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Developmental trajectories of externalizing behavior from ages 4 to 12: Prenatal cocaine exposure and adolescent correlates

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Abstract

Background: Although prenatal cocaine exposure (PCE) has been linked with greater externalizing behavior, no studies have investigated heterogeneity of developmental trajectories in children with PCE to date. The present study aimed to: (1) identify developmental trajectories of externalizing problems in childhood by using a person-oriented analytic approach; (2) examine whether trajectories differ by PCE and other environmental and biological correlates; and (3) investigate how trajectories were associated with adolescent substance use and sexual behavior.

Methods: Adolescents ($N=386$; 197 PCE, 187 non-cocaine exposed (NCE)), primarily African-American and of low socioeconomic status, were prospectively enrolled in a longitudinal study at birth. Externalizing problems were assessed with the Child Behavior Checklist (CBCL) at ages 4, 6, 9, 10, 11, and 12. Substance (tobacco, alcohol, marijuana) use, via self-report and biologic assays, and early (before age 15) sexual intercourse were assessed at age 15.

Results: Latent class growth modeling indicated four distinctive developmental trajectories of externalizing behavior from ages 4 to 12: low-decreasing group (32%); moderate-decreasing group (32%); accelerated risk group (14%); and elevated-chronic group (22%). PCE and maternal

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Contributors

Dr. Meeyoung O. Min conceptualized the paper, performed the statistical analyses, and wrote the initial and final draft. Dr. Sonia Minnes designed the study and interpreted the data. Dr. Hyungyong Park analyzed the data and summarized the findings. Dr. Ty Ridenour participated in the interpretation of the findings. Ms. June-Yung Kim assisted in the literature review, and drafting the manuscript. Ms. Miyoung Yoon assisted in the literature review and drafting the manuscript. Dr. Lynn T. Singer participated in the study's conception and design, interpretation of data, and reviewed the manuscript. All authors read and approved the final manuscript.

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Conflict of Interest

No conflict of interest declared.

psychological distress interactively differentiated developmental trajectories of externalizing behavior, which were related to subsequent adolescent substance use and early sexual behavior differently across gender.

Conclusions: The two high-risk trajectories (accelerated risk and elevated-chronic groups), comprising 36% of the sample, identified in the present study may reflect multi-causality of early substance use and perhaps greater risk for transition to substance use disorders later in development.

Keywords

Externalizing behavior; Developmental trajectories; Prenatal cocaine exposure; Latent class growth modeling; Adolescence

1. Introduction

Externalizing behavior refers to overt behavior problems that are characterized by impulsivity and lack of self-regulation (Tucker et al., 2015). It typically involves conflicts with other people (Achenbach and Rescorla, 2001), such as aggression, rule-breaking, and disruptive behavior. Externalizing behavior in childhood is associated with school failure, peer problems, and juvenile delinquency; it is also a well-established precursor to substance use (King et al., 2004; Iacono et al., 2008) and sexual risk behaviors (Min et al., 2015, 2016). These problems have life-long implications in terms of interfering with vocational and educational opportunities and attainment, and developing stable, supportive relationships, all pivotal for successful adjustment in adulthood.

Prenatal cocaine exposure (PCE) may increase the risk of externalizing behavioral problems (Bada et al., 2007; Minnes et al., 2010; Ackerman et al., 2010; Min et al., 2017a). PCE directly impedes fetal brain development by altering the monoamine neurotransmitter system involving dopamine, serotonin, and norepinephrine in the prefrontal cortex, a brain region known to impact emotional and behavioral arousal and regulation (Kosofsky et al., 1994; McCarthy et al., 2014). PCE may also alter brain function indirectly via its vasoconstrictive properties that limit oxygen and nutrition to the developing fetal brain (Volpe, 1992). These structural and functional alterations in the brain may underlie cognitive deficits including problems with executive function, attention, inhibitory control, and stress response in PCE children (Minnes et al., 2016; Singer et al., 2008; Thompson et al., 2009), contributing to the development of externalizing behavior problems.

Studies from longitudinal prospective birth cohorts reported conflicting evidence of PCE effects on externalizing behavior problems during the preschool years (Dixon et al., 2008; Frank et al., 2001), yet consistent findings have been observed at early school age and during preadolescence, despite methodological variability (Ackerman et al., 2010; Bada et al., 2007; Minnes et al., 2010). For example, PCE was related to child-reported symptoms of oppositional defiant disorder and attention-deficit/hyperactivity disorder at 6 years of age (Linares et al., 2005), caregiver-reported aggressive and delinquent behavior at 9 years (McLaughlin et al., 2011), teacher- and caregiver-rated externalizing behavior problems at 7, 9 and 11 years (Bada et al., 2011), and child-reported externalizing behavior at age 12 (Min

et al., 2014). However, the effect sizes were generally small at 0.20 SD on average (Ackerman et al., 2010).

Although these studies demonstrated that PCE accounts for individual variation in externalizing behavior problems, many of them used cross-sectional analyses, precluding any determination of how PCE effects may vary by developmental stages. When studies did employ longitudinal analyses (e.g., Bada et al., 2011; Minnes et al., 2010), they were based on the assumption that all children with PCE would follow a common developmental trajectory of either increase or decline, estimating a single trajectory that averages the individual trajectories of all participants in a given sample. However, given that the majority of children in these studies do not have externalizing behavior problems (Bongers et al., 2004; Vaughn et al., 2014), there may not be a common developmental course for externalizing behavior. Differing developmental patterns may partially explain the previously reported small effect size of PCE on externalizing behavior, calling for an alternative strategy to investigate potential heterogeneity of subgroups with distinctive trajectories. Little is known about whether and how PCE may contribute to different childhood developmental trajectories of externalizing behavioral problems, which may persist, desist, or escalate over time.

1.1 Developmental trajectories of externalizing behavior

A widely used developmental taxonomy of externalizing behavior is Moffitt's (1993) model of antisocial behavior proposing two mutually exclusive subgroups of antisocial individuals: the early-onset life-course-persistent antisocial individuals, representing approximately 5% of the population, whose antisocial/externalizing behavior problems start early in childhood and continue to be high throughout development including adulthood, and the late-onset adolescence-limited antisocial individuals, who engage in antisocial behaviors only during the teen years. Moffitt posits that the early and persistent antisocial behavior is likely related to a biological or genetic vulnerability that is exacerbated by poor parenting and early school failure, while adolescence-limited antisocial behavior tends to stem from later socialization experiences such as deviant peer affiliations in early adolescence.

In studies of children without PCE that empirically classified trajectory groups, heterogeneity in externalizing trajectories was demonstrated, consistently identifying two groups: a high persistent and chronic group, resembling Moffitt's life-course-persistent trajectory for some children, and a larger, low stable, normative group. Other additional trajectories were also empirically identified, although with less consensus, such as a moderate to decreasing group or an increasing/escalating group, especially in a sample of maltreated children. For example, the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care reported five distinctive groups of externalizing trajectories from ages 2 to 12, with high chronic (8.4% of the sample), low (27%), moderate (19.4%), and two (high and moderate) decreasing groups (45%), but not an increasing/escalating group (Fanti and Henrich, 2010). Similarly, the Shaw et al. (2003) study on boys' conduct problems from ages 2–8, recruited from low-income families using the Women, Infants, and Children (WIC) Program, also identified multiple trajectories: high chronic (6%); low (14%); and two (high and moderate) decreasing (80%) groups. However,

studies of maltreated children from ages 4–10 years utilizing data from the Longitudinal Study of Child Abuse and Neglect (LONGSCAN) or the National Survey of Child and Adolescent Well-Being (NSCAW), a nationally representative longitudinal study of children and families involved with the Child Protective Services (CPS), identified an increasing/escalating subgroup (8% in LONGSCAN; 7.8% in NSCAW) in addition to the high chronic (10.8%; 4.4%), low stable (56.9%; 32.6%), and decreasing (24.3%; 12.5%) groups (Woodruff and Lee, 2011; Tabone et al., 2011). Although differences in the nature of the samples, operationalization of problem behaviors, and the length of the follow-up period may yield variability in the number and shape of different trajectories and in the proportions of children following different trajectories, these studies collectively demonstrate that there are empirically identifiable subgroups of youth with distinct developmental trajectories of externalizing behavior.

1.2 The current study

The current study aimed, first, to identify developmental trajectories of externalizing behavioral problems from early childhood (ages 4–12) in children with PCE by utilizing a person-oriented analytic approach, which uncovers empirically distinct subgroups of individuals following a similar pattern of change over time on externalizing behavior (Nagin, 2015). Different trajectories may reflect distinctive etiologies (Nagin, 2005). The person-centered approach allows the detection of small, yet meaningful subgroups of the larger sample that do not fit the shape of the average trajectory generated by variable-centered approaches that have been traditionally used; what might be considered error variance at the group level in typical variable-oriented analyses are critically examined for understanding diversity in process and outcome (Cicchetti, 2013). Thus, person-oriented analyses are especially useful for identifying a subgroup representing highly skewed outcomes such as externalizing behaviors (NICHD Early Child Care Research Network, 2004).

Second, we examined whether PCE predicts developmental trajectories that are problematic, controlling for multiple biological and environmental confounders that may obscure the long-term effects of PCE. Prenatal exposure to other substances such as alcohol (Larkby et al., 2011), tobacco (Maughan et al., 2004), and marijuana (Goldschmidt et al., 2000), maternal/caregiver's continuous, postpartum substance use (Bada et al., 2007), poor quality of the home environment (Min et al., 2014), and adoptive/foster care placement (Linares et al., 2005) have been reported to be related to childhood externalizing behavior problems in children with PCE. In particular, maternal cocaine use has been consistently associated with higher levels of maternal psychological distress symptoms (e.g., Min et al., 2013; Minnes et al., 2010; Singer et al., 1997). Given the well-established causal role of caregiving quality shaping children's adjustment, especially in the early formative years of life, both independently (Jaffee, 2007; Olson et al., 2017; Shaw et al., 2003; Fanti and Henrich, 2010; Tabone et al., 2011) and interactively with biological risk factors (Brennan et al., 2003; Moffitt, 1993; Min et al., 2017b; Molnar et al., 2014), we explored the interaction between PCE and maternal psychological distress. The diathesis-stress model (Zahn-Waxler et al., 2008) suggests that those with a biological vulnerability are disproportionately likely to be adversely affected by an environmental stressor. The effects of PCE may be greater when a mother could not provide optimal care due to her high psychological distress. Thus, the joint

influences of PCE and high maternal psychological distress would be associated with the most problematic developmental trajectory.

Lastly, to evaluate the clinical significance and validity of these trajectory groups, each trajectory was compared on adolescent substance use and early sexual risk behavior, controlling for potential covariates of the outcomes such as parental attachment and monitoring, family conflict, violence exposure, childhood maltreatment, and sexual victimization (Wills et al., 2003; Dittus et al., 2015; Voisin et al., 2011; Min et al., 2007; Min et al., 2016). Interaction between trajectory group and gender was explored due to well-known gender differences in patterns of drug use (Becker et al., 2016) and sexual behavior (Dir et al., 2014; Zimmer-Gembeck and Helfand, 2008; Min et al., 2015). It was hypothesized that: (1) heterogeneous externalizing trajectories exist in children with PCE and can be identified as distinct subgroups; (2) PCE and maternal psychological distress would predict, independently and interactively, membership in groups with children exhibiting more problematic externalizing behavior trajectories; and (3) more problematic externalizing behavior trajectories (e.g., high chronic) in childhood would be related to subsequent adolescent substance use and early sexual behavior.

2. Methods

2.1 Sample and procedure

This study included 386 (197 PCE, 189 NCE) children and their mothers or caregivers recruited at infant birth (September 1994 to June 1996) from an urban county hospital for a longitudinal investigation of the effects of PCE. All recruited mothers were identified from a high-risk population screened for drug use. Urine drug toxicology screens were performed by the hospital on women who received no prenatal care, appeared intoxicated or taking drugs, had a history of involvement with the Department of Human Services in previous pregnancies due to drug use, self-admitted drug use, or appeared to be at high risk for drug use after an interview with hospital staff. Women with a psychiatric history of schizophrenia, bipolar disorder or attempted suicide, low intellectual functioning indicated in medical chart review, HIV-positive status, or chronic medical illness were excluded, as were infants with Down syndrome, fetal alcohol syndrome, or congenital heart defects. A nurse recruiter approached 647 screened women immediately before or after infant birth. Of these 647 women, 54 were excluded, 155 refused to participate, and 23 did not come to the enrollment visit.

Maternal and infant urine samples and infant meconium were obtained shortly before or after infant birth and analyzed for cocaine and other drug metabolites, including benzoylecgonine, meta-hydroxybenzoylecgonine, cocaethylene, cannabinoids, opiates, phencyclidine, amphetamines, and benzodiazepines. A total of 415 newborns and their birth mothers were enrolled at birth, of which 218 infants were identified as PCE based on positive screens of maternal and infant urine, infant meconium, or maternal self-report of cocaine use during pregnancy to hospital or research staff. Infants who were negative on all indicators of PCE were identified as non-cocaine exposed (NCE), but they may have been exposed to other substances (i.e., alcohol, tobacco, marijuana), forming a comparison group. Subjects and their caregivers were assessed by separate examiners who were blinded to

exposure status at follow-up assessments at 6, 12, and 18 months and 2, 4, 6, 9, 10, 11, and 12 years postpartum.

Since birth, 11 (8 PCE, 3 NCE) enrolled children died within the first year from sudden infant death syndrome (4 PCE, 2 NCE), cardiopulmonary arrest (1 PCE), pneumonia (1 PCE), accidental asphyxia (1 PCE), or respiratory distress syndrome (1 PCE, 1 NCE). The present study utilizes data from 386 children whose mothers/caregivers completed behavioral problem assessment at age 4, 6, 9, 10, 11, and/or 12 years, representing 95.5% retention of the 404 living participants in the original study. Among the 386 participating children, 93.5% ($n=361$) were assessed 4 time points. Of the 18 children not included (11 drop-out, 7 lost contact) in this analysis, the 13 PCE children were more likely to be White and to have lower Hobel Neonatal Risk scores than the 197 participating PCE children. The 5 NCE children not included in the study were more likely to have longer gestational age and lower Hobel Neonatal Risk scores than the 189 participating NCE adolescents. The Institutional Review Board of the participating hospital approved this study. All participants were given a monetary stipend, lunch, and transportation costs if needed. Parental written informed consent was obtained, with child assent beginning at age 9. A Certificate of Confidentiality (DA-09-146) was obtained from U.S. Department of Health and Human Services to protect the release of drug-related information from forced disclosure.

2.2 Measures

2.2.1 Prenatal cocaine and other substance exposures.—Birth mothers were asked to recall frequency and amount of drug use for the month prior to and for each trimester of pregnancy at the newborn visit (Singer et al., 2004). The number of tobacco cigarettes and marijuana joints smoked per day, and the number of drinks of beer, wine, or hard liquor per week was computed, with each drink equivalent to 0.5 oz. of absolute alcohol. As the majority of women (97%) in our study used crack cocaine, the number of “rocks” consumed and the amount of money spent on cocaine per day were noted, and was converted to a standard “unit” of cocaine, referring to \$20 worth of crack cocaine. Frequency of use was recorded for each drug on a Likert-type scale ranging from 0 (*not at all*) to 7 (*daily use*) to reflect the average number of days per week a drug was used, except for cigarettes, which was collected as the number smoked per day. Frequency was multiplied by the amount used per day to compute an average use score for the month prior to pregnancy and for each trimester. These scores were then averaged to obtain a total average score across the pregnancy. The drug assessment was updated with the child’s current caregiver at each follow-up visit to assess recent (prior 30-day period) postpartum, caregiver drug use.

2.2.2 Externalizing behavior.—Child’s externalizing behavior was assessed at ages 4, 6, 9, 10, 11, and 12 using the Child Behavior Checklist (CBCL) 4–18 years (Achenbach and Rescorla, 2001), a 113-item caregiver rating of emotional, behavioral, and social problems in the past six months. Items were rated on a three-point scale (0 = not true; 1 = sometimes true/somewhat true; 2 = very true/often true), with higher scores indicating greater behavior problems. The CBCL yields a broadband score of externalizing behavior comprised of items from the Aggressive Behavior (20 items) and Delinquent Behavior (13 items) domains. Raw scores were used for analyses, rather than age and gender normed *T* scores, due to a better

sensitivity for change than standardized scores (Achenbach, 1991). *T*-scores were used for descriptive purposes: *T*-scores < 60 are considered in the normal range; 60–63 represent borderline scores; and scores > 63 are in the clinical range (Achenbach, 1991).

2.2.3 Other potential antecedents of trajectory.—Birth, demographic, and medical characteristics extracted from hospital birth records included maternal age and marital status, years of education, child's race and gender, and infant head circumference. A Hollingshead score of IV (e.g., skilled manual workers, craftsmen) or V (e.g., clerical and sales workers, high school graduate) was used as an indicator of low socioeconomic status (Hollingshead, 1957). Maternal vocabulary was assessed at birth using the Peabody Picture Vocabulary Test-Revised (PPVT-R; Dunn and Dunn, 1981). Maternal psychological distress was assessed at birth and at each follow-up visit using the Global Severity Index ($\alpha = .95$), a summary scale of the Brief Symptom Inventory (Derogatis, 1992) assessing the experience of nine primary symptoms in the past seven days: somatic complaints, obsessive-compulsive behavior, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. At each visit, the child's placement (with either biological mother/ relative or adoptive/foster caregiver) and changes (defined by a change in both primary caregiver and physical setting lasting greater than one month) were noted. Child intelligence was assessed at age 4 using the Wechsler Preschool and Primary Scales of Intelligence- Revised (WPPSI-R; Wechsler, 1999). The Home Observation of the Environment (HOME) – Preschool version was administered to the caregiver in an interview format to assess the quality of the caregiving environment (Caldwell and Bradley, 1984).

2.2.4 Adolescents outcomes.—Adolescent substance use was assessed at age 15 using self-report and biologic assays. Self-reported alcohol, tobacco, and marijuana use were assessed using the Youth Risk Behavior Surveillance System (YRBSS; Centers for Disease Control and Prevention, 2009). Research nurses from the university's NIH-funded Clinical Research Unit collected samples of participants' urine, hair, and/or bloodspots, and sent them to the United States Drug Testing Laboratory for analysis (See Minnes et al., 2014 for a complete description of drug use assessment). Respondents positive on either self-report or biologic assays for a particular drug were coded 1 (*yes*) for that drug. Early sexual intercourse, defined as sexual intercourse prior to 15th birthday, was assessed at age 15 using the YRBSS.

2.2.5 Covariates of adolescent outcomes.—At age 12, parental attachment and monitoring, family conflict, and violence exposure were assessed using The Assessment of Liability and Exposure to Substance Use and Antisocial Behavior (ALEXSA; Ridenour, 2003), an illustration-based, audio, computer-assisted self-report of antisocial behavior, substance involvement and associated risk factors for children ages 9–12. The parental attachment scale ($\alpha = .80$; five items on a 4-point Likert scale) assesses the youth's perceived relationship/closeness with parents. The parental monitoring scale ($\alpha = .74$; five items on a four-point Likert scale) assesses the youths' perceptions of whether their parent(s) usually is (are) aware of the youths' activities and whereabouts. The family conflict index is a 10-item scale assessing family conflict tactics such as yelling, threatening

to hurt, throwing, hitting; the variable was a total count of these incidents. The violence exposure scale ($\alpha = .75$; eight items on a five-point Likert scale) assesses experiences of violence that have been inflicted directly on the respondent as well as violence that the respondent has witnessed (beaten, robbed or mugged, stabbed or shot), with higher scores indicating greater exposure. At age 17, childhood maltreatment and sexual victimization were assessed (1= *yes*; 0= *no*) retrospectively using the Juvenile Victimization Questionnaire (JVQ) – Adult Retrospective Version (Hamby et al., 2004; Finkelhor et al., 2005).

2.3 Statistical analyses

Analysis was performed in three phases, reflecting the three aims of the study. First, latent class growth modeling (LCGM) was employed to identify underlying subgroups with similar developmental trajectories on externalizing behavior (Aim 1) using SAS PROC TRAJ (Jones et al., 1999). A series of unconditional LCGM without covariates was conducted to determine the number of latent classes. We specified a single-class latent group model and increased the number of latent classes (e.g., 2-, 3-, ..., 6-classes) subsequently. Polynomial orders (intercept, linear, quadratic, and cubic function) of parameters in each class was tested to identify the shape of each trajectory in externalizing behavior over eight years of data, with non-significant higher order polynomial terms trimmed in subsequent models. The Poisson distribution specification was used for modeling externalizing behavior raw scores due to skewed distribution. Each model was evaluated by multiple model fit indices, including the Bayesian Information Criterion (BIC), the Akaike Information Criterion (AIC), entropy (precision of the class), average posterior probability (APP) of class membership, and odds of correct classification (OCC) (Jung and Wickrama, 2008; Nagin, 2005). The lower absolute value of AIC and BIC, $> .70$ for entropy and APP, and $OCC > 5$ for each class indicates the better fit for the data. We also considered the meaning of each latent class (interpretability) and minimum class sizes ($> 6\%$ of the sample) to capture small but meaningful groups for the practical usefulness. As the number of classes is determined, the most likely class variable was determined for each individual using the posterior probabilities of class membership obtained from LCGM.

Second, multiple antecedents assessed during the first four years of life were compared by the group membership using ANOVA and Chi-square analyses, with Tukey or Bonferroni post-hoc adjustment. In order to avoid multicollinearity and saturation of the model, antecedents correlated with overall class/group membership at $p < .20$ were included to the multinomial logistic regression model to identify early predictors/correlates associated with different trajectories (Aim 2). Maternal psychological distress was tested for interaction with PCE.

Lastly, to evaluate the clinical significance of the trajectories, logistic regression was used to examine how different trajectories were associated with adolescent substance use and sexual risk behavior, controlling for potential covariates (parental attachment and monitoring, family conflict, violence exposure, childhood maltreatment, and sexual victimization; Aim 3). If they were correlated with outcomes at $p < .20$, they were entered into the logistic regression model and retained if, on entry, they were significant at $p < .10$ or caused substantial ($> 10\%$) change in the trajectory coefficient (Mickey and Greenland, 1989).

When trajectory group had an overall significant effect, all pairwise group differences were probed. Gender was tested for interaction with trajectory groups. Adjusted least square means and standard errors were calculated from the estimated models.

3. Results

3.1 Sample characteristics

Compared to NCE children, children with PCE had a shorter gestational age and lower birth weight, length, and head circumference (Table 1). They were prenatally exposed to more tobacco, alcohol and marijuana on average, more likely to be placed in non-kinship foster or adoptive care by age 4, and tended to have lower IQ at age 4. Birth mothers of children with PCE were older, less educated, primarily unmarried, had lower vocabulary scores and reported more psychological distress than birth mothers of NCE children. Overall, externalizing behavior seemed quite stable throughout the childhood, with the mean *T*-score hovering around the population mean, ranging from 49.56 (*SD*=10.57) at age 6 to 51.59 (*SD*=12.44) at age 11.

3.2. Developmental trajectories of externalizing behavior in early childhood (ages 4 –12)

Table 2 compares model fit indices for each unconditional LCGM model with different numbers of latent classes. Although both AIC and BIC continued to improve as the number of latent classes increased, the APP, OCC, and the size of the smallest class indicated that a model with four classes was the best fitting model. Further, when we compared the 4-latent class model with 5- and 6-latent classes, one class in the model with 4-classes divided into two latent classes (model with 5 latent classes) or three latent classes (model with 6 latent classes), without meaningful differences. Thus, the model with four latent classes was selected as the best fitting model. Figure 1 shows the levels of externalizing behavior from ages 4 – 12 for each developmental trajectory group with estimated proportion, with the mean raw scores as well as *T*-scores in each trajectory group by age reported in Table 3. The first group (G1), *low-decreasing* group ($n = 126$, 32.4%, APP= .97), exhibited low levels of externalizing behavior at age 4 that continued to decrease over time. The second group (G2), *moderate-decreasing* group ($n = 125$, 31.7%, APP= .94), engaged in higher levels of externalizing behavior during early childhood (ages 4 and 6) than G1 and G2 yet showed a steady decline over time, following a trajectory similar in shape to G1 but at a higher level. The third group (G3), comprising the smallest group ($n = 51$, 13.7% of the sample, APP= .93), was named *accelerated risk* group, as it was characterized by a sharp increase of externalizing behavior at age 11, close to the borderline range, despite the low level of externalizing behavior at age 4. The fourth group (G4), *elevated-chronic* group, accounting for 22.1% of the sample ($n = 84$, APP= .99), exhibited high levels of externalizing behaviors across the observation period, with their externalizing behavior problem scores remained in clinical ranges since age 6.

3.3 Antecedents of externalizing behavior trajectory groups

Table 4 compares antecedents assessed at age 4 by the four trajectory groups, with overall group difference ($p < .05$) found only in non-kinship care by age 4 and maternal psychological distress assessed at birth. However, as results of multinomial logistic

regression analyses indicated significant PCE by maternal psychological distress interaction (Wald $\chi^2 = 11.85$, $p = .008$), PCE by maternal psychological distress interaction effects were probed by: (1) estimating maternal psychological distress effect separately for PCE vs. NCE; and (2) estimating PCE effect at three different levels (corresponding to 10, 50, and 90 percentiles) of maternal psychological distress (Table 5).

3.3.1 Accelerated risk group (G3).—Compared to the low-decreasing group (G1), higher maternal psychological distress was related to decreased odds of being in the accelerated risk group (G3) in PCE children (OR=0.25) but to increased odds of being in G3 in NCE children (OR=3.16). PCE was related to increased odds of being in G3 when maternal psychological distress was not high (OR= 8.73 and 3.69 with maternal psychological distress at 10th and 50th percentiles respectively in the distribution).

3.3.2 Elevated-chronic group (G4).—Higher maternal psychological distress was related to increased odds of being in the elevated-chronic trajectory group (G4) compared to the low-decreasing trajectory group (G1; OR=2.94) or the moderate-decreasing trajectory group (G2; OR=2.23) in NCE children, and to the accelerated risk group (G3) in PCE children (OR=5.79). PCE was related to decreased odds of being in G4, compared to G3, when maternal psychological distress was not high (OR=0.20 and 0.38 with maternal distress at 10th and 50th percentiles respectively in the distribution). Boys were 2.21 times more likely to follow G4 pattern than to follow the low-decreasing group (G1). Children with a history of non-kinship care were 3.43 times more likely to follow G4 than to follow the accelerated risk group (G3).

3.3.3 Moderate-decreasing group (G2).—Compared to the accelerated risk group (G3), maternal psychological distress was related to increased odds of being in the moderate-decreasing group (G2) only in PCE children (OR=4.79); PCE was related to decreased odds of being in G2 when maternal psychological distress was not high (OR=0.13 and 0.30 with maternal distress at 10th and 50th percentiles respectively in the distribution). Children with prenatal marijuana exposure were 2.97 times more likely to follow G2 than to follow G3 trajectory. No antecedent was identified that distinguished children following G2 from those following G1.

3.4 Childhood correlates of externalizing behavior trajectory groups

To further understand each trajectory, childhood correlates assessed after age 4 that may affect externalizing behavior, and known to be related to adolescent substance use and early sexual behavior, were compared in Table 6. More children in the elevated-chronic group (G4) experienced non-kinship care during the observation period (age 4–12) than children in the other three trajectory groups. Children in the low-decreasing group (G1) reported higher parental attachment and lower family conflict than those in the moderate-decreasing group (G2) and elevated-chronic group (G4). Children in the accelerated risk group (G3) and elevated-chronic group (G4) reported greater violence exposure and more childhood maltreatment than those in the other two groups (G1 and G2). More children in G4 reported sexual victimization than those in G1 and G2.

3.5 Externalizing behavior trajectories and subsequent adolescent outcomes

Figure 2 summarizes adolescent substance use and early sexual behavior by externalizing behavior trajectory groups and gender adjusted for covariates. Trajectory by gender interaction ($p < .05$) was found in all adolescent outcomes except tobacco use.

3.5.1 Tobacco use.—After controlling for race, family conflict, and sexual victimization, more adolescents in the elevated-chronic trajectory group ($G4$; 47.7%, $G4_m$ 42%, $G4_f$ 49%) smoked tobacco than those in the low-decreasing group ($G1$; 16.6%) and in the moderate-decreasing group ($G2$; 27.6%). More adolescents in the accelerated risk group ($G3$; 37.5%) smoked tobacco than those in $G1$. Sexual victimization was related to higher odds of tobacco use ($OR=3.17$, 95% $CI=1.71, 5.86$, $p < .001$).

3.5.2 Marijuana use.—After controlling for family conflict, violence exposure, and sexual victimization, a greater number of boys in the moderate-decreasing group ($G2_m$; 44.1%) smoked marijuana than boys in the low-decreasing group ($G1_m$; 16.9%). No other group difference was found in boys. More girls in the accelerated risk group ($G3_f$; 42.0%) and elevated-chronic trajectory group ($G4_f$; 50.0%) smoked marijuana than those in the low-decreasing group ($G1_f$; 18.7%) and in the moderate-decreasing group ($G2_f$; 16.8%). Gender difference within trajectory group was found only in the moderate-decreasing group ($G2$), with more boys reporting marijuana use than girls. Violence exposure was related to higher odds of marijuana use ($OR=1.57$, 95% $CI=1.12, 2.20$, $p = .009$).

3.5.3 Alcohol use.—Controlling for race, parental monitoring, and childhood maltreatment, more boys in the elevated-chronic trajectory group ($G4_m$; 51.0%) drank alcohol than those in the accelerated risk group ($G3_m$; 18.4%). However, more girls in the accelerated risk ($G3_f$; 61.7%) drank than those in the low-decreasing ($G1_f$; 31.8%) and moderate-decreasing groups ($G2_f$; 27.5%). Gender difference within trajectory group was noted only in the accelerated risk group ($G3$), with more girls reporting alcohol use than boys. Being African-American ($OR=0.29$, 95% $CI=0.15, 0.57$, $p < .001$) and greater parental monitoring ($OR=0.65$, 95% $CI=0.43, 0.97$, $p = .035$) was related to lower odds of alcohol use.

3.5.4 Early sexual behavior.—After controlling for parental monitoring, violence exposure, and sexual victimization, more boys in the accelerated risk group ($G3_m$; 70.7%) and in the moderate-decreasing group ($G2_m$; 48.7%) engaged in sexual intercourse before 15 years of age than those in the low-decreasing group ($G1_m$; 26.2%). More girls in the elevated-chronic trajectory group ($G4_f$; 43.1%) engaged in early sexual intercourse than those in the moderate-decreasing group ($G2_f$; 10.9%). Gender difference was found within the accelerated risk group ($G3$) and the moderate-decreasing group ($G2$), with more boys reporting early sexual engagement than girls. Greater parental monitoring was related to lower odds of early sexual behavior ($OR=0.57$, 95% $CI=0.36, 0.90$, $p = .015$), while violence exposure was related to higher odds of early sexual behavior ($OR=1.49$, 95% $CI=1.05, 2.13$, $p = .027$).

4. Discussion

The current study identified four distinctive developmental trajectories of externalizing behavior from ages 4 to 12 in a sample of children at risk for externalizing problems due to exposure to cocaine and other substances. About 36% of the children exhibited problematic (accelerated risk and elevated-chronic) trajectories. PCE and maternal psychological distress conjointly differentiated developmental trajectories of externalizing behavior. The accelerated risk group (G3) was composed of children with PCE whose birth mothers reported relatively lower psychological distress and children with NCE whose birth mothers reported higher psychological distress. The elevated-chronic group (G4) was characterized by children in unstable caregiving environments (non-kinship care) and having birth mothers who reported higher psychological distress at birth regardless of PCE status. These two groups were also marked by greater childhood adversity such as violence exposure and maltreatment than the other two decreasing trajectory groups, the low-decreasing (G1) and moderate-decreasing (G2). When the clinical significance of the four developmental trajectories of externalizing behavior were evaluated with subsequent outcomes of adolescence substance use and early sexual behavior, poorer outcomes for the two groups with problematic trajectories were found in general compared to the other two decreasing trajectory groups, with gender moderation on all outcomes except tobacco use. In the moderate-decreasing group (G2), more boys reported marijuana use and early sexual behavior than girls. In the accelerated risk group (G3), more boys reported early sexual behavior than girls, whereas more girls reported alcohol use than boys. There was no gender difference in either the elevated-chronic group (G4) or the low-decreasing group (G1). These findings may suggest that, although no gender differences may be found when behavioral problems are either severe or non-existent, in children with moderate behavioral problems, boys and girls may show differences in their risk behaviors, which needs to be replicated and validated by future studies.

To our knowledge, this is one of the first studies to examine different developmental trajectories of externalizing behaviors in high risk children affected by PCE. Our findings are similar to the studies of maltreated children (Woodruff and Lee, 2011; Tabone et al., 2011; Yoon, 2018), where an accelerated risk group was identified, in addition to an elevated-chronic group. The elevated-chronic group (G4) corresponds closely to Moffitt's (1993) life-course-persistent antisocial behavior prototype, characterized by early onset and poor caregiving environment. A substantial proportion (13.7%) of the children in our study were identified to follow the high chronic trajectory, much higher than the prevalence in the general population (~ 5%; Moffitt 1993; Vaughn et al., 2014), reflecting greater exposure to life adversity, probably far greater genetic propensity for behavioral problems, and fewer protective factors. In the present study, children in the elevated-chronic group (G4) reported lower levels of parental attachment than those in the low-decreasing group (G1).

Behavioral problems of the children in the accelerated risk group (G3) began to escalate at around age 10, implying that preventive intervention for children with PCE should be implemented before age 10 to curb behavioral problems. Whether the accelerated risk group (G3) may represent Moffitt's adolescence-limited antisocial behavior prototype is not clear, since the final assessment point in our study was when the children were 12 years old. Given

that children in G3 have greater childhood adversities than the low (G1) and moderate-decreasing (G2) groups, these environmental stressors might activate vulnerability present in children due to PCE or mothers' greater psychological distress in the NCE group. Longer follow-up will ascertain whether this developmental pattern truly reflects the adolescence-limited or another risky trajectory that is altered/affected by life adversities.

Approximately half of the boys, but not girls, in the moderate-decreasing group (G2) smoked marijuana at age 15 and engaged in sexual intercourse before 15 years of age despite the gradual decrease in externalizing behavior problems over time. Although more research is needed to understand the factors that explain the course and prognosis of this group (e.g., do they go on to develop a substance use disorder), it seems reasonable to recommend that these boys should also be a focus of preventive effort.

There are some limitations that must be noted in this study. First, because the study did not examine externalizing behavior beyond 12 years, it is not well equipped to identify the late-onset adolescence-limited trajectory. Nonetheless, our findings provide an important glimpse at the early course of externalizing behavior problems, a key strength critical to the development of early prevention programs. Second, since we focused on identifying antecedents that may predict later developmental trajectories, our analyses used antecedents collected during the first four years of life, overlooking the potential influence of time-varying covariates (e.g., HOME scores, parental attachment) that might contribute to developmental trajectories. Third, the relatively small sample size precluded us from investigating possible gender variations in the developmental trajectories with separate LCGM for boys and girls, forcing us to examine gender as an antecedent of the trajectories. Given that Moffitt's taxonomy was based on data from boys, a replication study with a bigger sample size using separate analyses for boys and girls will allow better assessment of possible gender variation. Fourth, although LCGM produces group classification/membership as a latent variable allowing some uncertainty in the membership, both multinomial logistic regression to identify early predictors associated with different trajectories and logistic regression to link with adolescent outcomes treated group membership as known, failed to take into account the uncertainty in the group classification. Nonetheless, our fit indices indicated an optimal fit for the data with excellent (.93) classification accuracy (i.e., entropy). Further, the four developmental trajectories were differentially related to subsequent adolescent outcomes, demonstrating the validity of the trajectories derived. Finally, our observational design cannot rule out that the apparent effects of PCE and maternal psychological distress on child externalizing behavior could be attributable to unmeasured genetic factors (D'Onofrio et al., 2013) and other biological and environmental confounders of PCE, given that maternal prenatal alcohol, tobacco, and marijuana use mostly relied on self-report, subject to recall error and social desirability bias.

In conclusion, PCE and maternal psychological distress were key antecedents that differentiated developmental trajectories of externalizing behavior, which can be used to improve early identification of at-risk youth. Given the strong relationship of externalizing behavior with later substance use, as evidenced in the present study, the two high-risk trajectories identified in the present study may reflect multi-causality of early substance use and perhaps greater risk for transition to substance use disorders later in development.

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Highlights

- Prenatal cocaine exposure (PCE) is associated with externalizing behavior problems.
- Four trajectories of externalizing behavior were identified in children with PCE.
- PCE and maternal psychological distress differentiated different trajectories.
- Adolescent substance use and early sexual behavior differed by the trajectories.

Figure 1.

Developmental trajectories of externalizing behavior from Age 4 – 12. The dotted lines that accompany each solid line indicate the 95% confidence intervals.

Figure 2.

Adolescent outcomes by externalizing behavior trajectory groups and gender adjusted for covariates. Trajectory by gender interaction ($p < .05$) except tobacco use.

Table 1:

Sample characteristics by PCE status

	PCE (<i>n</i> = 197)		NCE (<i>n</i> = 189)		
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>p</i>
<i>Child</i>					
Male, <i>n</i> (%)	90	(45.7)	93	(49.2)	.49
African-American, <i>n</i> (%)	162	(82.2)	150	(79.4)	.47
Gestational age, weeks	37.8	2.8	38.5	2.8	< .001
Hobel Neonatal Risk score	7.4	16.3	5.7	15.6	.30
Birth weight, g ^{<i>a</i>}	2712.7	641.9	3103.9	691.4	< .001
Birth length, cm ^{<i>a</i>}	47.3	3.9	49.12	3.7	< .001
Head circumference, cm ^{<i>a</i>}	32.3	2.1	33.5	2.3	< .001
Full Scale IQ at age 4	80.2	12.6	83.4	14.1	.02
Ever in non-kinship foster/adoptive care by age 4, <i>n</i> (%)	66	(33.5)	11	(5.8)	< .001
<i>Prenatal exposure</i>	<i>n</i> (%)	<i>IQR</i>	<i>n</i> (%)	<i>IQR</i>	<i>p</i> ^{<i>b</i>}
Alcohol, drinks per week	167 (85.2)	0.38 – 10.5	118 (65.2)	0 – 0.8	< .001
Tobacco, cigarettes per day	166 (87.4)	3 – 17.5	74 (40.9)	0 – 5	< .001
Marijuana, joints per week	92 (48.4)	0 – 0.6	24 (13.3)	0 – 0	< .001
Cocaine, units per week	197 (100)	3.38 – 24.5	---	---	---
<i>Maternal</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>p</i>
Age at birth	29.7	5.0	25.6	4.8	< .001
Education, years	11.6	1.7	12.0	1.4	.01
Completed high school, <i>n</i> (%)	103	(52.3)	128	(67.7)	< .002
Married, <i>n</i> (%)	16	(8.1)	33	(17.5)	< .006
PPVT-R Standard Score	73.7	15.5	77.7	14.9	.01
BSI GSI at birth	0.8	0.7	0.5	0.5	< .001
Low SES, <i>n</i> (%)	192	(98.0)	185	(97.9)	< .96
HOME score at age 4	42.0	6.4	41.7	6.7	.64

IQR=Inter-quartile (25% –75%) range; PPVT= Peabody Picture Vocabulary Test; BSI=Brief Symptom Inventory; GSI= Global Severity Index; HOME= Home Observation for Measurement of the Environment

^{*a*}Adjusted for gestational age;

^{*b*}*p*-value based on *n* (%)

Table 2:

Model fit indices

	1-class	2-classes	3-classes	4-classes	5-classes	6-classes
AIC	-11470	-8183	-7426	-7120	-7010	-6909
BIC	-11476	-8197	-7448	-7249	-7047	-6955
Entropy	1.00	.97	.95	.93	.93	.92
Lowest APP		.99	.98	.93	.94	.93
Lowest OCC		59	64	34	8	9
Smallest group, %		37.3	23.1	13.7	6.9	6.6

APP = Average Posterior Probability of group membership. OCC = Odds of Correct Classification

Table 3:Externalizing behavior by age and trajectory group: CBCL raw scores and *T*-scores, *M* (*SD*)

Trajectory Group	Age					
	4 (<i>n</i> = 358)	6 (<i>n</i> = 371)	9 (<i>n</i> = 367)	10 (<i>n</i> = 347)	11 (<i>n</i> = 317)	12 (<i>n</i> = 321)
Group 1: Low-Decreasing (<i>n</i> = 126, 32.4%)	5.03	3.60	1.61	1.33	1.28	1.16
	(3.65)	(3.15)	(1.72)	(1.93)	(1.71)	(1.77)
	44.40	41.69	40.74	39.55	39.38	38.81
	(7.49)	(6.79)	(5.92)	(6.35)	(6.14)	(5.79)
Group 2: Moderate-Decreasing (<i>n</i> = 125, 31.7%)	11.55	10.66	6.98	6.84	6.28	5.05
	(6.38)	(5.48)	(4.38)	(4.01)	(4.83)	(3.58)
	54.09	53.13	52.26	52.25	51.27	48.60
	(8.25)	(7.39)	(7.44)	(6.92)	(6.78)	(7.32)
Group 3: Accelerated Risk (<i>n</i> = 51, 13.7%)	4.04	4.12	6.66	6.89	11.48	11.59
	(3.55)	(3.67)	(5.22)	(4.81)	(8.28)	(6.13)
	41.80	42.71	51.00	51.70	58.21	57.49
	(7.76)	(7.49)	(8.70)	(8.21)	(9.45)	(7.35)
Group 4: Elevated-Chronic (<i>n</i> = 84, 22.1%)	15.28	16.28	19.99	20.61	19.84	18.90
	(8.15)	(8.10)	(10.77)	(10.81)	(7.91)	(7.61)
	58.37	59.83	66.80	67.32	67.01	64.54
	(9.38)	(9.19)	(8.35)	(8.51)	(6.70)	(7.07)

Table 4:Antecedents by externalizing behavior trajectory group, *M (SD)*

	G1: Low- Decreasing (<i>n</i> = 126)	G2: Moderate- Decreasing (<i>n</i> = 125)	G3: Accelerated Risk (<i>n</i> = 51)	G4: Elevated- Chronic (<i>n</i> = 84)	<i>p</i>
<i>Child</i>					
Male, <i>n</i> (%)	50 (40)	60 (48)	26 (51)	47 (56)	.12
African-American, <i>n</i> (%)	106 (84)	100(80)	40 (78)	66 (79)	.70
Gestational age, weeks	38.03 (2.91)	38.42 (2.85)	37.86 (2.59)	38.06 (2.86)	.59
Hobel Neonatal Risk score	6.81 (15.78)	6.17 (14.95)	4.10 (13.43)	8.13 (18.87)	.55
Birth weight, g [§]	2894 (679)	2936(678)	2860 (708)	2898 (739)	.94
Birth length, cm [§]	48.33 (3.93)	48.15 (3.68)	48.17 (4.04)	48.09 (4.19)	.32
Head circumference, cm [§]	32.82 (2.30)	32.87 (2.19)	33.10 (2.14)	32.81 (2.62)	.15
Full Scale IQ at age 4	83.10 (14.51)	82.66 (13.26)	79.70 (11.85)	79.74 (12.84)	.19
Ever in non-kinship care, <i>n</i> (%)	20 (16) ^a	22 (18) ^a	7 (13) ^a	28 (33) ^b	.006
<i>Prenatal exposure, n (%)</i>					
Alcohol	89 (75)	95 (77)	34 (69)	62 (78)	.69
Tobacco	71 (60)	80 (65)	34 (70)	55 (70)	.45
Marijuana	31 (26)	48 (39)	11 (22)	26 (33)	.09
Cocaine	55 (44)	65 (52)	30 (59)	47 (56)	.18
<i>Maternal</i>					
Age at birth	28.11 (5.11)	27.61 (5.60)	27.84 (5.16)	27.17 (5.20)	.64
Education, years	11.94 (1.57)	11.70 (1.57)	11.73 (1.51)	11.61 (1.61)	.46
Completed high school, <i>n</i> (%)	80 (63)	68 (54)	33 (65)	50 (60)	.43
Married, <i>n</i> (%)	20 (16)	11 (9)	7 (14)	11 (13)	.40
PPVT-R Standard score	74.85 (15.89)	76.45 (15.71)	75.50 (14.55)	75.93 (14.41)	.88
BSI GSI at birth	0.55 (0.61) ^a	0.67 (0.68) ^{ab}	0.60 (0.58) ^{ab}	0.86 (0.74) ^b	.007
HOME score at age 4	42.62 (6.30)	42.07 (6.24)	39.98 (7.03)	41.52 (6.79)	.10

PPVT= Peabody Picture Vocabulary Test; BSI= Brief Symptom Inventory; GSI= Global Severity Index; HOME= Home Observation for Measurement of the Environment

[§] Adjusted for gestational age; Different superscript indicates significant ($p < .05$) post-hoc pairwise difference using Tukey (for continuous variable) or Bonferroni (for categorical variable) correction. For example, non-kinship care difference was found between G4 (noted with “b”) and other groups (noted with “a”); BSI GSI difference was found between G1 (noted with “a”) and G4 (noted with “b”), with both G2 and G3 not differing from G1 or G4 (noted with “ab”).

Table 5:

Effect of prenatal cocaine exposure (PCE) and maternal psychological distress on externalizing behavior trajectory group, OR (95% CI)

reference group	Accelerated risk group (G3) vs.	Elevated chronic group (G4) vs.			Moderate- decreasing group (G2) vs.	
	G1	G1	G2	G3	G1	G3
Sex, male	1.41 (0.69, 2.87)	2.21 (1.19, 4.12)	1.55 (0.84, 2.85)	1.58 (0.73, 3.42)	1.43 (0.84, 2.43)	1.02 (0.50, 2.08)
Prenatal marijuana exposure	0.59 (0.24, 1.43)	1.01 (0.49, 2.10)	0.58 (0.29, 1.16)	1.71 (0.67, 4.39)	1.75 (0.93, 3.28)	2.97 (1.25, 7.08)
HOME score	0.97 (0.91, 1.02)	0.98 (0.94, 1.03)	1.00 (0.95, 1.04)	1.02 (0.96, 1.08)	0.99 (0.94, 1.03)	1.02 (0.97, 1.08)
Ever in non-kinship care by age 4	0.63 (0.22, 1.85)	2.17 (0.98, 4.79)	2.13 (0.99, 4.58)	3.43 (1.16, 10.11)	1.02 (0.48, 2.17)	1.61 (0.55, 4.67)
PCE* Maternal distress (GSI)						
GSI in NCE	3.16 (1.20, 8.27)	2.94 (1.25, 6.91)	2.23 (1.01, 4.92)	0.93 (0.38, 2.32)	1.32 (0.58, 3.00)	0.42 (0.17, 1.05)
GSI in PCE	0.25 (0.08, 0.81)	1.45 (0.82, 2.57)	1.21 (0.73, 2.02)	5.79 (1.78, 18.87)	1.20 (0.70, 2.07)	4.79 (1.50, 15.30)
PCE at low GSI (0.075)	8.73 (2.94, 25.89)	1.78 (0.70, 4.56)	1.63 (0.64, 4.11)	0.20 (0.06, 0.67)	1.10 (0.50, 2.42)	0.13 (0.04, 0.38)
PCE at middle GSI (0.415)	3.69 (1.60, 8.51)	1.40 (0.65, 3.03)	1.32 (0.61, 2.84)	0.38 (0.15, 0.96)	1.06 (0.55, 2.04)	0.30 (0.12, 0.67)
PCE at high GSI (1.528)	0.22 (0.04, 1.19)	0.64 (0.20, 2.05)	0.67 (0.23, 1.93)	2.90 (0.57, 14.80)	0.95 (0.30, 3.03)	4.34 (0.85, 22.31)

Note. Significant ($p < .05$) ORs (95% CI) were bolded. The low, middle, and high GSI correspond to 10, 50, and 90 percentiles in maternal psychological distress (GSI) distribution respectively.

Table 6

Childhood correlates by externalizing behavior trajectory group.

	G1: Low- Decreasing (<i>n</i> = 126)	G2: Moderate- Decreasing (<i>n</i> = 125)	G3: Accelerated Risk (<i>n</i> = 51)	G4: Elevated- Chronic (<i>n</i> = 84)	<i>p</i>
Non-kinship care between ages 4–12, <i>n</i> (%)	12 (10) ^a	19 (15) ^a	6 (12) ^a	30 (36) ^b	< .001
Parental attachment, <i>M</i> (<i>SD</i>)	2.35 (0.56) ^a	2.13 (0.70) ^b	2.14 (0.65) ^{ab}	2.05 (0.67) ^b	.001
Parental monitoring, <i>M</i> (<i>SD</i>)	2.51 (0.60)	2.49 (0.59)	2.31 (0.71)	2.40 (0.60)	.25
Family conflict, <i>M</i> (<i>SD</i>)	2.21 (2.14) ^a	3.09 (2.63) ^b	3.19 (2.34) ^{ab}	3.45 (2.58) ^b	.004
Violence exposure, <i>M</i> (<i>SD</i>)	0.45 (0.71) ^a	0.45 (0.55) ^a	0.97 (1.04) ^b	0.79 (0.78) ^b	< .001
Maltreatment, <i>n</i> (%)	19 (17) ^a	21 (19) ^a	17 (38) ^b	27 (36) ^b	.002
Sexual victimization, <i>n</i> (%)	15 (14) ^a	19 (17) ^a	12 (27) ^{ab}	24 (32) ^b	.012

Note. Different superscript indicates significant ($p < .05$) post-hoc pair-wise difference using Tukey (for continuous variable) or Bonferroni (for categorical variable) correction. For example, non-kinship care difference was found between G4 (noted with “b”) and other groups (noted with “a”) parental attachment difference was found between G1 (noted with “a”) and both G2 and G4 (noted with “b”), with G3 not differing from other groups (noted with “ab”)