

A Biosocial Interaction Between Prenatal Exposure to Cigarette Smoke and Family Structure in the Prediction of Psychopathy in Adolescence

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Abstract Although a great deal of empirical research has examined the association between psychopathic personality traits and antisocial phenotypes, comparatively less empirical research has examined the factors that might contribute to the development of psychopathy. In an attempt to shed some light on this gap in the literature, the current study explored the biosocial correlates to adolescent psychopathy in a sample of youths. Analysis of data drawn from the National Institute of Child Health and Human Development Study of Early Child Care revealed that prenatal exposure to cigarette smoke was associated with higher scores on the Youth Psychopathic Traits Inventory. Interestingly, prenatal exposure to cigarette smoke only was related to psychopathy for youths who were raised in a two-parent household; there was not association for youths who were raised in a single-parent household. Reasons for this finding are provided and avenues for future research are discussed.

Keywords Biosocial · Family structure · Prenatal exposure to tobacco · Psychopathy

Introduction

Prenatal exposure to cigarette smoke is a formidable environmental pathogen that constitutes a risk factor for developmental delays and externalizing/antisocial behaviors in children and adolescents [13, 17, 23, 26]. Researchers have illustrated a link between

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prenatal exposure to cigarette smoke and subsequent involvement in diverse manifestations of delinquent behavior. For instance, Wakschlag et al. [22] examined the effects of self-reported maternal smoking on conduct disorder (CD) among a clinical sample of 177 males and found that exposure to smoking (.5 packs of cigarettes per day) produced an odds ratio of 3.3 for CD. Based on data from ($n = 1,265$) males and females selected from a prospective New Zealand birth cohort, Fergusson et al. [7] found a linear relationship between maternal smoking during pregnancy and CD symptoms with heavily exposed boys demonstrating nearly threefold more CD symptoms than boys without exposure. The deleterious effects of prenatal smoking exposure on behavior persisted into middle childhood [6]. Recently, Wakschlag et al. [25] found a gene \times environment interaction between prenatal exposure to cigarettes and the low-activity MAOA 5' uVNTR genotype and CD symptoms for males and exposure and the high-activity MAOA 5' uVNTR genotype and CD symptoms for females among a sample of 176 adolescents.

In addition to CD, Milberger et al. [14] found that the prevalence of maternal smoking during pregnancy was nearly three times higher among males with DSM-III-R Attention-deficit/hyperactivity disorder (ADHD) than normal comparison subjects. In terms of delinquent and criminal behaviors, studies based on respondents from Denmark [3], Finland [19], and the United States [8, 9] have similarly shown that prenatal exposure to smoking is associated with elevated levels of violent offending, arrest, and early-onset offending.

There is additional evidence that prenatal smoking exposure interacts with family structure to produce antisocial conduct [8, 23]. To illustrate, Räsänen et al. [19] examined the effects of maternal smoking during pregnancy on criminal behavior through age 28 among ($n = 3,883$) males selected from the Northern Finland 1966 Birth Cohort. Sons of mothers who smoked during pregnancy had a greater than twofold risk of violent offending or habitual offending net the effects of family structure, perinatal complications, developmental lags, and socioeconomic characteristics. Maternal smokers who were pregnant before age 20, were single parents, had an unwanted pregnancy, and had sons with developmental problems increased the risks for offending exponentially. The odds ratios for violent offending increased 9-fold and risks for persistent/chronic offending increased 14-fold.

Despite investigations of the predictive validity of prenatal tobacco exposure and externalizing/antisocial behaviors, surprisingly little is known about the effects of prenatal tobacco exposure and psychopathy. An exception is the study by Burke et al. [4] who recently found that prenatal tobacco exposure predicted the interpersonal and affective facets of psychopathic personality as measured by Factor 1 of the PCL-R [10, 11]. The current study seeks to further the understanding of the effects of prenatal exposure to cigarette smoke on the etiology of psychopathy using data from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care.

Methods

Participants and Procedures

Data for this study come from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care. Detailed information about the NICHD sample has been published elsewhere [15, 16]. Briefly, the NICHD Study of Early Child Care is a prospective and longitudinal sample of 1,364 children who were drawn from 10

different sites. Four phases of data have been collected thus far, with data being collected at multiple times during each phase of data. The study participants began being assessed when they were 1 month old and the most recent data collection was completed when they were approximately 15 years old. A wealth of information has been collected about the participants, including items pertaining to child care, family environments, cognitive abilities, behavioral patterns, and parent–child interactions. Multi-rater assessment methodologies were employed, where parents, teachers, childcare providers, independent observers, and self-reports were used to collect detailed information. While the NICHD Study of Early Child Care data have been widely used to investigate a diverse range of topics related to child and adolescent development, it is important to note that these data are not nationally representative. As a result, findings based on these data should be viewed with caution, as the results may not be generalizable [15].

Measures

Youth Psychopathy

Youth psychopathy was assessed when the youths were 15 years old. During interviews, respondents completed 15 items drawn from the Youth Psychopathic Traits Inventory (YPI; [1]) that indexed the callous/unemotional (i.e., affective) component of psychopathy. For example, youths were asked to indicate whether they feel calm when other people are scared, whether they become sad when they see other people crying, whether they think crying is a sign of weakness, and whether they think that feeling guilty or regretful is a waste of time. Responses to these items were coded such that 1 = does not apply at all, 2 = does not apply well, 3 = applies fairly well, and 4 = applies very well. All of the items were transformed so that higher values reflected more psychopathic tendencies. The responses to the items were then summed together to create the youth psychopathy scale ($\alpha = .82$). Importantly, prior research has revealed that the measures used in the current analysis are valid and reliable indicators of youth psychopathy [1, 2, 5, 21]. Table 1 contains the descriptive statistics for the youth psychopathy scale as well as all of the other variables used in the analysis.

Maternal Smoking

To assess the amount of cigarettes smoked by the mother while she was pregnant, mothers were asked to indicate how often and how long they smoked while pregnant. Responses to this question, which were asked during Phase 1 interviews, were coded on a 5-point scale, where 1 = the mother did not smoke, 2 = the mother smoked, but stopped before pregnancy began, 3 = the mother smoked, but stopped during the first 3 months of pregnancy, 4 = the mother smoked through the first 3 months of pregnancy, but stopped before her child was born, and 5 = the mother smoked through the year of her pregnancy.

Environmental Exposure to Cigarette Smoke

The NICHD Study of Early Child Care also included a question that measured the amount of contact the mother had with smokers while she was pregnant. Again, during Phase 1 interviews, mothers were asked to indicate how frequently they came into contact with smokers. Responses to this item were coded as follows: 1 = never, 2 = sometimes, 3 = often, and 4 = always.

Table 1 Descriptive statistics for selected study variables

Measure	Mean	Percentage	SD
Psychopathy	29.35	–	7.05
Maternal smoking			
Did not smoke		76.5	
Smoked, but stopped before pregnancy		4.6	
Smoked, but stopped during first trimester		6.6	
Smoked during first trimester, but stopped		1.6	
Smoked throughout the entire pregnancy		10.7	
Environmental exposure to cigarette smoke			
Never had contact with smokers		24.3	
Sometimes had contact with smokers		45.7	
Often had contact with smokers		16.0	
Always had contact with smokers		14.1	
Child's gender			
Male		51.7	
Female		48.3	
Maternal race			
White		82.6	
Nonwhite		17.4	
Husband in household			
Present		85.5	
Absent		14.5	

Husband in Household

Single-parent households have been shown to be a risk factor to a wide range of antisocial behaviors [19, 20]. To take this finding into account, we included a dichotomous dummy variable of whether they husband/partner currently resided with the mother. During the initial round of interviews, mothers were asked to indicate whether they currently resided with their husband/partner. Responses were coded such that 0 = husband/partner currently lives with the mother and 1 = husband/partner does not currently live with the mother which is consistent with prior research [8].

Control Variables

To control for potential confounders, two control variables were included in the analyses. First, gender was coded as a dichotomous variable (1 = male and 2 = female). Second, maternal race was included as a dichotomous dummy variable (0 = white and 1 = nonwhite).

Analytical Strategy

The analysis for this study proceeded in three steps. First, the association between maternal cigarette smoking and the youth psychopathy scale and the association between environmental exposure to cigarette smoke and the youth psychopathy scale were examined using

ANOVA. Second, these associations were assessed in multivariate models where controls for child's gender, mother's race, and husband in household were entered into the equations. Third, prior research has revealed that the effect of prenatal exposure to cigarette smoke on antisocial outcomes is moderated by the presence of the husband/partner in the household [8]. This possibility was explored by estimating split-sample models, where one equation was estimated for the "Husband Absent" sample and one equation was estimated for the "Husband Present" sample. A biosocial interaction was detected if the effect of prenatal exposure to cigarette smoke on youth psychopathy scores varied between the two samples.

Results

The analysis began by estimating ANOVAs to test for associations between the two measures of prenatal exposure to cigarette smoke and youth psychopathy scores. As Table 2 shows, the association between maternal cigarette smoke and youth psychopathy scores was statistically significant ($F = 2.466, P < .05$) as was the association between environmental exposure to cigarette smoke and youth psychopathy scores ($F = 4.490, P < .05$).

To explore these associations in greater detail, mean scores on the psychopathy scale were plotted against scores on the measures of prenatal exposure to cigarette smoke. Figure 1 shows the association between maternal smoking during pregnancy and adolescent psychopathy. As can be seen, scores on the psychopathy scale increase monotonically across the first four categories, but then decline. A similar pattern of results is detected in Fig. 2 where the mean scores on the psychopathy score increase linearly across the first three categories, but then retreat for the last category. These two figures point to the likelihood of a nonlinear relationship between prenatal exposure to cigarette smoke and adolescent psychopathy scores. As a result, in the multivariate analyses presented below, the prenatal exposure to cigarette smoke variables were entered as a series of dummy variables as a way of capturing the nonlinear effects of prenatal exposure to cigarette smoke.

Table 3 contains the results of the OLS regression models predicting scores on the youth psychopathy score with the maternal smoking variable and the control variables. As

Table 2 Association between prenatal exposure to cigarette smoke and adolescent psychopathy

Measure of exposure	Mean	F-value
Maternal cigarette smoking		
Did not smoke	28.92	2.466*
Smoked, but stopped before pregnancy	29.68	
Smoked, but stopped during first trimester	30.45	
Smoked during first trimester, but stopped	32.08	
Smoked throughout the entire pregnancy	30.87	
Environmental exposure to cigarette smoke		
Never had contact with smokers	27.97	4.490*
Sometimes had contact with smokers	29.31	
Often had contact with smokers	30.53	
Always had contact with smokers	30.09	

* $P < .05$, two-tailed tests

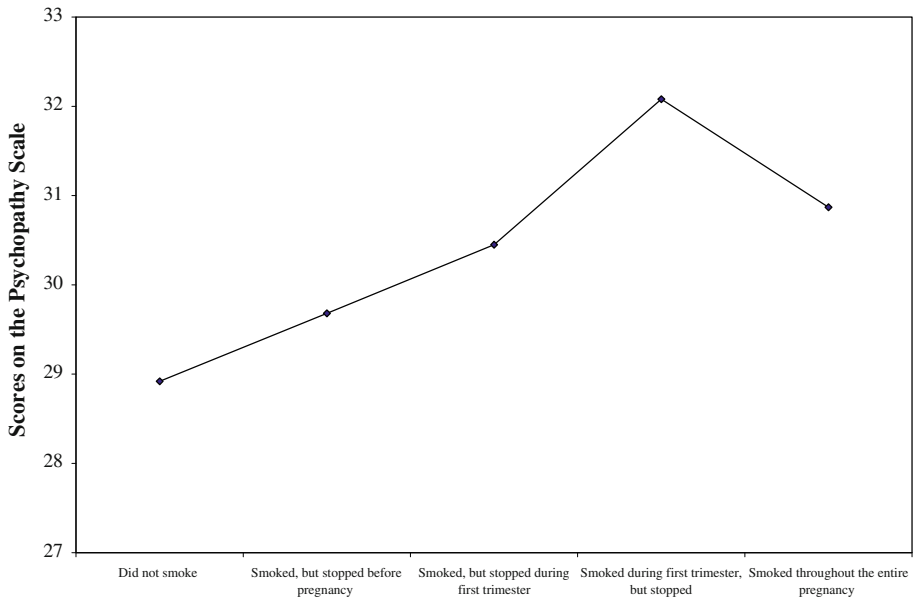


Fig. 1 Association between maternal smoking during pregnancy and adolescent psychopathy

can be seen, mothers who smoked during their entire pregnancy have adolescents who, on average, score significantly higher on the adolescent psychopathy measure when compared to mothers who did not smoke during the year prior to their pregnancy. The next two models in Table 3 examine whether the maternal smoking effect is moderated by the presence/absence of the husband/partner. In the “Husband Absent” model, there is no association between maternal smoking during pregnancy and scores on the youth psychopathy scale. In contrast, in the “Husband Present” model, there were two statistically significant effects. Specifically, in comparison with mothers who did not smoke during the year prior to their pregnancy, mothers who smoked during the first 3 months of their pregnancy and mothers who smoked during their entire pregnancy, had offspring who scored significantly higher on the adolescent psychopathy scale.

Table 4 is a duplicate of Table 3 except that the environmental exposure to cigarette smoke variable is used in place of the maternal smoking variable. The first model, which was estimated on the full sample, reveals that in comparison with mothers who never had contact with smokers, mothers who sometimes, often, or always had contact with smokers tended to raise offspring who scored significantly higher on the youth psychopathy scale. The second model in Table 4 shows the results of the equation that was estimated using the “Husband Absent” sample. As can be seen, the only significant association was for mothers who reported always being exposed to smokers. Interestingly, the effect was negative, meaning that mothers who were always exposed to smokers had, on average, adolescents with lower psychopathy scores when compared to mothers who never had contact with smokers. Last, the model estimated with the “Husband Present” sample shows that in comparison with mothers who never had contact with smokers, mothers who sometimes, often, or always had contact with smokers had, on average, adolescents who had significantly higher scores on the youth psychopathy scale.

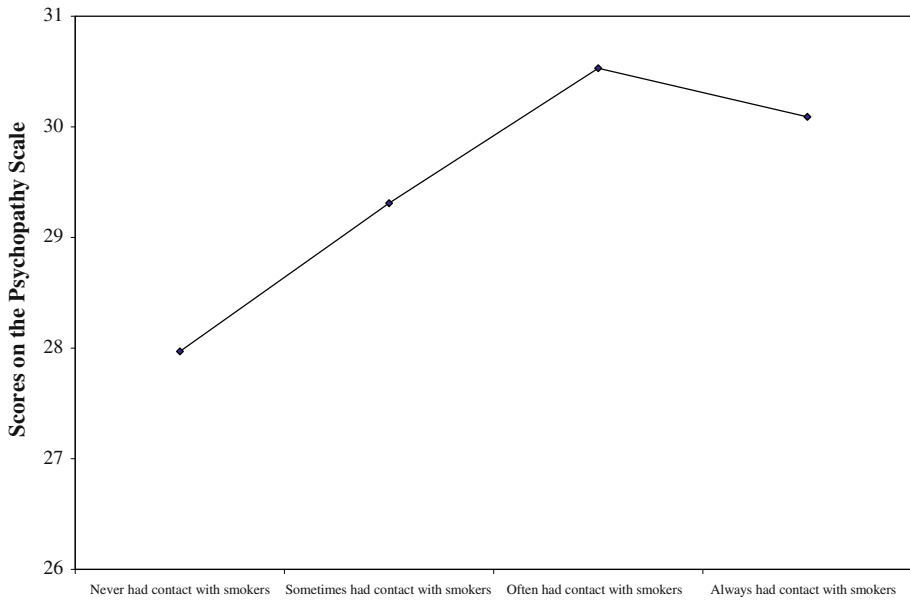


Fig. 2 Association between prenatal exposure to environmental cigarette smoke and adolescent psychopathy

Table 3 The effect of maternal smoking during pregnancy on adolescent psychopathy (OLS regression models)

Variable	Full sample			Husband absent			Husband present		
	<i>b</i>	Beta	SE	<i>b</i>	Beta	SE	<i>b</i>	Beta	SE
Maternal smoking									
Stopped before pregnant	.40	.01	1.00	.08	.00	3.01	.27	.01	1.05
Smoked first 3 months	1.16	.04	.85	-3.00	-.14	2.17	2.04**	.07	.94
Stopped before birth	1.68	.03	1.77	1.51	.05	2.87	.66	.01	2.49
Smoked entire pregnancy	1.24*	.05	.73	-1.16	-.06	1.98	1.47*	.06	.79
Control variables									
Child's gender	-6.31**	-.45	.69	-3.28**	-.23	1.38	-6.67**	-.48	.44
Mother's race	1.51**	.08	.61	-1.11	-.08	1.45	1.95**	.09	.69
Husband in household	1.75**	.08	.69	-	-	-	-	-	-

* $P < .10$, two-tailed tests

** $P < .05$, two-tailed tests

Discussion

Prenatal exposure to cigarette smoke is a known correlate to a wide range of antisocial behaviors [23], but its association to adolescent psychopathy is relatively unknown. The current study explored this association by analyzing data drawn from the NICHD Study of Early Child Care. Analysis of the data revealed three broad findings. First, maternal smoking represented a significant risk factor for offspring psychopathy. More specifically,

Table 4 The effect of prenatal exposure to environmental cigarette smoke and adolescent psychopathy (OLS regression models)

Variable	Full sample			Husband absent			Husband present		
	<i>b</i>	Beta	SE	<i>b</i>	Beta	SE	<i>b</i>	Beta	SE
Frequency of exposure									
Sometimes	1.12**	.08	.52	-.92	-.06	2.10	1.22**	.09	.53
Often	1.92**	.10	.69	-1.52	-.10	2.15	2.15**	.11	.73
Always	1.33*	.07	.71	-4.33*	-.26	2.23	2.16**	.10	.76
Control variables									
Child's gender	-6.31**	-.45	.42	-3.36**	-.24	1.35	-6.64**	-.48	.44
Mother's race	1.37**	.07	.61	-1.21**	-.09	1.37	1.83**	.08	.69
Husband in household	1.80**	.08	.68	-	-	-	-	-	-

* $P < .10$, two-tailed tests** $P < .05$, two-tailed tests

mothers who reported smoking during pregnancy had adolescents who scored significantly higher on the YPI affective component in comparison with adolescents whose mothers did not smoke while pregnant. Second, prenatal exposure to environmental tobacco smoke was also found to be associated with adolescent psychopathy. Third, and perhaps most importantly, the effect of prenatal exposure to cigarette smoke on adolescent psychopathy was found to be moderated by family structure. Interestingly, prenatal exposure to cigarette smoke was only associated with youth psychopathy for adolescents who were reared in a household where the mother's husband/partner was present; there was no association between prenatal exposure to cigarette smoke and psychopathy for adolescents who were reared in single-mother households.

This latter finding is of particular interest because most prior research examining the interaction between environmental pathogens and prenatal exposure to cigarette smoke has found that the effect is only statistically significant in high-risk environments [8, 18]. The findings reported here, however, reveal an opposite pattern. While admittedly post-hoc theorizing, we do offer one possible explanation for this finding. It is quite possible the measure of single-headed households employed here captures an array of latent criminogenic risk factors. For example, single-headed households are proxy indicators for environmental risk factors and genetic risk factors. As a result, the effect of prenatal exposure to cigarette smoke might be trumped by these other, more potent risk factors. In contrast, in two-parent households, where genetic and environmental risk factors are not as saturated, the effects of prenatal exposure to cigarette smoke may emerge as one of the more powerful predictors of psychopathy. Future research will have to explore these issues in greater detail.

The findings of the current study should be viewed with caution in light of a number of limitations. First, the NICHD Study of Early Child Care is not nationally representative, so whether the results reported here would be generalizable to other samples remains an open-empirical question that needs to be examined. Second, the psychopathy scale used did not measure all of the dimensions of psychopathy. Thus, whether prenatal exposure to cigarette smoke would have effects on other operationalizations of psychopathy and on other dimensions of psychopathy needs to be investigated in replication studies. Third, the measures of prenatal exposure to cigarette smoke were retrospective questions asked to the

mother after her child was born. Ideally, the data would have asked the mothers whether they were smoking while they were pregnant. Nonetheless, prior research has revealed that retrospective questions regarding prenatal exposure to cigarette smoke are valid and reliable [12, 24].

The precise etiological factors that are associated with the development of psychopathy remain relatively unknown. The current study took a cautious step in the direction of identifying the complex ways in which biological and environmental risk factors work in combination to explain variation in youth psychopathy. While there are certainly other, more powerful predictors of psychopathy, the results of the present research indicate that prenatal exposure to cigarette smoke and household structure represent two potential etiological factors that work both independently and interactively. However, before too much emphasis can be placed in these results, replication studies are needed.

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