Maternal smoking during pregnancy and self-reported delinquency by offspring

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ABSTRACT

Background Several studies have reported significant positive correlations between smoking during pregnancy by mothers and the involvement of their offspring in criminal/delinquent behaviour later in life, but these findings have been described as modest and the criminality based on official conviction statistics.

Aims We sought to verify this relationship and probe for more details on the basis of self-reported offending among college students.

Methods Independently completed questionnaires were collected from 6332 students and their mothers. The students provided information about their delinquent acts, if any, according to eight categories. Their mothers provided retrospective reports of their smoking habits, if any, during pregnancy.

Findings Mothers who recalled having smoked during pregnancy were significantly more likely than non-smoking mothers to have offspring who self-reported engaging in some types of delinquency. This relationship was more evident for female offspring than for male offspring and was most pronounced for illegal drug use by the offspring. There was, however, no relationship between offspring offending and estimated number of cigarettes smoked by mothers, month of pregnancy when smoked or consistency of smoking throughout pregnancy.

Conclusion Overall, our study confirms that maternal smoking during pregnancy is associated with offspring involvement in delinquency, but the lack of critical timing or dose–response relationships between maternal smoking and later offspring delinquency cast doubt on the possibility that the associations are due to teratogenic effects of tobacco smoke. Copyright © 2012 John Wiley & Sons, Ltd.
Introduction

Numerous studies have found significant statistical associations between maternal smoking during pregnancy and an elevated likelihood of an offspring eventually being taken into custody for, or found to be involved in, delinquent acts (Rantakallio 1983; Bagley, 1992; Rantakallio et al., 1992; Wakschlag et al., 2006) and adult criminality (Rasanes et al., 1999; Brennan et al., 2002; D’Onofrio et al., 2010; Paradis et al., 2011). In one of the few exceptions, the relationship fell short of being statistically significant although it was still in the direction of supporting the relationship (Gibson & Tibbetts, 1998), and a subsequent study by this research team did report a significant relationship for men but not for women (Gibson and Tibbetts, 2000). In a meta-analysis of the research on this relationship, Pratt et al. (2006) concluded that although the association between maternal smoking and offspring offending is modest, it appears to be robust.

Maternal smoking during pregnancy has also been found to be associated with childhood conduct disorder and adult anti-social personality disorder in offspring (reviewed by Wakschlag et al., 2002; also see Boutwell & Beaver, 2010; Button et al., 2005; Maughan et al., 2004; Huijbregts et al., 2008), with offspring drug dependence (Weissman et al., 1999) and with offspring attention deficit/hyperactivity disorder (Milberger et al., 1996; Button et al., 2005; Yoshimasu et al., 2009). These studies are noteworthy, too, in light of evidence that childhood conduct disorders, adult anti-social personality, drug dependence and attention deficit/hyperactivity disorder are all frequently documented clinical correlates of elevated involvement in delinquent and criminal behaviour (reviewed by Ellis et al., 2009).

Despite extensive evidence linking maternal smoking to offspring behaviour problems, including those of a criminal nature, the reason for such a relationship remains to be established. One possibility is that in utero exposure to nicotine or other cigarette smoke compounds has a directly damaging – teratogenic – effect on the brain, altering function in ways that cause behaviour problems in offspring following birth. Another possibility is that family background variables predispose mothers and offspring alike towards both smoking and various behaviour problems (including other forms of drug abuse). Two recently published studies have reported evidence pointing towards this latter possibility. One, a Swedish study based on a large cohort of over half a million subjects, confirmed that maternal smoking during pregnancy was associated with the probability of the offspring being convicted of a crime (D’Onofrio et al., 2010). On the basis of a sibling discordant design, however, these authors concluded that ‘family background factors account for the associations between maternal smoking and criminal convictions’ (p. 529). In a similar vein, Boutwell and Beaver (2010) reported a US study in which maternal smoking during pregnancy predicted offspring externalising behaviour (e.g. aggression or acting out when frustrated). After controlling for maternal anti-social behaviour, substance abuse, depression, low socioeconomic status and family adversity, they...
concluded that ‘the association between prenatal exposure to cigarette smoke and externalizing behavior problems was fully accounted for by confounding factors’ (p. 146).

Our study was undertaken to verify and extend the evidence concerning maternal smoking during pregnancy and offspring offending. For the first time in a study of this type, we will base analyses on self-reported offending rather than official statistics on arrests and convictions. The main advantage of self-reported data is that they tend to reveal more extensive information about minor offending, particularly regarding drug and other victimless crimes (Walsh & Ellis, 2007, p. 40). Among the other unusual aspects of our study is that it allowed us to look not only for juvenile and adult offending separately but also at possible dose effects for maternal smoking.

Methods

Our study was part of a broad investigation into perinatal influences on behaviour. It involved linking data from two questionnaires independently completed by offsprings and their mothers. The procedures were as follows: 11,961 college students taking courses in the social and behavioural sciences at 20 US and two Canadian universities completed questionnaires. Among other things, the students reported their involvement in a list of eight categories of delinquent acts.

The questionnaire given to each student was part of a packet containing envelopes and another separate questionnaire. Unless adopted, each student with a living mother was asked to give the additional questionnaire to her to complete. Mothers were asked to mail their completed questionnaire independently from the questionnaire submitted by their son or daughter, in a separate envelope. A total of 6332 mothers did so. Questions for the mothers were mainly about their pregnancy history, including whether they smoked while pregnant with the offspring who completed the student questionnaire. Thus, our study was composed of the 6332 mother–offspring pairs; data completion was good enough for analysis in 6327 of them.

Sample

The students (henceforth referred to as ‘offspring’) were 2007 men and 4325 women with an average age of 23.6 years (SD = 6.01). A total of 1553 (77.4%) of the men and 3443 (79.6%) of the women were single; 9.7% of the men and 12.9% of the women were married. The remaining offsprings were divorced (men: 1.3%; women: 3.3%), widowed (men: 0%; women: .1%) or failed to respond to this question (men: 11.4%; women: 3.6%). The racial/ethnic composition of the offspring sample was 85% White people, 4% Black people, 2% Native American, 2% Asian/Pacific Islander, 1% Hispanic and 6% who did...
not answer. These racial/ethnic proportions are similar to North American college students as a whole.

The average age of the mothers in our sample was 47.98 years (SD = 7.61). At the time they completed the questionnaire, 68.3% were married, 8.4% were divorced, 3.3% were widowed and 3.0% had never married.

Variables

Maternal smoking
Each mother was asked to report the number of cigarettes she smoked (if any) during each month of pregnancy while carrying the child who provided us with the offspring questionnaire. To calculate the total number of cigarettes smoked throughout pregnancy, we summed the number smoked per month.

The accuracy of self-reported smoking, especially after 20-odd years, may be questioned. Nevertheless, studies have shown that mothers exhibit a remarkable degree of recall of details surrounding their pregnancies (Yawn et al., 1998; Buka et al., 2004). On smoking during pregnancy specifically, one study compared data collected during pregnancy with maternal recall of having smoked while pregnant 30+ years after the fact. The correlation coefficient between these two measures was .86 (Tomeo et al., 1999). A more recent study reported similar results and concluded that mothers exhibit 'high stability and consistency in retrospective recall of smoking' during pregnancy (Post et al., 2008, p. 159).

Self-reported delinquency
Offspring were presented with a list of offences and were asked to report the number of times they recalled committing each one during three periods in their lives: Between 10 and 15, between 16 and 18 and after age 19. To measure delinquency, we added the reported number of offences in eight categories together for ages 10 through 18.

The eight offence categories were as follows: (1) serious violence – assaults in which another person required medical treatment; (2) less serious violence – assaults in which another person did not require medical treatment; (3) vehicle theft – stealing a motor vehicle; (4) thefts – all thefts other than of motor vehicles; (5) vandalism – damaging or destroying other people’s property; (6) illegal entry – burglary in a residence or business; (7) illegal drugs – using illegal drugs (did not include underage drinking); and (8) illegal commerce – selling illegal drugs or stolen property, writing bad cheques or tax fraud.

Statistical analyses
Gender is a pervasive correlate of delinquency (Ellis et al., 2009, pp. 11–20), so all analyses were performed for males and females separately. A t-test was used to compare the average number of offences self-reported by the offspring
according to whether mothers reported having smoked. This was carried out in terms of both the total number of cigarettes smoked throughout pregnancy and the number of cigarettes smoked during each month of pregnancy. To consider the possibility of dosage effects, we excluded non-smoking mothers and correlated the number of cigarettes smoked during each month of pregnancy with the number of each type of offence reported by the offspring.

Results

As shown in Table 1, 28.8% (1821) of the mothers reported having smoked sometime during the time they were pregnant with the indexed offspring. The percentage doing so was highest early in pregnancy and diminished slightly as pregnancy progressed.

Offspring involvement in delinquency is reflected in Table 2. It shows that males were much more likely to have committed all eight categories of offences than were females, with the greatest difference involving serious violence.

Table 3 presents the results of comparing (1) mothers who smoked with mothers who did not smoke during any month of pregnancy and (2) their offspring’s self-reported involvement in the eight different categories of delinquency. Asterisks identify all differences that were statistically significant according to t-test scores. The right-most column pertains to whether the mother smoked anytime during pregnancy, whereas the columns identified as first, second and so on have to do with maternal smoking during each of the typical 9 months of pregnancy.

Table 1: Numbers and proportions of mothers who reported having smoked while pregnant with the indexed offspring

<table>
<thead>
<tr>
<th>Month of pregnancy</th>
<th>Mothers who smoked</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>1722</td>
<td>27.2</td>
<td></td>
</tr>
<tr>
<td>Second</td>
<td>1668</td>
<td>26.3</td>
<td></td>
</tr>
<tr>
<td>Third</td>
<td>1603</td>
<td>25.3</td>
<td></td>
</tr>
<tr>
<td>Fourth</td>
<td>1578</td>
<td>24.9</td>
<td></td>
</tr>
<tr>
<td>Fifth</td>
<td>1568</td>
<td>24.7</td>
<td></td>
</tr>
<tr>
<td>Sixth</td>
<td>1558</td>
<td>24.6</td>
<td></td>
</tr>
<tr>
<td>Seventh</td>
<td>1544</td>
<td>24.4</td>
<td></td>
</tr>
<tr>
<td>Eighth</td>
<td>1522</td>
<td>24.0</td>
<td></td>
</tr>
<tr>
<td>Ninth</td>
<td>1490</td>
<td>23.5</td>
<td></td>
</tr>
<tr>
<td>Anytime during pregnancy</td>
<td>1821</td>
<td>28.8</td>
<td></td>
</tr>
</tbody>
</table>
Without exception, the t-test values were in the direction of indicating that mothers who smoked during pregnancy had offspring who were more involved in delinquency than offspring of non-smoking mothers, although only about a third of the differences were statistically significant.

Two other noteworthy findings in Table 3 are (1) that many more significant relationships were found between maternal smoking and offending among female offspring than among male offspring and (2) most of the significant correlations had to do with drug offences. The first of these two findings is not likely to be due to any sampling deficiencies. Although women constituted two-thirds of the entire sample of offspring in this study and their delinquency involvement was considerably lower than that of men, the total number of offences self-reported by men and women was roughly equal.

Table 3 also shows that none of the significant relationships between maternal smoking and offspring offending were concentrated in any specific month of pregnancy.

Further investigation of the possibility that there may be certain times during pregnancy when the foetus is particularly vulnerable in this respect was conducted by examining responses only of the mothers who reported having smoked at least some during pregnancy; we correlated the number of cigarettes they recalled having smoked for each month of pregnancy with their offspring’s self-reported involvement in the eight categories of delinquency. The resulting table (available upon request) revealed no significant correlations. An analysis of the number of cigarettes mothers smoked during each trimester as well as throughout pregnancy similarly failed to yield significant correlations with delinquency by their offspring. Overall, Table 3 confirms that delinquency rates, as indicated by all eight offence categories, are higher for persons whose mothers smoked during pregnancy than for those whose mothers did not.
<table>
<thead>
<tr>
<th>Type of offence</th>
<th>Sex</th>
<th>First</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
<th>Sixth</th>
<th>Seventh</th>
<th>Eighth</th>
<th>Ninth</th>
</tr>
</thead>
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<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serious violence</td>
<td>Males</td>
<td>1.13</td>
<td>.74</td>
<td>.46</td>
<td>.31</td>
<td>.23</td>
<td>.04</td>
<td>.10</td>
<td>.25</td>
<td>.25</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>3.65***</td>
<td>3.35***</td>
<td>2.83***</td>
<td>2.74***</td>
<td>2.50**</td>
<td>2.51**</td>
<td>2.62**</td>
<td>2.52**</td>
<td>2.37**</td>
</tr>
<tr>
<td>Less serious violence</td>
<td>Males</td>
<td>1.94*</td>
<td>2.06*</td>
<td>2.10**</td>
<td>1.80*</td>
<td>1.76*</td>
<td>1.72*</td>
<td>1.68*</td>
<td>1.82*</td>
<td>1.60</td>
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<tr>
<td></td>
<td>Females</td>
<td>3.02**</td>
<td>2.55**</td>
<td>2.58**</td>
<td>2.49**</td>
<td>2.30**</td>
<td>2.42**</td>
<td>2.50**</td>
<td>2.58**</td>
<td>2.59**</td>
</tr>
<tr>
<td>Vehicle theft</td>
<td>Males</td>
<td>1.48</td>
<td>1.69</td>
<td>2.07*</td>
<td>2.07**</td>
<td>1.93*</td>
<td>1.86*</td>
<td>1.78*</td>
<td>1.86*</td>
<td>1.87*</td>
</tr>
<tr>
<td></td>
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<td>2.59**</td>
<td>2.15**</td>
<td>2.17**</td>
<td>2.13**</td>
<td>2.07**</td>
<td>1.93*</td>
<td>1.58</td>
<td>1.53</td>
<td>1.54</td>
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<tr>
<td>Theft</td>
<td>Males</td>
<td>2.01*</td>
<td>2.14**</td>
<td>2.04*</td>
<td>1.85*</td>
<td>1.80*</td>
<td>1.68*</td>
<td>1.68*</td>
<td>1.84*</td>
<td>1.83*</td>
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<tr>
<td></td>
<td>Females</td>
<td>4.37***</td>
<td>3.57***</td>
<td>3.47***</td>
<td>3.75***</td>
<td>3.83***</td>
<td>3.87***</td>
<td>3.91***</td>
<td>4.01***</td>
<td>3.59***</td>
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<tr>
<td>Vandalism</td>
<td>Males</td>
<td>1.15</td>
<td>1.02</td>
<td>1.09</td>
<td>.57</td>
<td>.74</td>
<td>.89</td>
<td>.94</td>
<td>.82</td>
<td>.57</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>2.53**</td>
<td>2.82**</td>
<td>2.49**</td>
<td>2.84**</td>
<td>2.86**</td>
<td>2.88**</td>
<td>2.93***</td>
<td>2.93**</td>
<td>2.65**</td>
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<tr>
<td>Illegal entry</td>
<td>Males</td>
<td>1.16</td>
<td>1.16</td>
<td>1.08</td>
<td>.96</td>
<td>1.00</td>
<td>.96</td>
<td>1.04</td>
<td>1.08</td>
<td>1.47</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>3.30***</td>
<td>2.43**</td>
<td>2.61**</td>
<td>2.82***</td>
<td>2.96***</td>
<td>2.97***</td>
<td>3.32***</td>
<td>3.13**</td>
<td>2.86**</td>
</tr>
<tr>
<td>Illegal drug</td>
<td>Males</td>
<td>3.08**</td>
<td>3.02***</td>
<td>3.23***</td>
<td>3.18**</td>
<td>3.19**</td>
<td>3.00***</td>
<td>3.20***</td>
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<td>3.41**</td>
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<tr>
<td></td>
<td>Females</td>
<td>3.77***</td>
<td>3.32***</td>
<td>3.32***</td>
<td>3.51***</td>
<td>3.58***</td>
<td>3.37***</td>
<td>3.68***</td>
<td>3.54**</td>
<td>3.42**</td>
</tr>
<tr>
<td>Illegal commerce</td>
<td>Males</td>
<td>1.68</td>
<td>1.63</td>
<td>1.52</td>
<td>1.61</td>
<td>1.76*</td>
<td>1.77*</td>
<td>2.01*</td>
<td>2.10**</td>
<td>1.99*</td>
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<tr>
<td></td>
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<td>4.15***</td>
<td>3.22***</td>
<td>3.09***</td>
<td>2.99***</td>
<td>3.24***</td>
<td>3.05***</td>
<td>3.41***</td>
<td>3.25**</td>
<td>3.55**</td>
</tr>
</tbody>
</table>

*p < .05.
**p < .01.
***p < .001.
Discussion

A link between maternal smoking during pregnancy and offspring involvement in delinquency was reconﬁrmed by our study, which is the first to use self-report data for such an evaluation. This methodological approach and large sample size allowed us to examine more details of this relationship than any previous study. In particular, we were able to look for relationships between timing and amount of maternal smoking and eight distinguishable types of offending. All eight types were positively correlated with maternal smoking, particularly among women, with illegal drug use being especially strongly related. Furthermore, we were able to show that the maternal smoking/offspring offending relationship held throughout the entire 9 months of pregnancy rather than being limited to just a specific portion of pregnancy; also, no ‘dosage effect’ was found.

Three limitations of the study must, however, be mentioned. Firstly, self-reported offences commonly cover considerably less serious types of offences than is the case for ofﬁcially detected delinquency and crime (Hindelang et al., 1981; Jolliffe et al., 2003). Self-reported data also tend to underestimate the differences between individuals who are most and least involved in offending because those who are least delinquent appear to be more inclined to report even minor law infractions (Elliot & Ageton, 1980; Farrington et al., 1996). This means that one should not be surprised to ﬁnd at least some discrepancies between studies based on self-reports and those based on ofﬁcial data (Walsh & Ellis, 2007).

Secondly, self-reported smoking by the mothers may have been under-reported owing to shame or failure of recall (Ford et al., 1997). Nevertheless, as noted earlier, at least two studies designed to verify retrospective accounts of smoking during pregnancy both concluded that maternal recall was highly reliable (Tomeo et al., 1999; Post et al., 2008).

Thirdly, numerous factors besides maternal smoking are related to offspring delinquency, and many of these factors are likely to be considerably more important. To compensate for this fact, we used large sample sizes of mothers and offsprings to detect whatever effects might exist.

To our knowledge, only two other studies examined the amount of maternal smoking on offspring offending. One, by Brennan et al. (2002), contrary to our study, concluded that a signiﬁcant ‘dose–response relationship’ did exist between the number of cigarettes mothers smoked and the arrest rates for their offsprings. Their method was substantially different from ours in the following ways: ﬁrstly, they used arrest data rather than self-reported delinquency; secondly, their study measured self-reported maternal smoking only during the third trimester rather than throughout pregnancy; thirdly, to assess dose effect, we used the actual number of cigarettes smoked only by mothers who smoked sometime during pregnancy, whereas Brennan and colleagues included non-smoking mothers and the average number of cigarettes smoked each day throughout the third trimester. This provided the Brennan group with four dose categories: no cigarettes, one to two, three to ten...
and more than ten. We believe that excluding non-smoking mothers provided a more conservative measure of any dose effect and that knowing the number of cigarettes smoked during all months of pregnancy provided us with greater precision in measuring it.

The other study to report on a possible dose effect was by Paradis et al. (2011), comparing non-smoking mothers with mothers who reported having smoked less than 20 cigarettes a day during pregnancy and mothers reporting having smoked more than 20 per day. As in the Brennan et al. study, they found a dose effect, with mothers who smoked more than 20 cigarettes per day having a greater number of offspring with arrest records by age 33 years than either of the other two groups.

The apparent absence of either dose or timing of smoking effects in our study requires explanation. Together, these findings suggest that any teratogenic effects of cigarette smoke on the developing foetus are unlikely to explain the association between maternal smoking and delinquency. Other explanations include the possibility that cigarette smoking in pregnancy is mainly an indicator of/surrogate for other environmental factors, such as poor diet, other substance use and a general lack of care during pregnancy. Another might lie in the possibility in shared genes that predispose people to anti-social acts – for the mothers, these included but were not necessarily confined to smoking during pregnancy and for the offspring included a whole range of delinquent behaviours, but most particularly drug taking – for them, illicit drugs; and for the mothers, the legal drug, nicotine. A genetic hypothesis would need substantial further investigation. Ultimately, a story of gene–environment interaction as suggested elsewhere (Ellis, 2005; 2008) would be likely to provide the best explanation that there are antecedents common to both maternal smoking and offspring delinquency, which better account for the relationship than the one directly influencing the other.

Conclusions

We found further evidence for an association between smoking by mothers during pregnancy and offending by their offspring. The size of our sample enabled us to examine, in effect, a hypothesis that smoking per se is teratogenic, affecting foetal brain development. The absence of any relationship between amount smoked or timing of smoking in pregnancy and later delinquency goes against a direct toxic effect from smoking. Alternative explanations lie in the possibility that smoking in pregnancy is a marker for other relevant environmental problems or that there may be a common genetic antecedent to smoking and delinquency. Future research should focus on exploring such explanations further.

Supporting information

Additional supporting information may be found in the online version of this article.
References


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