Selection and the Effect of Prenatal Smoking

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Abstract

A large number of studies finds that smoking during pregnancy is associated with poor infant health outcomes. However, there is an on-going debate about the extent to which this association is causal. It is difficult to determine whether these poor health outcomes are the result of prenatal smoking or are also attributable to characteristics of the mother which are correlated with prenatal smoking. I examine the importance of selection on the effect of prenatal smoking by comparing the effect sizes across groups whose selection varies. Specifically, I use three British birth cohorts where the mothers' knowledge about the harms of prenatal smoking varied substantially. Preliminary evidence indicates that the effect of prenatal smoking on low birth weight for gestational age among children born in 2000 is twice that of children born in 1958, implying that selection plays an important part in the association between smoking and birth outcomes.

Extended Abstract

Research has found that maternal smoking during pregnancy is associated with retarded fetal growth, prematurity, fetal and neonatal deaths, and Sudden Infant Death Syndrome. However, there is an on-going debate about the extent to which these associations are causal. It is difficult to determine whether these poor health outcomes are the result of prenatal smoking or are also attributable to characteristics of the mother which are correlated with prenatal smoking.

I examine the importance of selection on the estimated effect size of prenatal smoking on birth outcomes by comparing the effect sizes across groups whose selection varies. Specifically, little was known about the harms of smoking prior to the 1964 U.S. Surgeon General's Report, nor the particular detrimental relationship between prenatal smoking and birth outcomes until the 1969 Surgeon General's Report. Thus, mothers who smoked during pregnancies that occurred prior to these reports were a less select group than mothers who smoked during pregnancies following them. I compare the effect sizes across three British birth cohorts – those children born in 1958, 1970, and 2000 – and expect that the effect is larger for the latter two cohorts than for the earliest cohort if selection plays an important part in the measured effect.

Figures 1 through 3 provide some evidence that selection into prenatal smoking differs across the cohorts. Figure 1 presents the percentage of mothers who smoked during pregnancy by the mother's age at birth. I divided mothers into three age categories – teenage mothers, older mothers, and a middle age group to whom the majority of births occur. The bars provide the distribution of mothers across these categories and the lines represent the percentage who smoked during pregnancy by age group. The distribution of births across mother's age has not changed in an important way across the cohorts. In contrast, the relationship between mother's age and smoking status has changed over time; the percentage does not vary across age groups for the 1958 cohort while there is nearly a 50 percentage point difference between the oldest and youngest mothers for the 2000 cohort. The smoking prevalence was higher for all age groups in the 1970 cohort and the difference across age groups is present but not as dramatic as for the 2000 cohort. This figure suggests that there was no selection into prenatal smoking by age group for the earliest cohort, but that as more information about the dangers of prenatal smoking disseminated, the more mature mothers in the later cohorts chose not to smoke.

Figure 2 presents the percentage who smoked during pregnancy by mother's education at birth. The indicator of mother's education is her age at leaving school. This question is asked soon after birth for both the 1970 and 2000 cohorts but is not asked of the 1958 cohort until several years later. Due to attrition, there are a large number of 1958 cohort mothers missing this variable. Still, I observe an increase in selection across the cohorts by mother's education. The fraction of mothers who smoked during pregnancy is higher among mothers who left school at younger ages than among more educated mothers, however, the contrast across education groups is greatest for the 2000 cohort and least striking for the 1958 cohort.

Finally, Figure 3 presents the percentage who smoked during pregnancy by the cohort member's father's social class at birth. In the UK, social class is a popular indicator of economic status and is based solely on occupation. The six classes are professional, managerial, non-manual skilled, manual skilled, manual semi-skilled, and unskilled. The distribution across these classes is roughly the same for the 1958 and 1970 cohort, however, there is some shuffling away from manual skilled to non-manual skilled and managerial in the 2000 cohort. As we have observed in the previous two figures, the differences across groups in the percentage who smoked during pregnancy is smallest for the 1958 cohort, slightly larger for the 1970 cohort, and much larger for the 2000 cohort, suggesting again that selection into smoking changed as knowledge about smoking spread.

In this preliminary analysis, I concentrate on three related birth outcomes: low birth weight for gestation, prematurity, and (unconditional) low birth weight. Low birth weight for gestation is of interest because research suggests that prenatal smoking is the leading cause of intrauterine growth retardation in developed countries. Prenatal smoking is also a risk factor for prematurity. Low birth weight can be attributed to short gestational length or a slow rate of fetal growth in utero so I use this third measure to capture both of these mechanisms. Table 1 provides some summary statistics for the three cohorts. Nearly 34% of mothers smoked during pregnancy in the 1958 cohort. Mothers were coded as not smoking during pregnancy if they did not smoke before the pregnancy, or quit smoking before or during the pregnancy. The rise in prenatal smoking in 1970 is consistent with the finding that smoking rates among women were at their highest levels in the UK in 1970 (Peto et al. 2000). The percent born low birth weight is roughly 7% across all cohorts. The rates of prematurity range between 10 and 15 percent, such that more pre-term deliveries take place in 2000 than in the earlier years, which probably reflects better survival rates due to technological advances. I control for the child's gender and twin status as both are correlated with birth weight.

Table 2 presents the effect of prenatal smoking on birth outcomes for all cohorts pooled with interactions between prenatal smoking and cohort. The coefficients on smoked during pregnancy is positive and significant for all three outcomes. In the first column, the coefficients on the interactions indicate that the effects of smoking on the probability of being low birth weight conditional on gestational age for the 1970 and the 2000 cohorts are significantly larger than for the 1958 cohort. In particular, the coefficient on the 2000 cohort interaction is larger than the coefficient on the 1970 cohort interaction, consistent with the hypothesis that the effect size scaled with the degree of selection. In the second column, the coefficients on the interactions are not significantly different from zero suggesting that selection may not play an important role in the effect size of prenatal smoking on prematurity. Finally, the interaction coefficients in the third column indicate that the effect of smoking is significantly greater for the 2000 cohort than for the 1958 cohort, while the 1970 cohort is not significantly different.

In sum, I am finding preliminary evidence that the impact of selection on the effect size of prenatal smoking on low birth weight conditional on gestation in particular is large. These estimates suggest that the effect of prenatal smoking on low birth weight for gestational age among children born in 2000 is twice that of children born in 1958.

Peto, Richard, S. Darby, H. Deo, P. Silcocks, E. Whitley, and R. Doll. (2000) "Smoking, smoking cessation, and lung cancer in the UK since 1950: combination of national statistics with two case-control studies." British Medical Journal, 321(7257), August 5, pg. 323.

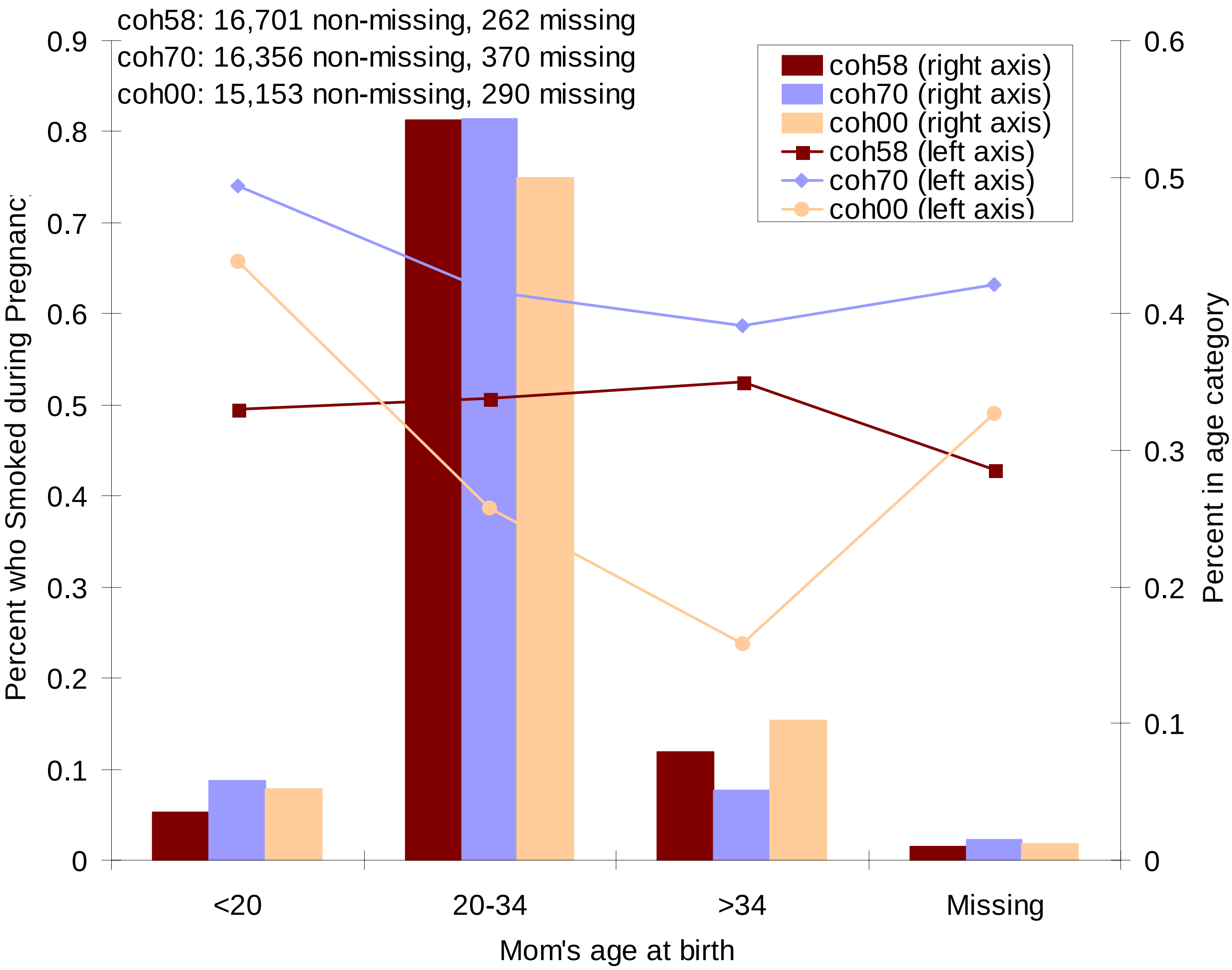
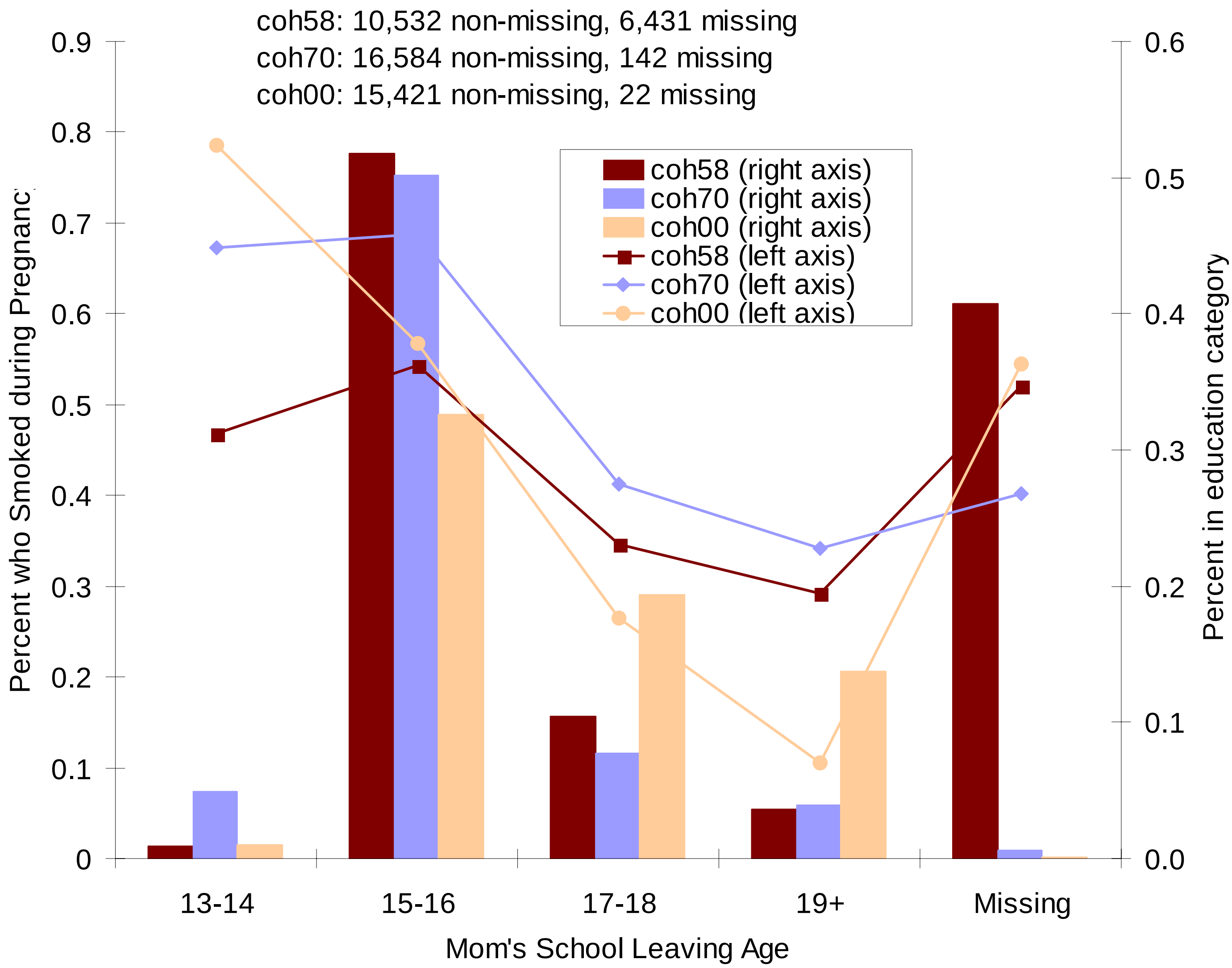

coh58: 16,701 non-missing, 262 missing
coh70: 16,356 non-missing, 370 missing
coh00: 15,153 non-missing, 290 missing
coh58 (right axis)
coh70 (right axis)
coh00 (right axis)
coh58 (left axis)
coh70 (left axis)
coh00 (left axis)
Percent who Smoked during Pregnanc
Percent in age category
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
<20
20-34
>34
Missing
Mom's age at birth

Figure 1



coh58: 10,532 non-missing, 6,431 missing
coh70: 16,584 non-missing, 142 missing
coh00: 15,421 non-missing, 22 missing
coh58 (right axis)
coh70 (right axis)
coh00 (right axis)
coh58 (left axis)
coh70 (left axis)
coh00 (left axis)
Percent who Smoked during Pregnanc
Percent in education category
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.6
0.5
0.4
0.3
0.2
0.1
0.0
13-14
15-16
17-18
19+
Missing
Mom's School Leaving Age

Figure 2

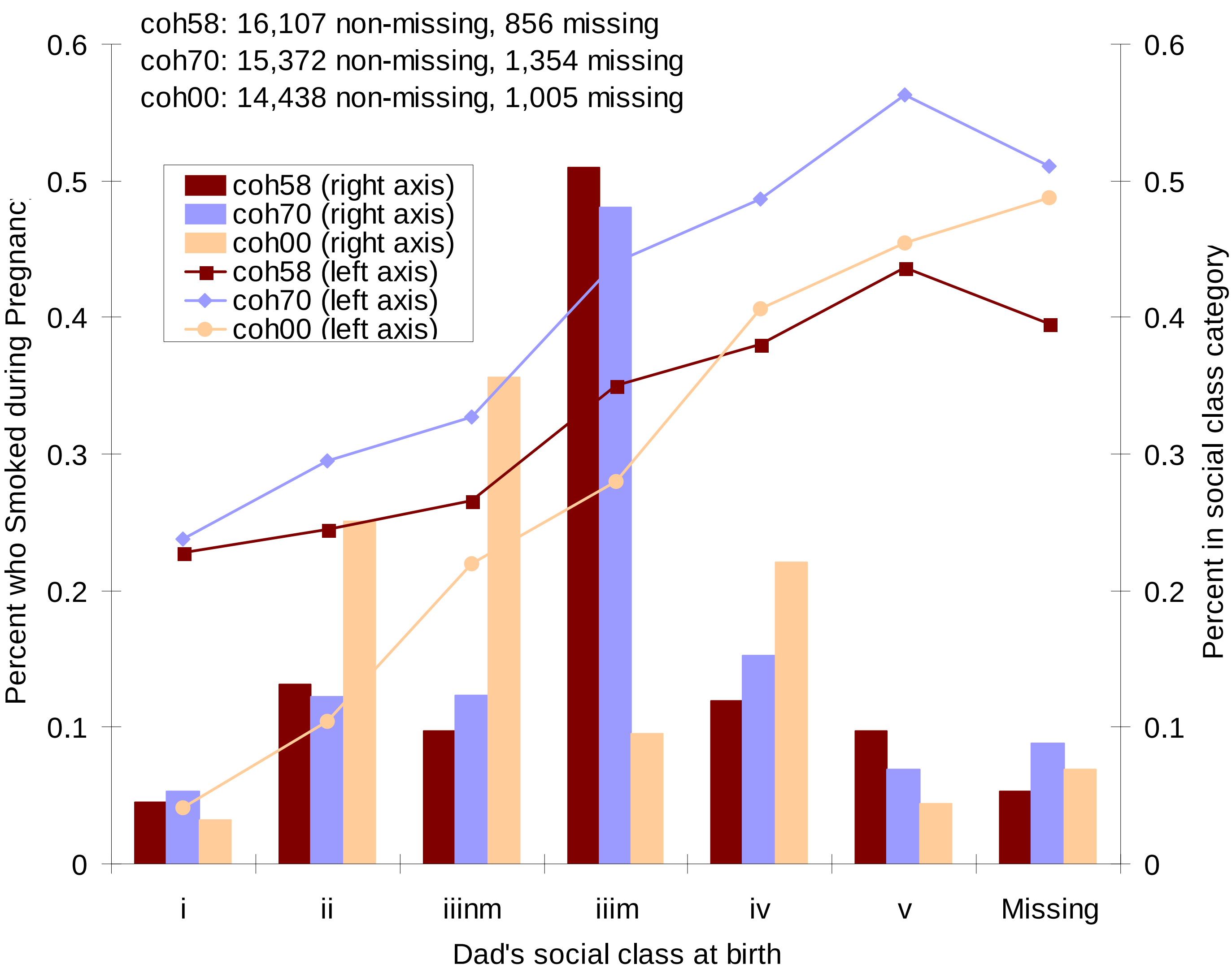

coh58: 16,107 non-missing, 856 missing
coh70: 15,372 non-missing, 1,354 missing
coh00: 14,438 non-missing, 1,005 missing
coh58 (right axis)
coh70 (right axis)
coh00 (right axis)
coh58 (left axis)
coh70 (left axis)
coh00 (left axis)
Percent who Smoked during Pregnanc
Percent in social class category
0.6
0.5
0.4
0.3
0.2
0.1
0
i
ii
iiinm
iiim
iv
v
Missing
Dad's social class at birth

Figure 3

Table 1: Summary Statistics

	1958 Cohort	1970 Cohort	2000 Cohort
Percent who smoked during pregnancy	33.8	42.2	25.8
Percent low birth weight (<2500g)	7.5	7.8	7.2
Percent premature (<38 weeks)	10.4	9.9	14.6
Percent male	51.6	51.9	51.4
Percent twin	2.4	2.2	2.9
Sample size	16,963	16,726	15,443

Table 2: The Effect of Prenatal Smoking on Birth Outcomes

	Low Birth Weight for Gestation	Premature	Low Birth Weight
Smoked during pregnancy	.020**	.033**	.036**
	(.003)	(.006)	(.005)
Gestational age	-.024**		
	(.001)		
Smoked during pregnancy * 70 cohort	.008+	-.002	.010
	(.004)	(.008)	(.006)
Smoked during pregnancy * 00 cohort	.020**	-.007	.020**
	(.005)	(.007)	(.007)
70 cohort	-.007**	-.004	-.009*
	(.002)	(.005)	(.004)
00 cohort	-.022**	.048**	-.008*
	(.002)	(.005)	(.003)
Male	-.013**	.013**	-.011**
	(.002)	(.003)	(.002)
Twin	.187**	.467**	.482**
	(.013)	(.015)	(.015)
Joint test of smoked during pregnancy coefficients (p-value)	.0000	.0000	.0000
Sample size	43,370	43,370	43,370

Note: Probits. Marginal effects reported. Standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%.