Exposure to Environmental and Mainstream Tobacco Smoke and Risk of Spontaneous Abortion

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The authors examined the risk of spontaneous abortion from environmental tobacco smoke (ETS) exposure in a prospective study of over 5,000 women conducted in California during 1990–1991. Among nonsmokers, there was little association by hours of ETS exposure at home or work (adjusted odds ratio (OR) for any exposure = 1.01, 95% confidence interval (CI) 0.80–1.27), or by paternal smoking. However, the risks associated with ETS exposure were increased among nonsmokers who had moderate alcohol or heavy caffeine consumption. A moderate association with maternal smoking was observed (adjusted OR for >5 cigarettes per day = 1.3, 95% CI 0.91–1.9). Am J Epidemiol 1999; 149:243-7.

Maternal smoking during pregnancy is considered a hazard to the fetus (1, 2). Studies of spontaneous abortion have generally found an association: reviews of the literature suggest increased risks on the order of 25–50 percent, with some studies showing greater effects with heavier smoking (3, 4). Because of these risks, exposure to environmental tobacco smoke (ETS) is also of concern. To our knowledge, only two studies have examined spontaneous abortion in relation to ETS exposure—one a case-control study that we conducted in California (5) and the other a prospective study carried out in Sweden (6). Both studies had similar findings of about a 50 percent increased risk, but had various limitations including only limited exposure ascertainment in the case-control study. Therefore, we have examined this issue further in a prospective study of spontaneous abortion which ascertained usual daily hours of ETS exposure at home and work. In addition, we present data on maternal and paternal smoking.

MATERIALS AND METHODS

Details of data collection have been published elsewhere (7, 8) and are summarized briefly here. Pregnant women were recruited during 1990–1991 from a large prepaid health plan in California when they called to make their first prenatal appointment. To be eligible for the study, pregnant women had to be at least 18 years old, 12 weeks gestation or less (mean = 8 weeks), and Spanish- or English-speaking. Telephone interviews were completed within a few weeks of initial contact for 5,342 women; reasons for noncompletion included 18 percent refusals, about 10 percent ineligible, and 3 percent lost to follow-up.

Pregnancy outcomes were ascertained primarily by computerized hospital admission records and abstraction of medical records. Less than one percent of outcomes could not be determined. These pregnancies were excluded as were therapeutic abortions and ectopic or molar pregnancies (n = 198). Pregnancies that ended by 20 completed weeks of gestation or earlier were defined as spontaneous abortions (n = 499). The remaining pregnancies resulted in 4,613 livebirths and 32 stillbirths.

Most of the consumption questions on the interview (e.g., alcohol, caffeinated beverages, and cigarettes smoked) were asked for two time periods: the week before interview (considered “during” pregnancy) and the week at last menstrual period. The smoking status of the spouse was also ascertained during pregnancy, but the amount he smoked was ascertained only for the 3 months before pregnancy. Exposure to ETS was ascertained as the average number of hours per day the respondent was near other people smoking at home and at work since the last menstrual period. Hours at the two locations were summed to create a total daily ETS exposure. ETS exposure was examined only among women who reported not smoking at both time periods (n = 4,209).
The hours of ETS exposure were categorized and crude risk ratios and 95 percent confidence intervals for spontaneous abortion were calculated relative to nonexposed. Any exposure versus none was entered in logistic regression models because there was little increase in risk (univariately) by greater hours exposed. Odds ratios were adjusted for maternal age, prior history of spontaneous abortion, alcohol and caffeine consumption during pregnancy, and gestational age at interview. Potential effect modifiers of a priori interest from previous smoking studies were alcohol and caffeine consumption, which were examined for departure from additivity of effects (9, 10). Effects of active smoking were examined using similar logistic regression models.

RESULTS

The proportion of spontaneous abortions was 9.7/100 (9.6/100 among nonsmokers). The median gestational age at loss was 11 weeks, with 72 percent of spontaneous abortions occurring in the first trimester. Risk factors for spontaneous abortion in these data (table 1) were similar to those generally found in the literature (11). Among nonsmoking women, 13.5 percent reported ETS exposure at home and 23 percent of working women reported ETS exposure at work (figure 1), with about 28 percent exposed overall. Although more women reported exposure at work than home, much of the exposure tended to be of short duration.

The proportion of spontaneous abortions did not increase consistently with increasing ETS exposure (table 1). When examined by source of exposure, miscarriage risk was somewhat elevated at >6 hours per week of home exposure compared with none (11.4/100 vs. 9.4/100), but greater hours of work exposure were not associated with greater risk of spontaneous abortion. The adjusted odds ratios for any ETS exposure by source were all close to null (table 2). Some effect modification by alcohol and caffeine consumption was found (table 3). There was no difference in the ETS association for earlier versus later losses.

Among nonsmokers, 15.5 percent of women reported that the father of the pregnancy smoked. The risk of spontaneous abortion was not increased with his smoking status during pregnancy, nor with amount smoked by the father before pregnancy (table 4). Combining women who reported either ETS exposure at home or spouse smoking or both did not identify any increased risks for spontaneous abortion.

In comparison, women who smoked ≥5 cigarettes per day during pregnancy were 40 percent more likely to have a spontaneous abortion than nonsmokers (table 5), but there was little dose-response trend for greater amounts smoked. Adjustment decreased the risk slightly. Women who reported that they quit smoking during early pregnancy were not at increased risk of having a spontaneous abortion. The risk from smoking (>5/day) appeared greater for losses which occurred after 10 weeks (adjusted odds ratio (OR) = 1.6, 95 percent confidence interval (CI) 1.0–2.4) than for earlier abortions (adjusted OR = 0.9, 95 percent CI 0.6–1.7). There was slight effect modification of the active smoking association by caffeine consumption of >150 mg/day, but not when categorized as >300 mg/day. There was no effect modification by alcohol consumption during pregnancy, nor by spouse smoking habits.

DISCUSSION

This prospective study found little evidence for an association of spontaneous abortion with ETS expo-
FIGURE 1. Proportion of nonsmokers who reported exposure to environmental tobacco smoke (ETS) at home, work, and combined, by hours exposed, in a prospective study of pregnancy outcome, California, 1990–1991.

TABLE 2. Adjusted* odds ratios (OR) for spontaneous abortion (SAB) and environmental tobacco smoke (ETS) exposure during pregnancy, among nonsmokers, California, 1990–1991

<table>
<thead>
<tr>
<th>Variable</th>
<th>No.</th>
<th>SAB (%)</th>
<th>Adjusted OR</th>
<th>95% CI†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any ETS at home</td>
<td>571</td>
<td>10.9</td>
<td>1.15</td>
<td>0.86–1.55</td>
</tr>
<tr>
<td>Any ETS at work</td>
<td>743</td>
<td>9.0</td>
<td>0.88</td>
<td>0.66–1.17</td>
</tr>
<tr>
<td>Any ETS, either place</td>
<td>1,178</td>
<td>9.6</td>
<td>1.01</td>
<td>0.80–1.27</td>
</tr>
</tbody>
</table>

* Adjusted for maternal age, prior spontaneous abortion, alcohol and caffeine consumption, and gestational age at interview, and compared with nonexposed for each source.
† CI, confidence interval.

sure, except among women who also consumed alcohol or caffeine in moderate to high amounts. The increase in risk seen with active maternal smoking is consistent with previous reports (3, 4). Women who consume alcohol or caffeine may be more susceptible to further risks from ETS than other women. However, effect modification of alcohol and caffeine on the relation with smoking was not seen clearly in this study nor in previous studies (5, 11–13), so these findings are tenuous.

We are aware of only two previous studies of spontaneous abortion with data on ETS exposure other than spousal smoking, which were limited to nonsmoking mothers and adjusted for confounders (5, 6). Both reported a moderate association of spontaneous abortion with ETS exposure, which we would have been able to detect with greater than 80 percent power. In the Swedish study (6), the association was observed only with workplace exposure (adjusted relative risk = 1.5, 95 percent CI 1.0–2.4), which was defined as spending most of the time at work around smokers. The California study (5) did not ask about sources of exposure separately, but rather whether subjects were exposed to ETS for ≥1 hours per day at home or work (adjusted OR = 1.6, 95 percent CI 1.2–2.1). These findings are of similar or greater magnitude to the associations found between spontaneous abortion and active smoking in the same data sets.

ETS contains many of the same chemical constituents as those in mainstream smoke, but the physiochemical nature of sidestream smoke compared with mainstream smoke leads to differences in the ratio of constituents, which may be higher in sidestream smoke (14). Sidestream smoke undergoes dilution and further chemical transformation to form ETS. Because cotinine levels measured in nonsmokers who are exposed to ETS are generally one to two orders of magnitude lower than in smokers (15), the effect of ETS exposure might be expected to be much lower than that of active smoking. However, this presupposes a linear relation and that cotinine (a metabolite of nicotine) is the primary toxicant of interest (14).

The current study is based on more detailed assessment of ETS exposure than the previous California study (5), but may be subject to some misclassification (and nullification of risks) because exposures outside the home or workplace were not ascertained, nor
were details about the intensity of exposure. The proportion of nonsmokers who reported ETS exposure is lower than in some studies, but is similar to our study conducted 4 years earlier and to other studies in California of nonpregnant women (5, 17). California has lower smoking rates than other states and more severe smoking restrictions (17, 18), so that exposure to ETS may not only be less frequent but also of a lower magnitude or intensity. To date, the literature on the possible association of ETS exposure and fetal loss is somewhat limited. Additional studies should include highly exposed women to provide power for detecting a possible association and more detailed exposure assessment.

**REFERENCES**


