The Effect of Local Smoking Ordinances on Fetal Development: Evidence from California

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Abstract

Smoking restrictions in workplaces have been shown to reduce the demand for cigarettes but little is known of their downstream effect on individual well-being. In this paper, I examine the impact of local workplace smoking restrictions on birth outcomes. It is known that maternal and passive smoking during pregnancy reduce birth weight and that low birth weight infants are more likely to experience acute health and developmental difficulties that inflict significant costs on society. I use variation in the timing of local smoking ordinances in California between 1988 and 2004 in combination with a large sample of birth certificates to identify the effects of these ordinances on birth weight. The results indicate that the state workplace ordinance decreases the average city birth weight. While the results show no effect on birth outcomes from local ordinances and only small effects from the state ordinance, the point estimates consistently suggest the opposite of what is expected. This detrimental outcome, while seemingly counterintuitive, supports Adda and Cornaglia (2006b).

- *Keywords*: smoking, state and local government regulation, birth weight

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1 Introduction

'Clean indoor air laws', also known as smoking ordinances, are enacted at state and local levels of government in an attempt to discourage cigarette smoking as well as to limit non-smokers' exposure to cigarette smoke (Chaloupka (1992)). The research on these laws has effectively shown that one of these goals has been accomplished; these laws have been associated with a decrease in demand for cigarettes (Chaloupka (1992); Czart et al. (2001); Evans et al. (1999) Gallet (2004); Ohsfeldt et al. (1998); Tauras (2006); Wasserman et al. (1991); Yurekli and Zhang (2000)). Workplace smoking ordinances in particular have been shown to decrease smoking prevalence by five percentage points and daily consumption by 10 percent (Evans et al. (1999)). The second goal, however, of limiting non-smokers' exposure to cigarette smoke, has not been well established.[1] If ordinances do limit exposure, one can test for possible beneficial physiological effects. This paper attempts to fill this gap by analyzing the impact of local and state workplace smoking ordinances on birth outcomes, thereby focusing on the effect on the non-smoking fetus.

There are reasons to expect, however, that limiting non-smokers' exposure can cause outcomes contrary to the obvious expectation. Adda and Cornaglia (2006b) show that in order to maintain a constant nicotine level, smokers increase the intensity of their smoking when they lower cigarette consumption in response to higher taxes.[2] They do this by smoking a larger fraction of each cigarette even though this provides disutility from the bad taste at its end. Such addictive behavior can have a detrimental impact on non-smokers who live with a smoker who is subject to a workplace ban. Similar to the response to a tax, the smoker who is unable to smoke as much during the work day may smoke more cigarettes after they arrive home. Moreover, consistent with Adda and Cornaglia's theoretical model, smoking fewer cigarettes during the work day may also lead to greater smoking intensity after arriving home from work. This of course could lead to greater exposure for non-smokers in the house-

[1] Exceptions are Adda and Cornaglia (2006a) who study the effect of state smoking bans and taxes on nonsmokers' cotinine levels and Markowitz (2006) that looks at the impact of state smoking bans on sudden infant death syndrome.

[2] Intensity is defined as the amount of nicotine extracted per cigarette.

hold. If a non-smoking household member is pregnant, she may experience a detrimental birth outcome. The observation of smokers lighting up as soon as permissable and smoking quite rapidly after disembarking from a long flight provides an anecdotal example.

Cities and counties in California began implementing local workplace smoking ordinances prior to the statewide workplace ordinance implemented in January 1995. This legislative history generates two "natural experiments." In the first, some cities and counties implemented workplace smoking ordinances while others did not. The former constitute a treatment group while the latter is a control. The second experiment is the statewide workplace smoking ordinance. With this ordinance, the treatment is reversed. It consists of areas that had no previous local ordinance, while areas that already had an ordinance in place constitute the control. By matching 17 years of California zip-code level birth certificate data to city, county, and state workplace smoking ordinances, I employ a difference-in-difference research design to take advantage of these "natural experiments". I compare the change in outcomes for treated cities to untreated cities to estimate the impact of workplace smoking ordinances. The results of this comparison indicate that the state workplace ordinance decreases the average city birth weight. While the results show no effect on birth outcomes from local ordinances and only small effects from the state ordinance, the point estimates consistently suggest the opposite of what is expected. This detrimental outcome, while seemingly counterintuitive, supports Adda and Cornaglia (2006b).

The remainder of this paper is divided into the following sections. Section 2 provides background information on the health effects of smoking and secondhand tobacco smoke on a fetus as well as a review of the current literature. Section 3 develops the empirical model and the data are described in Section 4. Results are reported in Section 5 and the final section concludes.

2 Background

2.1 Health Effects of Smoke on Fetus

Research shows that women who smoke during pregnancy risk complications, such as premature birth, low birth weight (LBW) infants, stillbirth, and infant mortality (Simpson (1957); Butler et al. (1972); D'Souza et al. (1981); Sexton and Hebel (1984); Backe (1993); Bardy et al. (1993); Wilcox (1993); Ellard et al. (1996); Hopkins et al. (1990); McDonald et al. (1992); Mainous and Hueston (1994)). This research identifies several pathways by which smoking affects the fetus, including fetal hypoxia from increased carboxyhemoglobin; reduced blood flow to the uterus, placenta and fetus; and direct effects of nicotine and other compounds in tobacco smoke on the placenta and fetus (U.S. Department of Health and Human Services (2004)). Yeruchimovich et al. (1999) shows elevated nucleated red blood cell counts, a marker of fetal hypoxia, among infants born to women that smoked actively during pregnancy. Dollberg et al. (2000) shows these same elevated nucleated red blood cell counts among women who were exposed to secondhand tobacco smoke. Nicotine and its metabolites have been detected perinatally in umbilical cord serum in infants born to women that did not smoke, as well as in the cervical mucus of nonsmoking women. Because these studies are able to clearly identify effects in both mothers that actively smoked during pregnancy as well as nonsmoking mothers exposed to secondhand tobacco smoke, it is reasonable to expect the same adverse outcomes, albeit less pronounced, for pregnant women exposed to secondhand tobacco smoke(U.S. Department of Health and Human Services (2006)).

2.2 Literature Review

The smoking behavior of pregnant women has been studied in detail, with much of this research focused on the response to changes in cigarette taxes. This is of interest because, like smoking ordinances, taxes can be used to deter smoking and hence secondhand tobacco exposure.

Evans and Ringel (1999) is the first paper to use the national natality detail files. They estimate conditional demand elasticities of the effect of cigarette taxes on pregnant women's smoking behavior and subsequent birth outcomes between 1989 and 1992 using the smoking indicator that was added in 1989. They also estimate of the impact of cigarette taxes on birth weights.[3] They include state and month fixed effects and finds that the elasticity of smoking for pregnant women is approximately -0.5. This implies that increasing the cigarette tax by 10% decreases smoking participation by 5% but has no effect on the number of cigarettes smoked. The authors also estimate that a one-cent increase in the state cigarette tax increases the average birth weight by 0.16 grams. The authors include four types of smoking ordinances in the model to test the robustness of the marginal effect of the cigarette tax on smoking participation. They find no substantial change in the marginal effect of the cigarette tax on smoking participation.

Ringel and Evans (2001) extend this analysis to explore the differences in responsiveness to cigarette taxes across subgroups. The authors add three more years of the natality detail files and find an elasticity of smoking participation for pregnant women of -0.7 which is much higher than the elasticity of the general population. They also find that older, married, and more educated women have elasticities greater than one in absolute value.

Elasticity estimates produced by Gruber and Koszegi (2001), using the natality detail files, are much smaller. It finds a participation elasticity of -0.35, which is half that of Ringel and Evans (2001). The primary difference in methodology between the two studies is that Gruber and Koszegi (2001) includes an additional year of data and collapse the data into monthly cells. This paper also finds that pregnant women respond to announced changes in taxes by decreasing consumption prior to implementation.

Lien and Evans (2005) estimate a difference in difference model on four states that experience large one-time increases in their cigarette tax to determine the impact of cigarette taxes on birth weight. They also use the natality detail files to investigate whether cigarette taxes influence a pregnant woman's decision to smoke as well as the impact of this decision on the

[3]California along with New York, Indiana and South Dakota were not included in the analysis because they do not include this indicator for smoking in the birth data.

birth weight of the child. They find that large tax increases reduce smoking and that smoking reduces birth weight by 182 grams and doubles the chance of a low birth weight.

Colman et al. (2003) use the Pregnancy Risk Assessment Monitoring System to investigate the relationship between cigarette taxes and the smoking behavior of pregnant women. They find that higher cigarette taxes are negatively related to the probability of smoking before, during, and after pregnancy. The authors also find that higher taxes are positively associated with quitting prior to pregnancy as well as quitting prior to delivery.

Bradford (2003) uses the National Maternal and Infant Survey and its followup to find a negative relationship between cigarette price and the probability of smoking as well as the quantity smoked. However, the more interesting finding is that pregnant women are not more responsive to cigarette taxes than nonpregnant women.

In general, this research shows that higher taxes do affect the behavior of pregnant women and the health of their babies in a positive way. It is reasonable to expect that smoking ordinances can have similar impacts because, albeit less directly, and in a nonpecuniary fashion they also make smoking more costly. The focus of the literature on smoking ordinances has been their impact on cigarette demand. With a few exceptions it has primarily dealt with state rather than local ordinances.[4]

As stated in Section 1 the research on smoking ordinances has shown they are associated with a decrease in demand for smoking (Wasserman et al. (1991), Chaloupka (1992), Ohsfeldt et al. (1998), Yurekli and Zhang (2000), Czart et al. (2001), Gallet (2004), Tauras (2006), Evans et al. (1999)). Moreover, the research emphasizes that there are differences in responses across subgroups, sexes, ages, and socioeconomic status.

Wasserman et al. (1991) use the National Health Interview Survey and National Health and Nutrition Examination Survey II to determine that state smoking regulations have significant, but different, effects on adult and teenage cigarette demand. The laws affect teenagers' decisions to become smokers and the number of cigarettes smoked by smoking adults. Chaloupka (1992) also uses the National Health and Nutrition Examination Survey II to find that smok-

[4]The exceptions are Ohsfeldt et al. (1998), Czart et al. (2001), and Adams and Cotti (2007).

ing ordinances reduce average cigarette consumption by men but not women. Moreover, mens' smoking is sensitive to tax increases while women's is not.

Evans et al. (1999) use the 1991 and 1993 National Health Interview Survey to find that workplace smoking ordinances reduce smoking prevalence by 5 percentage points and daily consumption among smokers by 10 percent, or 2.5 cigarettes per day. The authors suggest that with a 25% smoking participation rate in their sample, it would take a 400% increase in the average tax per pack to induce an equivalent reduction in the smoking rate.

Yurekli and Zhang (2000) use aggregate state-level data to find that state ordinances reduce per capita consumption as they become more restrictive and comprehensive. Gallet (2004) also uses aggregate state-level data to show that state ordinances reduce demand for cigarettes and increase competition in the cigarette market while accounting for the level of restrictiveness and enforcement of the smoking ordinances.

Tauras (2004) uses the National Health Interview Surveys to distinguish the impact of smoking ordinances on current smokers as opposed to some-day smokers. The author finds that private workplace ordinances have the largest impact of the ten types studied and this impacts some-day smokers the most.

There is very little research on local smoking ordinances. Ohsfeldt et al. (1998) use the Current Population Survey and match local ordinances to MSAs. If no local ordinance can be matched, a state ordinance is used. They assume all local ordinances are more restrictive than state ordinances and find that ordinances regulating cigarette use, including in the workplace, discourage cigarette consumption. The authors limit the sample to males and find larger effects on males 24 and older than on males 16 to 24 years.

Czart et al. (2001) also incorporate local ordinances find that local and state-level smoking ordinances have a cumulative impact on the level of smoking by current smokers. When the smoking ordinances are included individually, none of the local or state policies have an impact on smoking consumption. However, once they are collapsed into an index that captures the number of restrictions an individual faces, they lower consumption.

Finally two papers study the impact of smoking ordinances on nonsmokers. Both focus

only on state ordinances. The first, Adda and Cornaglia (2006a), uses the National Health and Nutrition Examination Survey III to show that ordinances affect the concentration of cotinine, a metabolite of nicotine over time in adults that live with smokers, and that tighter regulations in public places contribute to an overall reduction of nicotine exposure in adults. In a subgroup analysis, the authors find the opposite effect in some groups. Consistent with Adda and Cornaglia (2006b), the authors find that stricter regulations lead to an increase in cotinine levels in young children and in the lowest income households.

The second paper focused on nonsmokers is the only one that studies the association between smoking ordinances and their impacts on infant health. Using national natality files from 1973 to 2003 Markowitz (2006) finds that higher prices, taxes, and stronger restrictions on smoking in restaurants and child care centers are effective in reducing sudden infant death syndrome. The author does not study other measures of birth outcomes, which is the focus of this analysis.

3 Model and Expectations

3.1 Empirical Model

The legislative history in California generates two "natural experiments" in which I employ a difference-in-difference research design to take advantage. Cities and counties in California began implementing local workplace smoking ordinances prior to the statewide workplace ordinance implemented in January 1995. In the first experiment, some cities and counties implemented workplace smoking ordinances while others did not. The former constitute a treatment group while the latter is a control. The second experiment is the statewide workplace smoking ordinance. With this ordinance, the treatment is reversed. It consists of areas that had no previous local ordinance, while areas that already had an ordinance in place constitute the control. This approach is analogous to that used by Gruber et al. (1999) to analyze the effects of abortion legalization. This work uses state laws allowing abortion and enacted prior to Roe v. Wade as a natural experiment. Similar to local smoking ordinances

enacted before the statewide ordinance, these "repeal states" constitute the treatment group. Passage of Roe v. Wade, like passage of the statewide smoking ordinance creates a second experiment in which the "nonrepeal states" become treated.

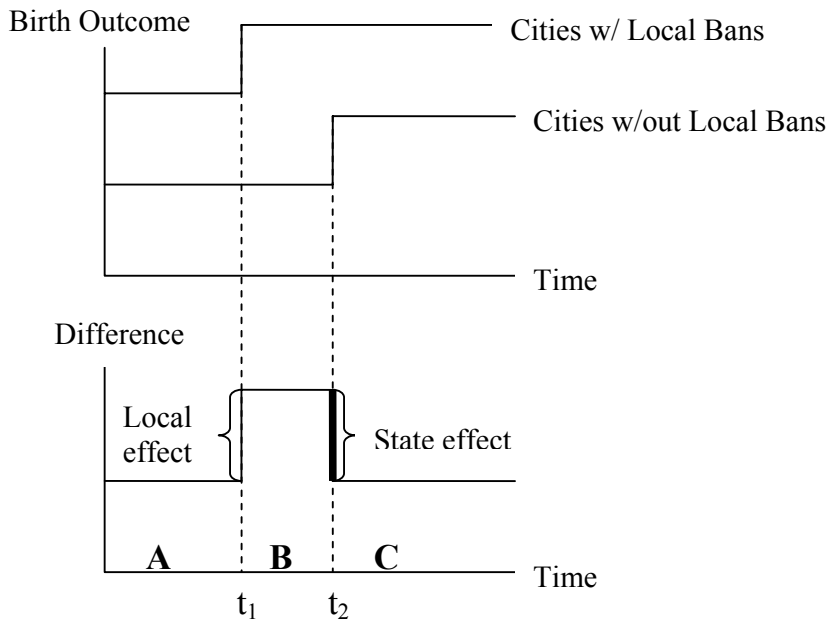

Figure 1: Illustration of Impact of Workplace Smoking Ordinances on Birth Outcomes

A stylized representation of the effect on birth outcomes of these "natural experiments" is shown in Figure 1. Assuming that ordinances have beneficial impacts, the top panel shows how birth outcomes are expected to improve in each set of cities with their implementation.[5] The bottom panel shows the difference in birth outcomes between the two sets of cities. The difference shown in time segment B is greater than that shown in time segment A because local ordinances are implemented at time t_1. The statewide ordinance is not implemented until time t_2. Areas that had no local ordinances before this should experience improved outcomes, which reduces the difference for time segment C. In short, the lower panel shows

[5]The diagram is applicable to birth weight, and gestation and would be reversed in the case of low birth weight or very low birth weight, which are undesirable outcomes. For expositional purposes, it also implies better outcomes for cities with local ordinances before they are enacted.

the effect of local ordinances as a difference-in-difference at t_1, and the effect of the statewide ordinance on cities with local ordinances as a difference-in-difference at t_2.

Figure 1 simplifies the first "natural experiment" by suggesting that every city implements its smoking ordinance at the same time, which is not the case. Cities and counties were implementing workplace ordinances from 1988 through 1994. Figure 2 shows the number of cities that implemented local ordinances in each quarter between 1988 and 1994.

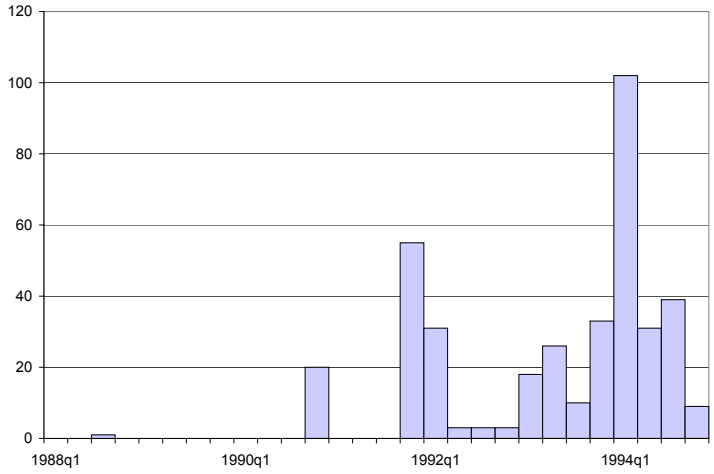

Figure 2: Number of Cities with Local Ordinances Prior to the State Ordinance

By the end of 1994, 41.5% of California's population was living in a city subject to a local ordinance. This immediately increased to 100% when the statewide ordinance took effect on January 1, 1995.[6] This is shown on Figure 3.

[6]All population figures are from the 1990 census holding zip-code population weights constant.

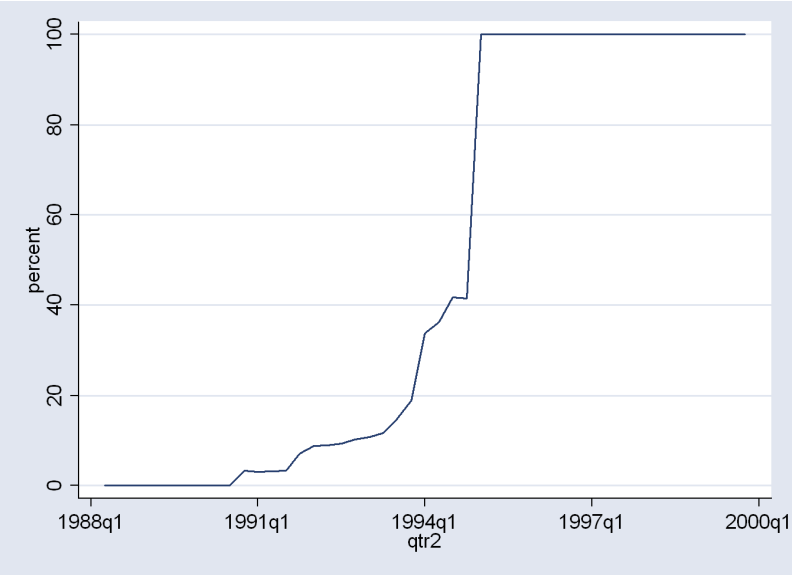

Figure 3: Percentage of Population Covered by a Workplace Ordinance

Only those ordinances that meet a minimum requirement of '100% Smokefree' or 'Qualified' are included in the analysis. 'Qualified' ordinances are those that include exemptions for workplaces that either have separately ventilated rooms or workplaces with a certain number of employees. The California statewide workplace ordinance is an example of a 'Qualified' ordinance because it does not apply to workplaces with less than five employees. 31.8% of the workplace smoking ordinances passed between 1988 and 2004 were 'Qualified', and 'Qualified' ordinances covered 54% of births in cities with workplace ordinances. However, prior to the statewide ordinance, this number was 17.7% of the births. Of the cities subject to local ordinances, 18.1% were subject to 'Qualified' ordinances.

3.2 Regression Framework

The empirical model suggests the following regression equation

$$OUTCOME_{c,q} = \beta_0 + \beta_1 EVER_c * D8894_{c,q} + \beta_2 EVER_c * D9599_q + \beta_3 X_{c,q} + \beta_4 QtrYr_q + \beta_5 city_c + \varepsilon_{c,q}, \quad (1)$$

where $OUTCOME_{c,q}$ is the birth outcome of interest in city c in quarter q. $EVER_c$ is an indicator variable equal to one if city c ever had a local workplace smoking ordinance. $D8894_{c,q}$ is an indicator variable equal to one if quarter q is after city c imposes a local ordinance, but before the state ordinance is implemented. $D9599_q$ is an indicator variable equal to one after implementation of the statewide ordinance. $X_{c,q}$ is a vector of demographic control variables in city c in quarter q. $QtrYr_q$ is a vector of quarter*year fixed effects and are included to capture any trends that may be occurring over time that are constant across all cities. $city_c$ is a vector of city fixed effects, which are included to control for any factors that are fixed over time but vary across cities. Together with $X_{c,q}$, these latter two variables help lessen any bias in the estimated effect of the policy variable on $OUTCOME_{c,q}$. $\varepsilon_{c,q}$ is a random error term. Consistent with previous work (Evans and Ringel (1999) and Markowitz (2006)), the timing of all variables is relative to quarter of conception. Quarter of conception is estimated from data on month of birth and the clinical estimate of gestation.

The impact of ordinances on cities that implement local ordinances prior to the state ordinance is captured by β_1. This corresponds with movement from Segment A to Segment B in Figure 1. The impact of the state ordinance on cities that ever have local ordinances relative to those that never do estimated by $\beta_2 - \beta_1$ and corresponds with movement from Segment B to Segment C in Figure 1. However, of more interest is the impact of the state ordinance on cities that never had a local ordinance relative to cities with local ordinances. This impact is estimated by $\beta_1 - \beta_2$.

Demographic controls included in the models are the mean age of the mother, the mother's race/ethnicity, the mother's education, the sex of the child, parity, and plurality. All regressions are weighted by the number of births in the city and standard errors are clustered to

adjust for serial-correlation at the city-level (Bertrand et al. (2004)).

The parameters of interest in Equation 1 are β_1 and $\beta_1 - \beta_2$. Their expected signs and magnitudes will depend on the birth outcome estimated. Decreasing the amount of cigarette smoke to which pregnant women in the workplace are exposed, whether it is active or passive, can be expected to increase desirable birth outcomes such as greater average birth weight and longer gestation.[7] For these outcomes β_1 is expected to be positive, because it captures the effect of pre-state local ordinances. $\beta_1 - \beta_2$ is also expected to be positive because it captures the effect of the statewide ordinance on cities that previously did not have a local ordinance. Undesirable birth outcomes are also estimated. These include the probability of low and very low birth weight, where a low birth weight is any newborn weighing less than 2,500g and a very low birth weight is a newborn less than 1,500g. Undesirable birth outcomes have the opposite expectations. That is, $\beta_1 < 0$ and $\beta_1 - \beta_2 < 0$.

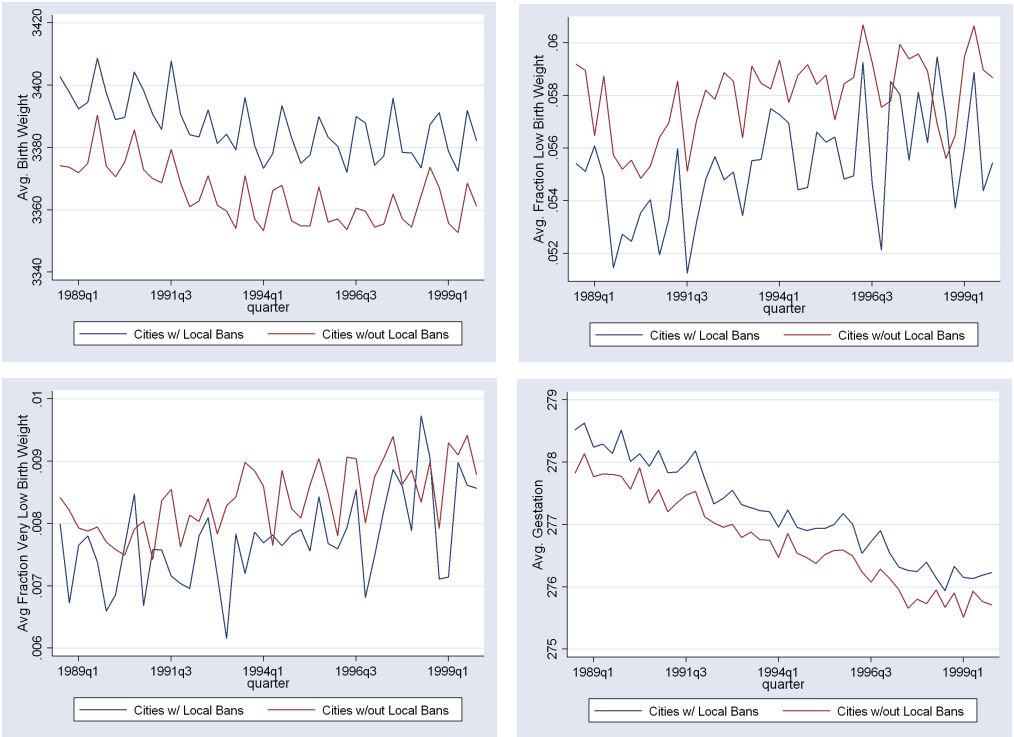

Figure 4: Difference in Avg. Birth Outcome between Cities with Local Smoking Ordinances and Cities Without Local Ordinances

[7]California birth certificate data does not provide information on whether or not the mother smokes.

Figure 4 shows that, on average, cities that implement local workplace ordinances have higher average birth weights, longer average gestation, and a lower fraction of low and very low birth weight births. This figure highlights the importance of controlling for city fixed effects. Neglecting them will result in an upward bias because those cities that implement local ordinances will show better outcomes.

The models identification comes from differences in trends between treatment and control cities. If there are permanent differences, as seen in Figure 4, city fixed effects will control for the bias. However, if the treatment cities are improving over time relative to control cities, then the estimates will be biased upward. Or if the control cities are improving relative to the treatment cities the estimates will be biased downward. In order to account for differences in trends across treatment and control cities I estimate specifications with city-specific linear time trends as well as specifications with city-specific quadratic time trends.

4 Data

Birth certificate data provide information on birth outcomes in each California city as well as the socioeconomic and demographic controls required to estimated the above models. The birth certificate data is provided by the California Department for Health Services, Center for Health Statistics, Office of Health Information and Research. The data contain zip code of residence information on each birth. [8] I exclude any observations for gestation that were beyond four standard deviations of the mean. Summary statistics are provided for birth outcomes and demographic variables in Table 1.

Information on timing of implementation and strength of city and county smoking ordi-

[8]However, there is a potential sample selection problem when data are arranged by quarter of conception. The data comprise the period January, 1989 and December, 2000 implying each birth was conceived between the second quarter of 1988 and the third quarter of 2000. Not all babies conceived in the same month will make it into the sample. For example, most children conceived in the April of 1988 will be born in January 1989, the first month of birth certificate data. However, some will be born before the ninth month of pregnancy and will not be included in the sample. So the first few months of the sample have higher than average birth weights. Similarly, babies born in December, 2000 were conceived at some point between February and August of 2000. Babies conceived late in the sample have lower than average birth weights. For this reason I limit the sample to the interior quarters consisting of the period from the third quarter of 1988 through the fourth quarter of 1999.

nances in California was obtained from Americans for Non-Smokers' Rights (www.no-smoke.org). Because the smoking ordinance data is at the city and county level while the birth certificate data is at the zip-code level, it was necessary to map the birth certificate data to the city. Due to changes in zip code boundaries over time, this mapping was created from U.S. Post Office announcement of boundary changes.

Table 1: Summary Statistics

	Full Sample 1988 - 1999						
Variable	Obs	Mean	S.D.	Variable	Obs	Mean	S.D.
Outcome Variables				*Demographic Controls*			
Birth Weight (g)	44181	3374.584	67.672	Male	44181	0.512	0.044
Gestation (days)	44181	276.977	1.966	Parity	44181	1.090	0.202
Very Low Birth Weight (proportion)	44181	0.008	0.008	Plurality	44181	0.024	0.020
Low Birth Weight (proportion)	44181	0.057	0.022	Mother's age	44181	27.172	1.674
				High school dropout	44181	0.329	0.172
				High school	44181	0.298	0.081
Policy Variables				Some college	44181	0.197	0.071
$EVER_c$	44181	0.424	0.494	College or more	44181	0.176	0.142
$EVER_c * DT8894_{c,q}$	44181	0.060	0.238	Mother white	44181	0.370	0.242
$EVER_c * D9599_q$	44181	0.175	0.380	Mother black	44181	0.071	0.083
				Mother asian	44181	0.071	0.079
				Mother Hispanic	44181	0.451	0.244
				Mother other race	44181	0.037	0.041

Notes:
The Sample consists of births conceived between the third quarter of 1988 and the fourth quarter of 1999. $EVER_c$ is an indicator for whether a city has ever implemented a local workplace smoking ordinance. $EVER_c * D8894_{c,q}$ is an indicator variable equal to one if city c has a smoking ordinance in place in quarter q and it is prior to the statewide ordinance. $EVER_c * D9599_q$ is an indicator for whether the city implements a local workplace ordinance prior to the state ordinance interacted with an indicator for the time period following the state workplace ordinance. Summary statistics were weighted by the number of births in the city.

5 Results

5.1 Basic Specifications

The results of the estimation of Equation 1,

$$OUTCOME_{c,q} = \beta_0 + \beta_1 EVER_c * D8895_{c,q} + \beta_2 EVER_c * D9599_q + \beta_3 X_{c,q} + \beta_4 QtrYr_q + \beta_5 city_c + \varepsilon_{c,q}, \quad (2)$$

are reported in Table 2 which is comprised of three panels. All three panels include city fixed effects and quarter*year fixed effects. The first panel provides results for this basic

specification. The second panel adds city-specific linear time trends to the basic specification while the third adds city-specific quadratic time trends. The estimated β_1 represents the impact of implementing a local ordinance on birth outcomes. In the top panel, with the exception of low birth weight births, the estimated signs of the point estimates suggest a beneficial outcome, however none is statistically distinguishable from zero. The estimated coefficients for β_1 in the second and third panels are again consistently indistinguishable from zero, with the exception of the impact on very low birth weight births in the third panel. The coefficient estimate suggests that local ordinances decrease the fraction of very low birth weight births in cities with local ordinances by 0.04 percentage points. The point estimates of β_1 for gestation and low birth weight births suggest a beneficial but small and insignificant impact of local ordinances while those for birth weight and very low birth weight births are suggest small and insignificant detrimental effects. The point estimate of β_1 in panel 2 suggests the implementation of local ordinances is associated with a decrease in birth weight of 1.83 grams while increasing gestation by 0.03 days. Overall there is no evidence that local ordinances have an impact on birth outcomes.[9]

[9]Overall results are similar for specifications that use a shorter time period and only test the impact of local ordinances. Results are not reported but are available upon request.

Table 2: Impact of the Workplace Smoking Ordinance on Birth Outcomes

	BIRTH OUTCOME			
	Birth Weight mean=3374.58 obs=44181	Gestation mean=276.98 obs=44181	LBW mean=0.057 obs=44181	VLBW mean=0.008 obs=44181
$EVER_c * D8894_{c,q}$	0.0141	0.0440	0.0004	-0.00037
	[1.5873]	[0.0588]	[0.0007]	[0.00023]
$EVER_c * D9599_q$	6.5898***	0.0968	-0.00026	-0.0001
	[2.0300]	[0.0646]	[0.00055]	[0.0002]
$\beta_1 - \beta_2$	-6.5757***	-0.0529	0.0006	-0.0002
	[1.4880]	[0.0526]	[0.0007]	[0.0003]
R-squared	0.52	0.40	0.30	0.09
$EVER_c * D8894_{c,q}$	-1.8314	0.0346	0.0009	-0.0003
	[1.6961]	[0.0696]	[0.0008]	[0.0003]
$EVER_c * D9599_q$	0.6198	0.0989	0.0009	0.0000
	[2.4165]	[0.1381]	[0.0009]	[0.0004]
$\beta_1 - \beta_2$	-2.4512	-0.0643	-0.00001	-0.0003
	[1.8362]	[0.0991]	[0.0007]	[0.0003]
R-squared	0.54	0.43	0.32	0.12
City*linear F.E.	Yes	Yes	Yes	Yes
$EVER_c * D8894_{c,q}$	-0.3367	0.0406	0.0006	-0.0004*
	[1.7555]	[0.0617]	[0.0007]	[0.0002]
$EVER_c * D9599_q$	2.7843	0.1294	0.0004	-0.0003
	[2.6291]	[0.1117]	[0.0009]	[0.0003]
$\beta_1 - \beta_2$	-3.1209	-0.0888	0.0002	-0.0002
	[2.1276]	[0.0912]	[0.0008]	[0.0003]
R-squared	0.54	0.43	0.32	0.12
City*linear F.E.	Yes	Yes	Yes	Yes

Notes:
The variable Birth Weight, measured in grams, is the mean birth weight for all births in each city in each quarter. LBW is the fraction of births below 2,500 grams each city in each quarter. VLBW is the fraction of births below 1,500 grams in each city in each quarter. Gestation, measured in days, is the mean gestation for all births in each city in each quarter. $EVER_c * D8894_{c,q}$ is an indicator variable equal to one if city c has a smoking ordinance in place in quarter q and it is prior to the statewide ordinance. $EVER_c * D9599_q$ is an indicator for whether the city implements a local workplace ordinance prior to the state ordinance interacted with an indicator for the time period following the state workplace ordinance. All regressions include city fixed effects, qtr*yr fixed effects, and controls for sex of the child, parity, plurality, mother's age, mother's education, and mother's race and ethnicity. In parentheses: Heteroskedasticity-robust standard errors clustered at the city-level. Regressions weighted by the number of births in each city. * significant at 10%; ** significant at 5%; *** significant at 1%.

The impact of the statewide ordinance on cities that did not previously have local ordinances is estimated by $\beta_1 - \beta_2$. The estimates in Table 2 suggest the statewide ordinance is associated with a significant decline in birth weight of 6.58 grams. However after controlling for the possibility that treatment and control cities may be on different trajectories, the magnitude decreases to 2.45 and 3.12 grams, depending on the specification, and is no longer

significantly different from zero. The point estimates all suggest a detrimental but small and insignificant effect of the statewide ordinance on gestation. These estimates range from a decline of 0.05 days to 0.09 days, which are a small fractions of the average gestation of 277 days. The point estimates for very low birth weight births are statistically indistinguishable from zero however they all suggest the statewide ordinance had a beneficial impact by decreasing the fraction of low birth weight births by 0.02 to 0.03 percentage points. The decline in birth weight along with a decline in the fraction of low birth weight births suggests that the distribution of births has not merely shifted to the left but has also experienced a compression. Overall, these estimates suggest the statewide ordinance had a detrimental impact on birth weight, gestation, and low birth weight births while having a beneficial impact on very low birth weight births. The detrimental impact on birth weight is consistent with Adda and Cornaglia's model of smoking intensity (Adda and Cornaglia (2006b)).

5.2 Sub-Sample Analysis

Certainly the age of the worker is related to the number of hours they spend working, and in the absence of workplace ordinances their overall exposure to tobacco smoke at work. It is reasonable to expect greater efficacy from a workplace ordinance for pregnant women who spend more time in the workplace. The regression models described in Section 3 are applied separately to the different age groups to see if this is the case. Mothers age 16 and younger have a labor force participation rate of 0.03 in California and work an average of 0 hours according to calculations from the Current Population Survey. Workplace smoking ordinances should therefore not affect this population. Prime working age mothers, on the other hand, have a larger workforce presence with both greater labor force participation and hours worked. Workplace ordinances should thus affect this population more.

Results from estimation of the above model on the population of mothers age 16 or younger are reported on the left hand side of Table 3. The results show no significant impact of the local or statewide workplace ordinances on birth outcomes for this group. The point estimates for the impact of the statewide ordinance suggest detrimental but small impacts on birth

weight and gestation but beneficial impacts on very low birth weight births. Results from the estimation on the population of mothers age 22 or older shows a significant decrease of 0.05 percentage points in the fraction of very low birth weight births with the implementation of local ordinances. The point estimates of the impact of the statewide ordinance suggest a detrimental but insignificant impact on birth weight and gestation and a positive and insignificant impact on very low birth weight births.

Table 3: Impact of the Workplace Smoking Ordinance on Birth Outcomes - By Age Categories

	AGE CATEGORIES					
	BIRTH OUTCOME				BIRTH OUTCOME	
Mother 16 or younger				**Mother 22 or older**		
	Birth Weight	Gestation	VLBW		Birth Weight	Gestation	VLBW
$EVER_c * D8894_{c,q}$	-1.1892	0.5418	0.0020	$EVER_c * D8894_{c,q}$	-0.9658	0.0477	-0.00054*
	[9.3245]	[0.3577]	[0.0023]		[1.9350]	[0.0674]	[0.00029]
$EVER_c * D9599_q$	-0.4681	0.6435	0.0039	$EVER_c * D9599_q$	1.4131	0.1517	-0.0003
	[15.0027]	[0.5846]	[0.0034]		[2.4254]	[0.1368]	[0.00041]
Observations	20406	20406	20406	Observations	43295	43295	43295
R-squared	0.18	0.14	0.11	R-squared	0.49	0.40	0.12
$\beta_1 - \beta_2$	-0.7211	-0.1017	-0.0019	$\beta_1 - \beta_2$	-2.3789	-0.1041	-0.0002
	[11.9468]	[0.4030]	[0.0026]		[2.0375]	[0.1020]	[0.0004]

Notes:
The variable Birth Weight, measured in grams, is the mean birth weight for all births in each city in each quarter. VLBW is the fraction of births below 1,500 grams in each city in each quarter. Gestation, measured in days, is the mean gestation for all births in each city in each quarter. $EVER_c * D8894_{c,q}$ is an indicator variable equal to one if city c has a smoking ordinance in place in quarter q and it is prior to the statewide ordinance. $EVER_c * D9599_q$ is an indicator for whether the city implements a local workplace ordinance prior to the state ordinance interacted with an indicator for the time period following the state workplace ordinance. All regressions include city fixed effects, qtr*yr fixed effects, city*linear trend fixed effects, and controls for sex of the child, parity, plurality, mother's age, mother's education, and mother's race and ethnicity. In parentheses: Heteroskedasticity-robust standard errors clustered at the city-level. Regressions weighted by the number of births in each city. * significant at 10%; ** significant at 5%; *** significant at 1%.

If the primary mechanism of exposure to tobacco smoke for pregnant women is not at the workplace but at home or out with friends, then hours worked are not a good predictor of the impacts of workplace ordinances on birth outcomes. Adda and Cornaglia (2006a) find differences across income levels in exposure to tobacco smoke resulting from state smoking ordinances, where exposure is defined as the concentration of cotinine in the blood. The authors find that as a result of state ordinances low income groups experience an increase in exposure while high income groups experience a decrease. Differences across income levels suggest the possibility of differences across education levels because of a positive correlation between them.

Results from estimation of the above model across four education categories are presented

in Table 4. With the exception of a 0.13 percentage point decrease in the fraction of very low birth weight births to mothers with at least a college education, there is no significant impact of local ordinances on birth outcomes. There are however striking differences across education levels in the impact of the statewide ordinance. Similar to the full sample, in the sample of mothers who have not completed a high school degree, the impact of the state ordinance decreases birth weight by 9.25 grams and decreases gestation by 0.26 days. At the opposite end of the education distribution, a similar impact of the statewide ordinance was estimated for the sample of mothers with a college education or more, a decline in birth weight of 9.51 grams. There were no statistically significant impacts of the state ordinance for the sample of mothers with some college, however the point estimates also suggest a detrimental effect of the statewide ordinance. The surprising result is the beneficial impact of the statewide ordinance for the sample of mothers with a high school degree. The effect of the statewide ordinance on this group was an increase in birth weight of 10 grams and a decrease in the fraction of very low birth weight births by 0.2 percentage points.

Table 4: Impact of the Workplace Smoking Ordinance on Birth Outcomes - By Education Categories

	EDUCATION					
	BIRTH OUTCOME			BIRTH OUTCOME		
Mother High School Dropout				**Mother High School Graduate**		
	Birth Weight	Gestation	VLBW		Birth Weight	Gestation	VLBW
$EVER_c * D8894_{c,q}$	1.5490	0.0705	0.0001	$EVER_c * D8894_{c,q}$	-1.7870	0.0643	-0.0002
	[2.70237]	[0.08412]	[0.00048]		[2.63274]	[0.13749]	[0.00049]
$EVER_c * D9599_q$	10.7951***	0.3295**	-0.0004	$EVER_c * D9599_q$	-11.7878**	-0.1303	0.0017**
	[3.7082]	[0.1463]	[0.0006]		[4.5818]	[0.24085]	[0.0007]
Observations	36166	36166	36166	Observations	39480	39480	39480
R-squared	0.31	0.23	0.09	R-squared	0.4	0.29	0.11
$\beta_1 - \beta_2$	-9.2460***	-0.2590*	0.0005	$\beta_1 - \beta_2$	10.0008***	0.1946	-0.0020**
	[2.8671]	[0.1339]	[0.0006]		[3.6596]	[0.1593]	[0.0007]
Mother Some College				**Mother College or More**			
	Birth Weight	Gestation	VLBW		Birthweight	Gestation	VLBW
$EVER_c * D8894_{c,q}$	-1.6364	-0.0931	-0.0002	$EVER_c * D8894_{c,q}$	-3.3298	0.0961	-0.0013**
	[3.3147]	[0.1218]	[0.0006]		[2.9076]	[0.0969]	[0.0005]
$EVER_c * D9599_q$	3.7237	-0.0493	-0.0003	$EVER_c * D9599_q$	6.1785	0.2340	-0.0022**
	[5.3577]	[0.2002]	[0.0008]		[4.3261]	[0.1469]	[0.0009]
Observations	36693	36693	36693		32985	32985	32985
R-squared	0.38	0.25	0.11	R-squared	0.39	0.28	0.11
$\beta_1 - \beta_2$	-5.3601	-0.0438	0.0001	$\beta_1 - \beta_2$	-9.5083**	-0.1380	0.0009
	[4.6005]	[0.1402]	[0.0007]		[4.0395]	[0.1311]	[0.0008]

Notes:
The variable Birth Weight, measured in grams, is the mean birth weight for all births in each city in each quarter. VLBW is the fraction of births below 1,500 grams in each city in each quarter. Gestation, measured in days, is the mean gestation for all births in each city in each quarter. $EVER_c * D8894_{c,q}$ is an indicator variable equal to one if city c has a smoking ordinance in place in quarter q and it is prior to the statewide ordinance. $EVER_c * D9599_q$ is an indicator for whether the city implements a local workplace ordinance prior to the state ordinance interacted with an indicator for the time period following the state workplace ordinance. All regressions include city fixed effects, qtr*yr fixed effects, city*linear trend fixed effects, and controls for sex of the child, parity, plurality, mother's age, and mother's race and ethnicity. In parentheses: Heteroskedasticity-robust standard errors clustered at the city-level. Regressions weighted by the number of births in each city. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5 presents results of the estimation across race and ethnicity categories. White mothers is the only group that shows an impact of local smoking ordinances. The estimated impact is an increase in gestation of 0.19 days and a decrease in the fraction of very low birth weight births by 0.06 percentage points. There is a significant detrimental impact of the statewide ordinance on birth weight of 7.2 grams for the sample of Hispanic mothers but no impacts of the statewide ordinance on the other groups.

Table 5: Impact of the Workplace Smoking Ordinance on Birth Outcomes - By Race and Ethnicity Categories

	RACE AND ETHNICITY						
	BIRTH OUTCOME				BIRTH OUTCOME		
Mother White				**Mother Black**			
	Birth Weight	Gestation	VLBW		Birth Weight	Gestation	VLBW
$EVER_c * D8894_{c,q}$	-1.6344	0.1948***	-0.0006*	$EVER_c * D8894_{c,q}$	-0.4643	-0.0225	0.0012
	[2.1112]	[0.0691]	[0.0003]		[8.6217]	[0.3179]	[0.0016]
$EVER_c * D9599_q$	-4.7514	0.2013	-0.0001	$EVER_c * D9599_q$	0.9066	0.3706	0.0013
	[3.3894]	[0.1275]	[0.0006]		[10.8768]	[0.4984]	[0.0019]
Observations	42314	42314	42314	Observations	18388	18388	18388
R-squared	0.35	0.33	0.10	R-squared	0.28	0.19	0.12
$\beta_1 - \beta_2$	3.1170	-0.0066	-0.0005	$\beta_1 - \beta_2$	-1.3708	-0.3931	0.0000
	[3.0705]	[0.1035]	[0.0005]		[7.1116]	[0.3045]	[0.0015]
Mother Hispanic				**Mother Asian**			
$EVER_c * D8894_{c,q}$	0.0531	-0.0281	-0.0001	$EVER_c * D8894_{c,q}$	-3.2998	-0.1684	-0.0007
	[2.5487]	[0.0902]	[0.0003]		[5.0186]	[0.1645]	[0.0008]
$EVER_c * D9599_q$	7.2559**	0.0521	0.0004	$EVER_c * D9599_q$	3.2941	-0.5468*	-0.0012
	[3.5864]	[0.1609]	[0.0006]		[7.3141]	[0.2788]	[0.0013]
Observations	34673	34673	34673	Observations	20844	20844	20844
R-squared	0.29	0.26	0.09	R-squared	0.23	0.20	0.10
$\beta_1 - \beta_2$	-7.2028***	-0.0802	-0.0005	$\beta_1 - \beta_2$	-6.5938	0.3784	0.0005
	[2.8036]	[0.1254]	[0.0005]		[6.5975]	[0.2354]	[0.0013]

Notes:
The variable Birth Weight, measured in grams, is the mean birth weight for all births in each city in each quarter. VLBW is the fraction of births below 1,500 grams in each city in each quarter. Gestation, measured in days, is the mean gestation for all births in each city in each quarter. $EVER_c * D8894_{c,q}$ is an indicator variable equal to one if city c has a smoking ordinance in place in quarter q and it is prior to the statewide ordinance. $EVER_c * D9599_q$ is an indicator for whether the city implements a local workplace ordinance prior to the state ordinance interacted with an indicator for the time period following the state workplace ordinance. All regressions include city fixed effects, qtr*yr fixed effects, city*linear trend fixed effects, and controls for sex of the child, parity, plurality, mother's age, and mother's education. In parentheses: Heteroskedasticity-robust standard errors clustered at the city-level. Regressions weighted by the number of births in each city. * significant at 10%; ** significant at 5%; *** significant at 1%.

6 Conclusion

This paper analyzes the impact on birth outcomes of local and state workplace smoking ordinances in California. The primary finding suggests that the state workplace smoking ordinance had a statistically significant though small negative impact on birth weight of 7 grams. Local workplace ordinances, however, do not appear to have similar effects.

A possibly more interesting finding is that the state ordinance, which is qualified, is more effective than the local ordinances, most of which are not qualified. That is, the more restrictive local ordinances appear to be less effective. It follows that other research that weights unqualified ordinances more heavily under the assumption of greater efficacy may be inappropriate. There may be reasons why more restrictive ordinances are less effective. In fact,

it is possible they may lead to adverse outcomes. For example, pregnant women exposed to less smoke at work may be exposed to more at home before and after work from a smoking household member subject to greater workplace restrictions. In fact, some of the results presented here, while seemingly incorrectly signed and significant, are consistent with this idea. It may be that higher smoking concentrations from greater smoking intensity by household members, more than longer exposure time, cause the adverse outcomes. This is potentially testable, but not with California data at the local level.

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