



Maternal smoking during pregnancy and anger temperament among adult offspring

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ABSTRACT

Maternal smoking during pregnancy has been consistently associated with aggressive behaviors among offspring across the life course. We posit that anger, as a precedent of aggression, may have mediated the association. The current study examines the relation between maternal smoking during pregnancy and anger proneness among the adult offspring. Participants were 611 adult offspring (ages 38–48 years) of mothers enrolled in the Collaborative Perinatal Project between 1959 and 1966 in Boston and Providence. Information on maternal smoking during pregnancy was collected during prenatal visits. Spielberger's trait anger scale was used to measure anger proneness which has two components: anger temperament and angry reaction. Results from the full sample analyses showed that offspring whose mother smoked one pack or more per day on average scored 1.7 higher in anger temperament *T* scores in comparison to offspring whose mother never smoked during pregnancy ($\beta = 1.7$, 95% Confidence Interval (CI): 0.1, 3.2). The fixed effects analyses among siblings that accounted for more confounding found a greater effect of around one standard deviation increase in anger temperament *T* scores corresponding to maternal smoking of one pack or more ($\beta = 7.4$, 95% CI: 0.5, 14.4). We did not observe an association of maternal smoking during pregnancy with offspring angry reaction or other negative emotions including anxiety and depression. We concluded that prenatal exposure to heavy cigarette smoke was associated with an increased level of anger temperament, a stable personality trait that may carry the influence of prenatal smoking through the life course.

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1. Background

Maternal smoking during pregnancy has been consistently linked to a range of mild to severe aggressive behaviors among offspring across the life course (Brennan et al., 1999; Ernst et al., 2001; Fergusson et al., 1998; Rasanen et al., 1999; Tremblay et al., 2004; Wakschlag et al., 1997; Wakschlag et al., 2002). It has been proposed that exposure to cigarette smoke toxins during the prenatal period may cause deficits in the developmental fetal brain that subsequently lead to disruptive behaviors (Ernst et al., 2001; Slotkin, 2004) although the precise pathway remains unclear.

Cigarette smoke contains many known toxicants, some of which, such as nicotine and carbon monoxide, have been suggested as the key neurobehavioral teratogens (Richardson & Tizabi, 1994; Singh, 1986). They could pass the placenta to influence the normal development of the fetal brain through (1) teratologic effects on the developing fetal nervous system, and (2) hypoxic effects on the fetal–placental unit that reduce the fetal blood circulation (DiFranza et al., 2004; Wakschlag et al., 2002). Reduced thickness of the orbital prefrontal cortex had been found among adolescents exposed to maternal smoking during the prenatal period (Toro et al., 2008). Patients with lesions in the orbital prefrontal cortex and adjacent regions showed explosive bursts of anger, impulsive aggression and violent behaviors (Anderson et al., 1999; Blair and Cipolotti, 2000). In addition, evidence for the impact of exposure to cigarette smoke during the prenatal period on neural substrates of disruptive behaviors had also been provided in functional MRI neuroimaging (Bennett et al., 2009), genotype

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(Wakschlag et al., 2010) and phenotype (Wakschlag et al., 2011) studies.

Temperament as a stable personality trait has long been suggested as having a neurobiological basis (Whittle et al., 2006) For instance, the orbital prefrontal cortex region had been proposed as a key region associated with a fundamental dimension of temperament – restraint (Whittle et al., 2006). In normal individuals, activation of certain brain regions including the orbital prefrontal cortex that occur during anger arousal constrains the impulsive expression of emotion and the presence of aggressive behaviors (Davidson et al., 2000).

Previous studies had shown that infants and school aged children who were exposed to maternal smoking during the prenatal period were more likely to have difficult temperament, for example low positive/high negative mood, in comparison to their unexposed counterparts (Martin et al., 2006; Pickett et al., 2008). Temperament reflects prepositions to behavior patterns as it underlies and drives behavioral manifestations (Dadds and Salmon, 2003). Among a diverse set of temperamental traits, we consider that anger temperament might be particularly relevant to impulsive aggressive behaviors. Anger as a negative effect has been identified as a fundamental cause or pre-condition for impulsive aggression. It reduces inhibitions against and sometimes justifies and energizes aggressive behaviors towards others (Anderson and Bushman, 2002).

Spielberger's trait anger scale (Spielberger, 1999) that had been widely used to measure anger proneness consists of two components. (1) Anger temperament that refers to a person's propensity to outbursts of anger with minimum provocation; and (2) angry reaction that denotes the tendency to become angry when treated unfairly by others. In the current study, we examine the relation between maternal smoking during pregnancy and anger temperament, angry reaction as well as trait anger among the adult offspring. We posit that the frequently noted link between maternal smoking during pregnancy and subsequent aggressive behaviors may be mediated through offspring anger temperament. In addition, because a high level of anger temperament may co-occur with other negative effect such as anxiety and depression, we further assess their relation with maternal smoking during pregnancy to test the specificity of the study finding.

2. Methods

2.1. Study sample

As shown in Fig. 1, participants were offspring of pregnant women enrolled in the Collaborative Perinatal Project (CPP) between 1959 and 1966 (Niswander and Gordon, 1972). The Collaborative Perinatal Project was a multi-site prospective cohort study designed to investigate developmental consequences of pregnancy and delivery complications. Comprehensive data on expectant mothers' health, behavior and demographic characteristics were recorded at the time of registration (usually at their first visit for prenatal care). Information on offspring birth outcomes and subsequent growth and development was obtained periodically during their first year of life, and again at ages 4 and 7 years.

Building on the Collaborative Perinatal Project, the New England Family Study (NEFS) was established in 2001 to locate and interview the adult Collaborative Perinatal Project offspring at the Providence, Rhode Island and Boston, Massachusetts sites ($N = 17,921$). From then on several studies have derived their samples from the New England Family Study (Almeida et al., 2010; Buka et al., 2003; Gilman et al., 2008; Graham et al., 2008; Paradis et al., 2010). One of the follow-up studies had assessed 1625 adult

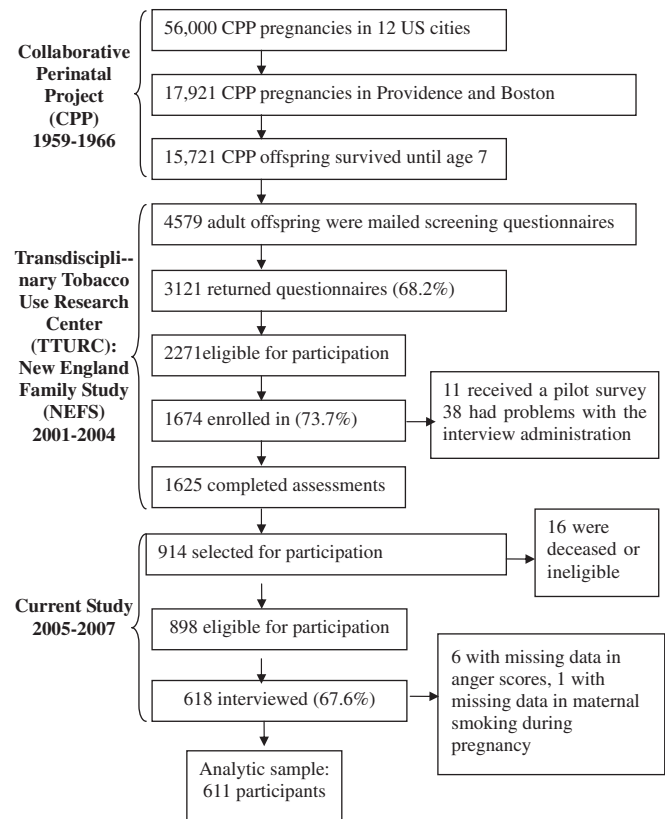


Fig. 1. Flow chart for study sampling.

offspring to investigate nicotine dependence and health outcomes across the lifespan and across generations. Additional funds were later obtained for a new study of the association between educational attainment and subsequent health status; funds were available to study approximately 900 of the 1625 previously assessed participants. All non-white subjects (predominantly African American: $N = 219$) were first selected to maximize power for race/ethnic comparisons. Second, to best adjust for confounding due to family-level factors, all siblings who were discordant for attained level of education ($N = 396$) were selected. The remaining were 299 individuals who were selected to balance the sample by race, attained education, and predicted level of education. In total 914 adult offspring were selected to participate, among them 16 were determined to be deceased or were otherwise ineligible for follow-up assessments (e.g., incarcerated). From the 898 eligible individuals, 618 were successfully located and interviewed (67.6%). They participated in a 3-h in-person interview that collected extensive information on education, socioeconomic status, psychological and cognitive status, as well as health behaviors (Almeida et al., 2010). In comparison with the non-respondents ($N = 280$), the respondents ($N = 618$) were more likely to be white ($p < 0.001$) and highly educated ($p < 0.001$), and their mothers reported more years of education ($p < 0.01$), less cigarette smoking during pregnancy ($p = 0.02$), and less mental illness ($p = 0.04$).

Participants with missing data for anger proneness ($N = 6$) or for maternal smoking during pregnancy ($N = 1$) were excluded from the analyses, resulting in a final analytic sample of 611 individuals, included 340 singletons, 104 sibling pairs, 17 sibling trios, and 3 sibling quartets.

The institutional review boards of Brown and Harvard Universities approved the follow-up studies; written informed consent was obtained from participants.

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