or medical staff at the prenatal clinics. In 2001–2002, when the participants were age 15–16, they were asked to complete a postal questionnaire on health, living habits, and social background (80% participation rate). By this time, 217 were deceased, emigrated, or had an unknown address. They also were invited to a clinical examination, during which youth filled in an additional questionnaire (76% participation rate) (Miettunen et al., 2015). Written informed consent was obtained from 92% of both parents and children. The study was approved by the ethical committee of the Northern Ostrobothnia Hospital District.

The analysis sample for the current study is 6963, which represents all consented youth with data collected during adolescence (74% of live births at the study's outset), with one randomly selected child from each set of participating non-singletons. Participants in the analysis sample were 49% male and had an average age in adolescence of 16.0 (14.58 to 16.96) years. Attrition analyses showed that the analysis sample has more females (51% v. 48%; X^2 (1, $N = 16395$) = 10.41, $p < .01$), fewer low birth weight babies (3% v. 3.7%; X^2 (1, $N = 16395$) = 5.21, $p < .05$), and fewer children of mothers who smoked during pregnancy (X^2 (1, $N = 14637$) = 5.73, $p < .05$) than the original live-born birth cohort.

2.2. Measures

2.2.1. Prenatal/Birth Cumulative Contextual Risk Index—Ten indicators measured contextual risk during the prenatal/birth period. With the exception of birth weight (provided by medical staff at time of delivery), all measures were collected through the pregnancy questionnaires completed by mothers. The indicators included: 1) low birth weight, 2) teenage mother, 3) single parent, 4) multiple unions, 5) drop-out mother, 6) smoking while pregnant, 7) drinking while pregnant, 8) paternal alcohol use, 9) economic exclusion, and 10) material deprivation. Each indicator was coded 1 to represent presence of the risk and 0 to represent absence of the risk (i.e., the reference category).

Low birth weight was coded 1 if the child was born weighing under 2500 g (Zegers-Hochschild et al., 2009). *Teenage mother* was coded 1 if the mother gave birth to the participant at age 19 or younger. *Single parent* was coded 1 if the mother was unmarried,

widowed, divorced, or not cohabiting. *Multiple unions* was coded 1 if the mother had at least one prior registered union, such as marriage or cohabitation. *Drop-out mother* was coded 1 if the mother had completed no more 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.

As noted, the long-standing tradition in this literature is to operationalize cumulative risk as a count variable. Accordingly, the CCR index was computed as the sum of the 10 dichotomous indicators, which generated an observed range of 0–6.

Adolescent Substance Use was a latent variable with 3 indicators: 1) lifetime drunkenness, 2), current regular cigarette use, and 3) lifetime illegal drug use. All data were collected through adolescent self-report. Frequency of *lifetime drunkenness* was measured with the question, "How many times in your life have you been drunk?," with responses coded as: 0 "never", 1 "1–2 times", 2 "3–5 times", 3 "6–9 times", 4 "10–19 times", 5 "20–39 times", and 6 "40 times or more." Current regular *cigarette use* was determined according to the question, "Do you smoke now?", with responses coded as 0 "not at all", 1 "occasionally", 2 "one day a week", 3 "2–4 days a week", 4 "5–6 days a week", and 5 "7 days a week." Lifetime *illegal drug use* was measured with three questions about marijuana, hard drugs, or intravenous drug use. Response options were never, once, 2–4 times, 5 times or more, or regular user. Due to low prevalence rates, these three items were collapsed into a single dichotomous lifetime illegal drug use (1) or non-use (0) variable.

Adolescent Conduct Problems were represented as a latent variable composed of the *delinquent behavior* and *aggressive behavior* subscales from Achenbach's Youth Self-Report (YSR; Achenbach, 1991). For each item, youth selected how true that item was for them at that time or within the 6 months prior, using response options of: 0 "not true", 1 "somewhat or sometimes true", or 2 "very true or often true." Raw scores were summed into delinquent behavior and aggressive behavior subscales per Achenbach scoring algorithms (Achenbach, 1991), with minor variations. For example, the substance use item was excluded from the delinquency scale computation to avoid overlap with the substance use latent variable. The internal consistencies of the YSR subscales were acceptable ($a = .61$ for delinquent behavior and $a = .84$ for aggressive behavior).

Risky Sexual Behavior was measured via self-reported adolescent sexual behaviors regarding multiple partners and lack of condom use, which were used to create a risky sex latent variable. *Multiple partnersxy* was measured with the question, "How many sexual partners have you had?" with response options ranging of 0 "none", 1 "one", 2 "two", 3 "three or four", or 4 "five or more." Using the question "What contraceptive method did you use for your FIRST intercourse?," a dichotomous variable representing *lack of condom use*

was computed. Condom use (with or without contraceptive pills) and "never had intercourse" were collapsed into 0, while "nothing", "contraceptive pills" or "some other method" were collapsed into 1.

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

2.3. Data analyses

The data were analyzed with structural equation modeling (SEM) in three stages. In the first stage, a first-order SEM was estimated that included the CCR index, child gender, and a CCR × Gender product term as predictors of first-order adolescent substance use, conduct problems, and risky sex latent variables. This model permitted a test of the degree to which CCR predicts the adolescent latent variables as individual outcomes. In the second stage, a second-order SEM was conducted to examine the CCR index, child gender, and a CCR × Gender product term as predictors of a single adolescent general problem behavior factor, which had the three first-order latent variables as indicators. This model permitted a test of the degree to which CCR predicts general problem behavior, which captures variance that is shared in common across substance use, conduct problems, and risky sex.

In the third stage, the first and second stage models were combined to examine the degree to which CCR predicts the first-order substance use, conduct problems, and risky sex factors over-and-above the second-order general problem behavior factor. However, a single model that simultaneously examines all general and specific effects together cannot be conducted, because the model is underidentified and parameter estimates cannot be generated. Thus, three separate models were conducted that added paths from the CCR index, child gender, and the product term to each first-order factor, in turn, while including predictive paths to general problem behavior.

A supplemental analysis was conducted in which the first-order SEM was modified by removing the substance use latent variable and treating each of its indicators as a manifest outcome. Specifically, the three substance use indicators along with the conduct problems and risky sex latent variables were regressed on the CCR index, child gender, and a CCR × Gender product term. This model tested whether the CCR index had long-term predictive associations that were substance specific.

SEM analyses were conducted using Mplus 7.11 (Muthén & Muthén, 2012). Parameter estimates were derived using the weighted least squares mean- and variance-adjusted (WLSMV) estimator, since two of the latent variable indicators (illegal drug use and condom use) were dichotomous. WLSMV estimation in Mplus implements pairwise missing data estimation, retaining the full analysis sample of 6963 cases. Model fit was evaluated using the chi-square statistic, comparative fit index (CFI), and root mean square error of approximation (RMSEA) according to recommended guidelines (e.g., CFI around .95 or greater; RMSEA around .06 or less) (Hu & Bentler, 1999).

3. Results

Fifty-eight percent of participants had no risks, 27% one risk, 10% two risks, and 5% three or more risks. The average number of risks was low ($M = .65$, $SD = .94$) in this community sample. Correlations, means, and standard deviations of the measured variables are reported in Table 1. There were statistically significant positive correlations among the indicators of adolescent substance use, conduct problems, and risky sex. CCR had statistically significant positive and male gender statistically significant negative correlations with the adolescent problem behavior indicators.

To begin, the first-order SEM depicted in Fig. 1 was estimated. The fit between the data and the model was acceptable, X^2 (23 df, $N = 6963$) = 187.64, $p = .00$, CFI = .985, RMSEA = .032. Factor loadings were positive and statistically significant, indicating an acceptable measurement model. CCR was a statistically significant positive predictor of each adolescent outcome. For risky sex, the predictive relationship was moderated by gender. Follow-up analyses indicated that the positive effect was significant for both groups, but stronger for girls.

Next, a second-order SEM that included the CCR index, child gender, and a CCR × Gender product term as predictors of a general problem behavior factor displayed acceptable fit statistics, X^2 (29 df, $N = 6963$) = 321.42, $p = .00$, CFI = .974, RMSEA = .038. Examination of the path coefficients showed that the CCR × Gender interaction effect was not statistically significant ($p > .05$); therefore, the product term was dropped and the model re-estimated. The re-estimated model (Fig. 2) displayed acceptable fit statistics, X^2 (23 df, $N = 6963$) = 311.47, $p = .00$, CFI = .960, RMSEA = .042. Factor loadings were positive and statistically significant. CCR was a statistically significant positive predictor of general problem behavior.

Finally, three separate models were conducted that added paths from the CCR index, child gender, and the product term to each first-order factor, in turn, while including paths from CCR and child gender to general problem behavior. Fit statistics and path estimates from each model are reported in Table 2. In all three models, the positive relationship between CCR and general problem behavior remained statistically significant. There was no evidence of specific effects in relation to either substance use or conduct problems. There was a statistically significant specific effect of CCR on risky sex that was moderated by gender. Examination of the significant interaction showed that the positive specific effect of CCR on risky sex was present only for girls.

Turning to the supplemental analysis, the modified first-order SEM examining potential substance-specific effects displayed acceptable fit, X^2 (13 df, $N = 6963$) = 114.38, $p = .00$, CFI = .991, RMSEA = .033. CCR had statistically significant positive associations with lifetime drunkenness ($b = .39$, se = .04, $p < .05$; $\beta = .17$), current regular cigarette use ($b = .31$, se = .03, $p < .05$; $\beta = .16$), and lifetime illegal drug use ($b = .12$, se = .04, $p < .05$; $\beta = .11$), none of which were moderated by gender. Thus, results did not reveal substance-specific effects. The basic pattern of findings for the conduct problems and risky sex latent variable outcomes was the same as that reported in Fig. 1 (results available on request).

4. Discussion

This study examined the consequences of cumulative contextual risk (CCR) at birth in relation to adolescent substance use and co-occurring problem behaviors in a large Finnish birth cohort. CCR had both general and specific associations with substance use, conduct problems, and risky sex. The Finnish context of this study is unique. As a Nordic welfare state, Finland offers universal support for children and families regardless of their economic resources, and these systems of support tend to be stronger and more comprehensive than what is available in most other countries. Despite this supportive macro-societal context, significant contextual risks were observed and shown to predict problem behaviors. The consequences of CCR may represent general developmental phenomena. For example, CCR effects might be biologically-mediated through the lasting impact that early risks can have on an individual's stress responsivity (National Scientific Council on the Developing Child, 2010), which increases risk for later problems.

Results showed that the associations among substance use, conduct problems, and risky sex could be captured, in part, by a general problem behavior factor. This is consistent with problem behavior theory (Jessor & Jessor, 1977) and the common liability model (Vanyukov et al., 2012), and prior research (Donovan & Jessor, 1985; Donovan et al., 1988; Tarter et al., 2012). Analyses further revealed that CCR had a long-term predictive relationship with general problem behavior, which was not moderated by gender. It is likely that the CCR index itself captures common liability by measuring genetic and early environmental factors that pre-dispose individuals to general problem behavior later in development. There was no specific effect of CCR on substance use or conduct problems, after accounting for associations among the outcomes due to general problem behavior. This suggests that the statistically significant effects of CCR on substance use and conduct problems observed in prior studies of singular outcomes would be better explained by the tendency for CCR to predict general problem behavior, rather than substance use and conduct problems, per se.

By contrast, a specific effect of CCR on risky sex was observed, representing prediction of variance in risky sex that is not due to general problem behavior and, therefore, not shared in common with adolescent substance use and conduct problems. This finding may represent an exception to the general pattern predicted by problem behavior theory and the common liability model. The specific effect was moderated by gender, such that positive prediction from CCR to risky sex was evident for girls but not boys. Developmental theory and etiological studies suggest that early exposure to risk may accelerate pubertal development (Belsky et al., 2010), and prior research has shown that early maturation is a risk factor for precocious sexual debut and risky sex behavior, particularly among girls (Savolainen et al., 2015). It is possible that this developmental process explains the specific effect of CCR on risky sex.

There are some limitations to this study. Data were collected primarily via self-reports from mothers and youth, and the assessments could not be cross-validated. Although common for birth cohort studies, some of the measures were brief. The Finnish context is a strength; however, additional studies are needed that directly compare multiple countries.

5. Conclusions

This study documented both general and specific effects of CCR at birth on substance use and co-occurring problem behaviors in adolescence. The effects on risky sex were stronger for girls. Findings indicate the need for early screening and prevention efforts to promote resilience among vulnerable children exposed to multiple contextual risks early in development.

Acknowledgments

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HIGHLIGHTS

- Cumulative Contextual Risk (CCR) at birth had long-term consequences for teens.

- CCR predicted substance misuse, conduct problems, and risky sex over the long term.

- CCR also had a long-term predictive association with general problem behavior.

- CCR had a specific predictive association with risky sex for girls but not boys.

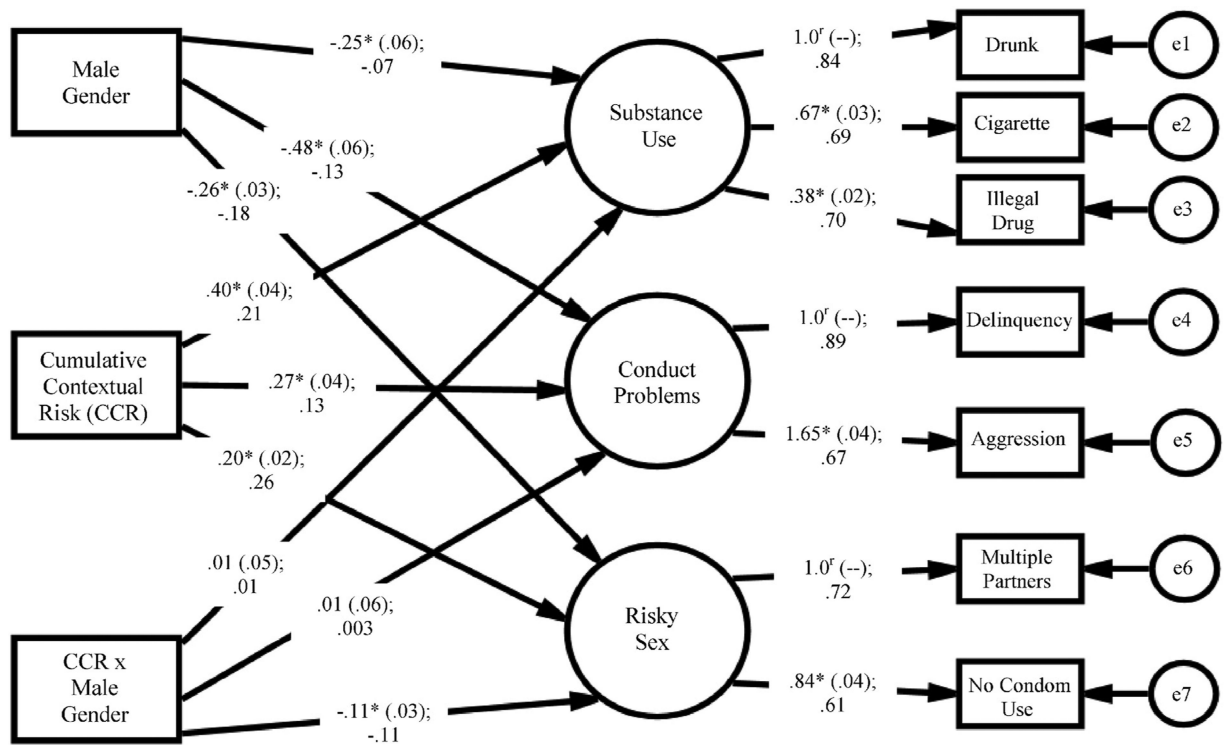- The study, conducted in Finland, extends prior research conducted in the US and UK.

Fig. 1.
First-order structural equation model. Unstandardized coefficients are presented first, followed by standard errors in parentheses, followed by standardized coefficients. * = $p < .05$.
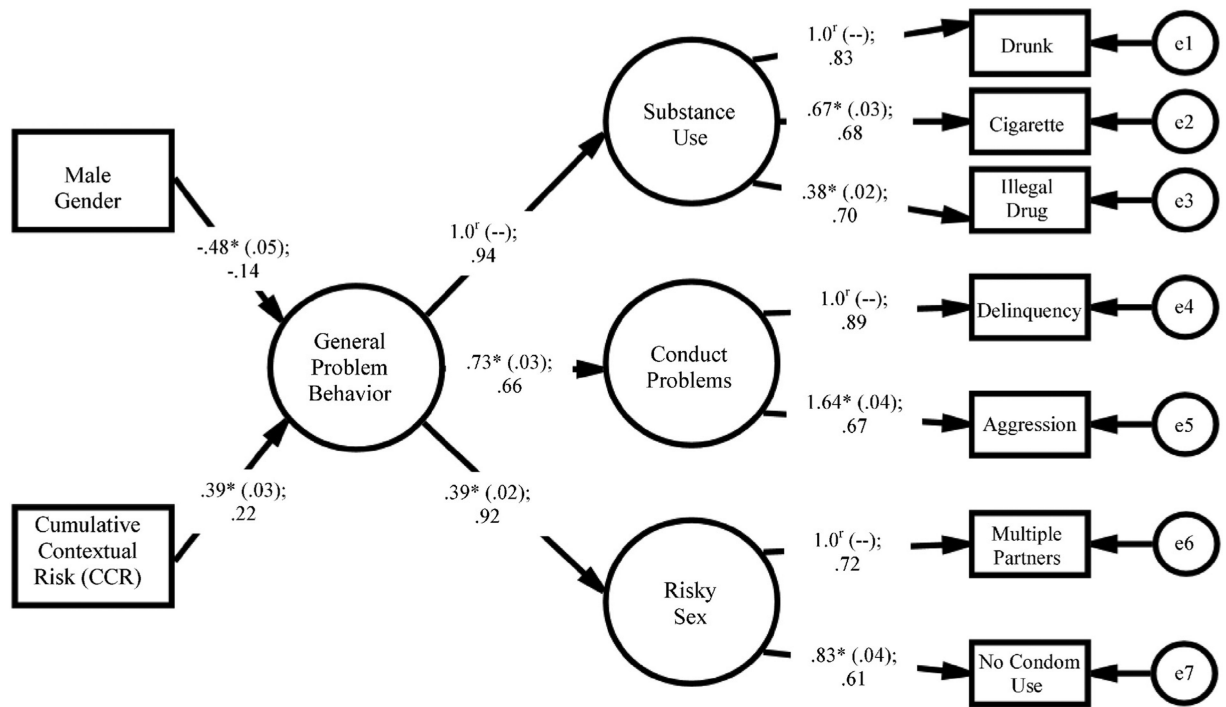
Fig. 2.
Second-order structural equation model. Unstandardized coefficients are presented first, followed by standard errors in parentheses, followed by standardized coefficients. * = *p* < . 05.

Table 1

Correlations, means, and standard deviations of study variables.

Variable	1	2	3	4	5	6	7	8	9
1. Child gender (male)									
2. Cumulative contextual risk	$-.02$								
3. Drunkenness	$-.05^*$	$.16^*$							
4. Cigarette use	$-.06^*$	$.17^*$	$.51^*$						
5. Illegal drug use	$-.03^*$	$.07^*$	$.32^*$	$.30^*$					
6. Delinquency	$-.06^*$	$.12^*$	$.45^*$	$.43^*$	$.26^*$				
7. Aggression	$-.15^*$	$.09^*$	$.31^*$	$.30^*$	$.17^*$	$.60^*$			
8. Multiple partners	$-.16^*$	$.14^*$	$.53^*$	$.45^*$	$.33^*$	$.36^*$	$.27^*$		
9. No condom use	$-.08^*$	$.05^*$	$.21^*$	$.19^*$	$.15^*$	$.18^*$	$.14^*$	$.31^*$	
Mean	.49	.65	2.41	1.05	.06	12.73	24.87	.54	.04
Standard deviation	.50	.94	2.19	1.80	.24	2.13	4.66	1.01	.20

*
$p < .05.$

Table 2

Tests of specific cumulative contextual risk effects over-and-above its general effect

	Model 1: substance use		Model 2: conduct problems		Model 3: risky sex	
	General	**Specific**	**General**	**Specific**	**General**	**Specific**
Cumulative contextual risk (CCR)	.41[*] (.03); .21	−.01 (.04); −.01	.40[*] (.03); .21	−.01 (.04); −.01	.40[*] (.03); .22	.05[*] (.02); .07
Male gender	−.89[*] (.09); −.23	.61[*] (.09); .16	−.43[*] (.06); −.12	−.20[*] (.06); −.05	−.37[*] (.05); −.11	−.11[*] (.03); −.08
CCR × Gender	--	.03 (.05); .01	--	.02 (.05); .01	--	−.11[*] (.03); −.11

Note: unstandardized coefficients are presented first, followed by standard errors in parentheses, followed by standardized coefficients. Model 1 Fit Statistics: X^2 (27 *df, N* = 6963) = 185.80, *p* = .00, CFI = .986, RMSEA = .029. Model 2 Fit Statistics: X^2 (27 *df, N* = 6963) = 338.65, *p* = .00, CFI = .972, RMSEA = .041. Model 3 Fit Statistics: X^2 (27 *df, N* = 6963) = 238.04, *p* = .00, CFI = .981, RMSEA = .034.

[*] p < .05.