Appalachian State University

Department of Economics Working Paper

Number 13-16 | August 2013

Timing of Prenatal Smoking Cessation or Reduction and Infant Birth Weight: Evidence from the United Kingdom Millennium Cohort Study

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Timing of Prenatal Smoking Cessation or Reduction and Infant Birth Weight: Evidence from the United Kingdom Millennium Cohort Study[1]

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Abstract

Objectives: Smoking during pregnancy is a key preventable risk contributor to poor infant health. Our study presents a full dynamic relationship between the timing of prenatal smoking cessation or reduction and infant birth weight. *Methods*: Using a large representative dataset of birth cohort in the United Kingdom, we apply multiple linear regressions to examine how smoking cessation or reduction at different stages especially different months of pregnancy affects infant birth weight. For robustness checks, a rich set of covariates are controlled and a series of variable selection procedures are used. *Results*: We find robust evidence that mothers who quit smoking before the fourth month of pregnancy have infants of the same weight as those of nonsmokers. However, cessation after the fourth month or smoking beyond this threshold month is associated with substantially lower infant birth weights. Two third of the total adverse smoking impact on infant birth weight occurs in the second trimester. Our study also shows heavy persistent smokers should cut smoking intensity before the fourth month during pregnancy, in order to deliver infants as heavy as those born to persistent light smokers. *Conclusions*: Overall, our research suggests that the cost effectiveness of prenatal smoking cessation services can be significantly improved, if they can encourage more pregnant women to quit or reduce smoking by the end of the first trimester. Promoting timely smoking cessation or reduction can help policy makers and medical practitioners reduce the huge healthcare costs of poor birth outcomes attributable to prenatal smoking.

Keywords: Prenatal Smoking; Timing of Smoking Cessation; Timing of Smoking Reduction; Infant Birth Weight

JEL Codes: I12, I18

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1 The authors thank helpful comments of Arnie Aldridge, Albert Baernstein, Meghan Bailey, Sarah W. Ball, Jimin Ding, Bart Hamilton, Tim McBride, Karen Norberg, Michelle D. Hoersch, Longjian Liu, Bob Pollak, Robin H. Pugh-Yi, Stanley Sawyer, Mary A. Steiner, Emma Winter, and other participants of seminars in Washington University in Saint Louis and 2011 American Public Health Association Annual Meeting.
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Introduction

Prenatal smoking is a key preventable risk contributor to poor infant health in developed countries. Since Simpson [1] reported infants born to mothers who smoked during pregnancy were significantly lower than those of nonsmokers, a number of subsequent studies have confirmed this detrimental impact. In general, they consistently show prenatal smoking is associated with a reduction of birth weight of offspring in the range of 150 to 250 grams (g) [2]. In the past several decades, smoking during pregnancy was linked to many other adverse birth outcomes such as placental abruption, preterm birth, intrauterine growth retardation, and sudden infant death syndrome [3-5]. Despite the volume of evidence on the smoking's harmful impact on infant health, the prevalence of maternal smoking is still quite high in industrial countries [6]. Tong et al [7] shows about 22-24% of women in the United States smoked just before or during pregnancy in 2000-2005. In the same period, 33-35% of women across the United Kingdom (UK) reported smoking prior to or during pregnancy, and about 60% of these smokers had smoked throughout pregnancy [8].

Given the large percentage of prenatal smokers and the detrimental impacts of maternal smoking on infants, policies to encourage smoking cessation are increasingly being pursued. The UK government has set reduction in prenatal smoking as a top priority of National Health Service (NHS) planners and managers, since the publication of the landmark White Paper *Smoking Kills* [9]. Comprehensive cessation services are provided to female smokers who are either pregnant or are planning a pregnancy, because both smoking cessation and reduction are found to substantially mitigate the smoking associated deficits in birth outcomes [10-11]. These services cover a variety of recommended strategies, such as individual counseling, group behavior therapy, pharmacotherapies (for instance, nicotine replacement therapy), self-help materials, and telephone quitlines [12]. Similar strategies are used in other industrial countries such as the United States [13-14]. However, the guidance for the wide range of cessation treatments has been vague or silent in the timing issue of prenatal smoking cessation or reduction. It is unclear by what month during pregnancy prenatal smokers should quit to insure that they deliver infants as heavy as those of nonsmokers. Similarly, no guideline has specified a critical time during pregnancy, by which persistent smokers should reduce smoking intensity to significantly mitigate the adverse impact of smoking on the infant health. The importance of the timing issue cannot be understated. A well understood and specified deadline in pregnancy for women to cut smoking can remarkably improve the benefit-cost ratio of any prenatal smoking cessation intervention [15-16].

The literature to date has provided conflicting results on how the timing of prenatal smoking cessation affects birth outcomes especially infant birth weight. Some studies demonstrate infants of women who quit smoking by month seven during pregnancy are as heavy as those of nonsmokers [17-19]. But Macarthur and Knox [20] shows that smoking cessation by the end of the second trimester only mitigates the deleterious impact of smoking on newborn birth weight. Other findings suggest women must quit before the second trimester to make fetal exposure to smoking have a negligible effect on infant health [21-24]. Similarly, inclusive and limited evidence has been reported on the timing of prenatal smoking reduction [17, 19]. In summary, the dispute in this literature concentrates on whether the beginning of the second or third trimester is the threshold for the initiation of acute fetal response to smoking. Identifying the threshold would provide insights to set an important deadline month (just prior to the threshold) for smoking cessation or reduction during pregnancy.

A key limitation of all the above studies is that their datasets only code maternal smoking status a few times during or prior to pregnancy. Therefore, they are unable to adequately evaluate the effects of stopping or reducing cigarette use by different stages of pregnancy especially different months of pregnancy. In addition, samples used in the previous studies are usually highly selective from a few hospitals or regions, or lack of important parental socioeconomic variables. Our research advances the literature by presenting a full dynamics of the timing of fetal exposure to smoking in relation to infant birth weight. The unique UK birth cohort dataset we use contains crucial information of maternal smoking month by month during pregnancy. It is also a representative sample of all the UK pregnant women that provides a rich set of infant, parental, and family level covariates. All these advantages provide an unprecedented opportunity to thoroughly investigate the relationship between the timing of prenatal smoking cessation or reduction and infant birth weight.

Methods

Study Design and Population

Our study uses data from the first wave of the UK Millennium Cohort Study (MCS). MCS is an on-going population based survey which tracks a large child cohort from birth throughout childhood into adolescence. So far, four waves of data collection have been carried out to gather diverse information on child development, parenting, child and parental health, family socioeconomic status, and neighborhood, etc. Our research focuses on the first wave, where a random sample of infants (aged 9 months on average) were drawn from all live births in the UK, over 12 months from September 2000 in England and Wales and December 2000 in Scotland and North Ireland. This cohort was disproportionately stratified to ensure adequate representation of all the four UK countries.

From this birth cohort, two samples are constructed to address the timing of prenatal smoking cessation or reduction in relation to infant birth weight. The first is smoking cessation sample which focuses on 13,495 women who in person answered all the survey questions, reported their histories of cigarette use, as well as provided complete information on their demographic characteristics. Additional sample exclusion conditions include: missing data on infant birth weight (n=30); women with multiple births (n=240); preconception health risk factors (cancer, diabetes, hypertension, and asthma) known to affect prenatal smoking cessation by impairing fetal growth [19, 22] (n=642);

women using other tobacco products such as cigar, roll-ups, or a pipe (n=361); missing data of family income (n=825), and missing information on who else was present as the baby was born (n=266). The final sample consists of 11,131 mothers and their singleton births. Similar exclusion procedures are applied to construct the other sample of smoking reduction during pregnancy. It is limited to persistent smokers who never quit but may change the number of cigarettes smoked daily during pregnancy. This sample consists of 2,306 smokers.

Measures

Women who participated in the first wave of MCS were asked a series of questions on tobacco use: whether they had ever smoked, which tobacco products they had smoked, how many cigarettes per day they had smoked per day before the pregnancy, whether and in what month of the pregnancy they had changed the number of cigarettes smoked per day, and the number of cigarettes smoked per day after this change. In the smoking cessation sample, we use their answers to those questions to classify women as: nonsmokers (the reference group), preconception quitters who stopped smoking before pregnancy, month "j" quitters who gave up smoking in pregnancy month "j" (j=1, 2,…7), and beyond month seven smokers who consist of women who ceased smoking after the seventh month and those who never quit smoking during pregnancy. Very few women in our sample stopped smoking after month seven, giving little statistical power to estimate the impact of cessation in either the eighth or ninth month. Therefore, we group the few late quitters with persistent smokers who never quit during pregnancy. This grouping is innocuous to explore the deadline month of smoking cessation, since all the past studies indicate prenatal smoking should have substantially impaired infant health before the eighth month [17-23].

In the smoking reduction sample, we classify persistent smokers into six categories, where women who smoked no more than 10 cigarettes daily throughout pregnancy (persistent light smokers) are used as the reference group [17]: month "k" reducers who cut the number of daily cigarettes smoked to less than 10 in month "k" (k=1, 2,…5), and women who reduced smoking to less than 10 cigarettes per day after month 5 or persistently smoked at least 10 cigarettes daily throughout pregnancy (persistent heavy smokers). Again, due to the small number of the women who reduced smoking after the fifth month, we group them with persistent heavy smokers. This grouping does not affect identifying the precise deadline month of smoking reduction during pregnancy, as shown below. Finally, in the following analysis, prenatal smokers are also re-categorized by the trimester of smoking cessation or reduction to provide additional insights.

The birth outcome of interest in our study is infant birth weight, the primary and most frequently used infant health measure. Past studies show increasing infant birth weight causally improves childhood health, behavior, cognitive development, as well as adulthood educational attainment, earnings, and other lifetime outcomes [25-28]. Many confounding factors associated with smoking and birth weight can be controlled in our study. The basic covariates used in the baseline analysis are: birth characteristics (infant male, parity, infant birth year and quarter), parental demographics (age, race, ethnicity, and education), maternal socioeconomic status (marital status, antenatal care initiation in the first trimester, family income, and father present as the baby was born), maternal health, and other risky health behavior (preconception height and weight, any alcohol use during pregnancy).

For robustness checks, additional confounding factors are controlled: having a job during pregnancy, receiving any benefits (jobseekers allowance, income support, working family tax credits, or disabled persons tax credits), being satisfied about the current home, religion affiliations, frequent alcohol use during pregnancy (drinking alcohol for at least 3 times per week), and indicators of racist and religion-based insults in the living area.

Statistical Analysis

We use multiple linear regressions to study the relationship between the timing of prenatal smoking cessation or reduction and infant birth weight. The basic confounding factors are controlled in the baseline analysis, and then additional covariates are added to check the robustness of the baseline results. We also implement four variable selection procedures as another sensitivity analysis. Each procedure works as a screening of all the explanatory variables including smoking measures, and in the end, gives a subset of those variables which have significantly predictive power on the dependent variable infant birth weight. If a certain month is the threshold when smoking begins to remarkably affect infant birth weight, then the indicator of smoking cessation in this month should survive every variable selection approach. The same thought applies to determining the threshold month of prenatal smoking reduction.

The first variable selection procedure is forward selection. We start with adding the most significant explanatory variable into an initial model with no input. Then we test other variables not included, and add the most significant one of these remaining variables, so long its P value is below 0.1. Repeat this process until none of the remaining variables are significant at 0.1, when added to the model. The second approach is backward selection. We start with all the explanatory variables at hand in the regression, then the least significant variable is dropped if it is not significant at 0.1. Continue applying this elimination rule to successively refit the reduced model, until all the remaining variables are significant at 0.1. The third is forward stepwise selection, where explanatory variables once entered may be dropped if they are no longer significant at 0.1 as other variables are included. The last is backward stepwise selection. It starts off in a backward selection approach, and then potentially adds back variables dropped earlier if they later on appear to be significant at 0.1. The first two methods are used more widely in the literature [19, 29].

Results

Figure 1 shows average birth weights of the infants born to nonsmokers, preconception quitters, mothers who stopped smoking by pregnancy month seven but differed in their cessation months, and mothers who smoked beyond pregnancy month seven. The birth outcomes of nonsmokers and preconception quitters are similar and used as the base for comparison. This figure shows the infants born to mothers who ceased smoking in the first three pregnancy months were almost as heavy as those of nonsmokers or preconception quitters. However, pregnancy month 4 quitters delivered babies 120-160 g lighter than earlier quitters or nonsmokers. Smoking beyond the fourth month was further associated with a decrease in infant birth weight by about 50-100 g.

[Insert Figure 1]

In Figure 2, smoking women are grouped by trimester of smoking cessation. When mothers gave up smoking in the first trimester, their infants were nearly as heavy as those of nonsmokers or preconception quitters. In contrast, those who smoked through the second trimester had much worse birth outcomes. This preliminary comparison suggests that prenatal smokers must quit by the third month to avoid the initiation of acute fetal response to smoking. Similar results are found in the graphical analysis of smoking reduction among persistent smokers (not shown).

[Insert Figure 2]

Table 1 uses multiple regressions to address the impact of prenatal smoking cessation by month on infant birth weight. Column 1 controls for the basic covariates. It shows the estimated impacts of smoking cessation before or in the first three months of pregnancy are all very small and insignificant. But month 4 quitters give birth to infants significantly lighter than those of nonsmokers by 141 g. There is a further decrease in infant birth weight of 34-71 g, if mothers cease smoking between the fifth and seventh month during pregnancy. Besides, smoking beyond month 7 significantly reduces birth weights by about 249 g in total. Column 1 also shows male infants are heavier, while babies who are the first born or whose parents are Black or Asian are lighter. If women are more educated, younger, married, living in North Ireland or Scotland, they are more likely to deliver heavier babies. Finally, newborn babies are heavier if their fathers are younger than 40 or present at their births.

[Insert Table 1]

Column 2 of Table 1 includes additional confounding factors on maternal social economic status, health behavior, and neighborhood characteristics. The results of the smoking cessation variables and basic covariates discussed above are almost unchanged. We then implement the four variable selection approaches. All of them give identical results. To save space, we only report the outcomes of the forward selection and backward selection in Columns 3 and 4. The four indicators of smoking cessation before the fourth month are all dropped, suggesting none of them can significantly decrease infant birth weight. In contrast, smoking cessation in the fourth month is always a significant and important predictor of having a remarkably lighter baby. Other indicators of smoking beyond the fourth month are also selected into the final models. Therefore, prenatal smokers must quit by the end of the first trimester (before the fourth month threshold) to nullify the adverse smoking impact on the newborn babies.

In Table 2, we present the results of regression analyses of prenatal smoking cessation by trimester. Column 1 shows cessation prior to pregnancy or in the first trimester makes fetal exposure to smoking have a negligible effect on birth weight. Smoking cessation in the second trimester, however, is significantly associated with much lower birth weights by 161 g. Smoking beyond the second trimester reduces infant birth weight by 248 g. Once again our results are robust either in the presence of additional covariates in Column 2, or with two model selection procedures in Columns 3 and 4. The outcomes of the two stepwise selection approaches (not shown) are the same as Columns 3 and 4.

These results also suggest that about two third of the total deleterious smoking impact on infant birth weight occurs in the second trimester. Although several past studies find that mothers can postpone smoking cessation until the end of the second trimester to deliver infants as heavy as those of nonsmokers [17-19], Tables 1 and 2 present robust evidence against it using a large representative dataset.

[Insert Table 2]

Table 3 examines how the timing of prenatal smoking reduction affects birth weights of infants born to persistent smokers. Column 1 shows mothers who reduce smoking in pregnancy month one to three give birth to infants with indistinguishable weights from those of persistent light smokers (the reference group). Nevertheless, switching from heavy to light smoking as late as the fourth month is significantly associated with much lower birth weights by 58 g. Heavy smoking beyond the fourth month further decreases infant birth weight by 19-31 g. With additional covariates included in Column 2, the results are very similar to Column 1. In Columns 3 and 4, we report estimates on smoking reduction by trimester. Both columns indicate heavy smokers have to reduce smoking intensity before the second trimester, in order to deliver infants as heavy as those born to the persistent light smokers. The results are robust to the four variable selection approaches. The corresponding estimates are not reported for brevity, but available upon request. To summarize, we find even if some heavy smokers cannot completely quit during pregnancy, they can substantially mitigate the detrimental smoking impact on infant birth weight, through reducing smoking timely by the end of the first trimester.

[Insert Table 3]

Discussions

Our study uses a large dataset of the UK birth cohort to shed new light on the relationship between the timing of prenatal smoking cessation or reduction and infant birth weight. Using multiple regression analyses, we find if mothers quit smoking before the fourth month during pregnancy, the beginning of the second trimester, their infants are as heavy as those of nonsmokers. However, cessation as late as the fourth month or smoking beyond this threshold month is associated with substantially lower infant birth weights. Two third of the total adverse smoking impact on infant birth weight occurs in the second trimester. In addition, heavy smokers should reduce smoking intensity before the fourth month during pregnancy, in order to deliver infants as heavy as those born to persistent light smokers. All the baseline results are robust in the presence of additional covariates, and with a series of variable selection procedures. These results suggest with expedited smoking cessation or reduction by the end of the first trimester, prenatal smokers can gain the most health benefits for their babies.

One concern on this study is that there can be recall errors of smoking cessation or reduction. The number of such errors may be small, since mothers were interviewed a few months after delivering their babies. It is also possible that some smokers can misreport themselves as earlier quitters. Given that delayed smoking cessation during pregnancy leads to poorer infant health than cessation during early pregnancy, this misreporting is very likely to make the previous analyses understate the adverse impact of cessation in the fourth month during pregnancy, and overstate the impact of cessation in the first three months. So the baseline result is still valid. Similar reasoning applies to misreporting in prenatal smoking reduction.

Another limitation is that we are unable to study how smoking cessation or reduction separately affects gestation and fetal growth, since gestational ages were not asked in the survey. Although imputed gestational ages are provided in the dataset, they are much less accurate than the actual values. Other interesting birth outcomes are not considered such as crown-heel length, ponderal index, head circumference, as well as infant brain and nervous system development, due to the data limitations.

Finally, this analysis is limited to one birth cohort. In future research, it merits consideration to address the timing of smoking cessation or reduction with different birth cohorts.

Our findings highlight the importance of incorporating the timing issue into any prenatal smoking cessation intervention. Several evaluations report the NHS stop-smoking intensive treatments only lead to low CO-validated quit rates among prenatal smokers [30-31]. In addition, recent reviews of randomized clinical cessation trials further confirm current prenatal smoking programs generally achieve quite limited success, not only in the UK but also in other developed countries such as the United States [32-33]. However, our research shows even though it is challenging to increase quit or reduction rates among enrollees in smoking cessation programs, the cost-effectiveness of present smoking cessation interventions can be substantially improved, if health professionals can significantly curb smoking by the end of the first trimester. Meanwhile, it is also necessary to promote timely smoking cessation and reduction for new participants in those programs. These new strategies can help guide policy makers and medical practitioners to remarkably reduce the huge healthcare costs of poor birth outcomes attributable to prenatal smoking [34-35].

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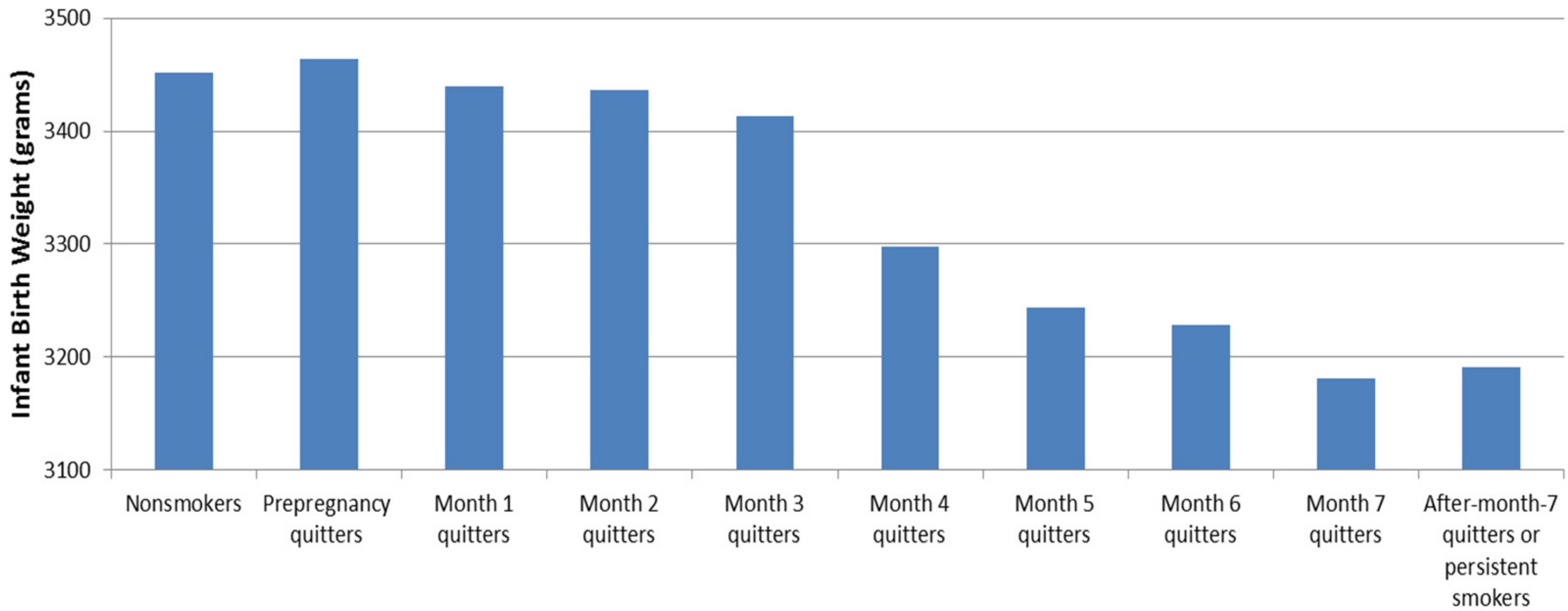

Figure 1 Timing of Prenatal Smoking Cessation (by Month) and Infant Birth Weight

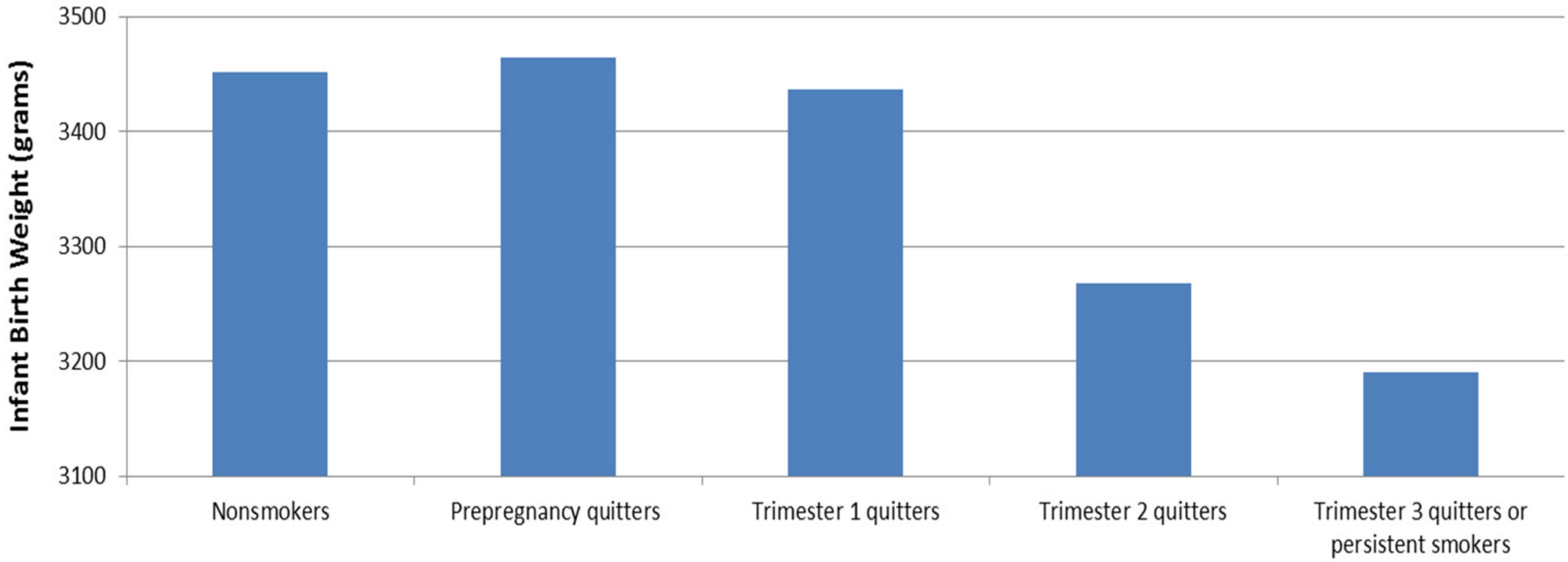

Figure 2 Timing of Prenatal Smoking Cessation (by Trimester) and Infant Birth Weight

Table 1 Timing of Prenatal Smoking Cessation (By Month) and Infant Birth Weight

Variable	Infant Birth Weight			
	(1) Basic Controls	(2) Full Controls	(3) Forward Selection	(4) Backward Selection
Smoking cessation before pregnancy	-8.36 (20.07)	-8.39 (20.25)		
Smoking cessation in month 1	-6.38 (14.14)	-4.86 (14.24)		
Smoking cessation in month 2	-5.99 (32.54)	-5.35 (32.53)		
Smoking cessation in month 3	-10.76 (29.08)	-9.32 (27.54)		
Smoking cessation in month 4	-140.37** (52.30)	-142.67** (53.22)	-142.94** (48.62)	-142.94** (48.62)
Smoking cessation in month 5	-175.36** (53.56)	-169.61** (50.93)	-169.19*** (50.23)	-169.19*** (50.23)
Smoking cessation in month 6	-188.84* (93.12)	-184.49* (90.63)	-186.04* (87.26)	-186.04* (87.26)
Smoking cessation in month 7	-216.57** (91.97)	-215.44** (92.16)	-199.11* (100.05)	-199.11* (100.05)
Smoking cessation after month 7 or no cessation	-248.23*** (23.73)	-245.29*** (22.26)	-247.99*** (19.54)	-247.99*** (19.54)
Infant male	134.06*** (2.33)	134.48*** (2.23)	134.41*** (2.22)	134.41*** (2.22)
Parity	47.11*** (7.77)	49.78*** (5.86)	45.86*** (8.51)	45.86*** (8.51)
Asian mother	-186.88** (73.41)	-216.76** (84.98)	-209.62** (87.71)	-209.62** (87.71)
Black mother	-83.23* (38.77)	-91.42* (39.72)	-129.04*** (37.27)	-129.04*** (37.27)
Asian father	-130.48* (58.76)	-138.20** (54.07)	-135.56** (55.97)	-135.56** (55.97)
Black father	-47.57 (60.11)	-48.92 (60.57)		
Mother's education= O level	14.98 (8.45)	12.11 (8.51)	16.21* (8.57)	16.21* (8.57)
Mother's education ≥ A level	44.21*** (12.18)	40.30** (13.29)	46.73*** (12.79)	46.73*** (12.79)
Mother's age less than 20	76.97*** (19.27)	83.65*** (23.53)	47.39*** (13.38)	47.39*** (13.38)
Mother's age between 20 and 30	25.91 (19.13)	27.87 (20.84)		
Father's age less than 30	47.33** (17.16)	46.22** (17.23)	55.98** (19.18)	55.98** (19.18)
Father's age between 30 and 40	34.91* (16.43)	33.86* (15.78)	39.37* (17.23)	39.37* (17.23)
Mother married	32.75 (18.76)	27.76 (21.29)		
Father present when the baby was born	101.01** (32.22)	99.55** (33.38)	106.78*** (30.91)	106.78*** (30.91)
Mother living in Wales	-7.94* (4.21)	-6.32 (4.38)		
Mother living in North Ireland	52.39*** (7.67)	35.58** (11.89)	53.46*** (13.32)	53.46*** (13.32)
Mother living in Scotland	36.03*** (7.77)	33.46*** (8.79)	43.09*** (5.39)	43.09*** (5.39)
Number of observations	11,131	11,131	11,131	11,131

Note: The model in Column (1) also adjusts for infant birth year/quarter, antenatal care initiation in the first trimester, maternal weight, maternal height, family income, and any alcohol use during pregnancy. The model in Column (2) additionally controls for having a job during pregnancy, receiving any benefits (jobseekers allowance, income support, working family tax credits, or disabled persons tax credits), being satisfied about the current home, religion affiliations, frequent alcohol use during pregnancy, indicators of racist and religion-based insults in the living area. The model in Column (3) applies a forward selection procedure of variables using all the control variables in the model of Column (2). Finally, the model in Column (4) applies a backward selection using all the control variables in the model of Column (2). Robust standard errors are reported in the parentheses where *** means statistically significant at 1% (P<0.01), ** significant at 5% (P<0.05), * significant at 10% (P<0.1).

Table 2 Timing of Prenatal Smoking Cessation (By Trimester) and Infant Birth Weight

Variable	Infant Birth Weight							
	(1) Basic Controls		(2) Full Controls		(3) Forward Selection		(4) Backward Selection	
Smoking cessation before pregnancy	-8.34	(20.11)	-8.37	(20.29)				
Smoking cessation in trimester 1	-6.75	(15.81)	-5.51	(15.14)				
Smoking cessation in trimester 2	-160.43***	(34.93)	-158.94***	(32.96)	-159.31***	(29.41)	-159.31***	(29.41)
Smoking cessation in trimester 3 or no cessation	-248.13***	(23.47)	-245.20***	(22.06)	-247.91***	(19.59)	-247.91***	(19.59)
Infant male	134.04***	(2.32)	134.47***	(2.22)	134.41***	(2.22)	134.41***	(2.22)
Parity	47.11***	(7.77)	49.78***	(5.87)	45.85***	(8.52)	45.85***	(8.52)
Asian mother	-186.75**	(73.14)	-216.71**	(84.61)	-209.59**	(87.41)	-209.59**	(87.41)
Black mother	-83.11*	(38.76)	-91.34*	(39.73)	-129.07***	(37.22)	-129.07***	(37.22)
Asian father	-130.58*	(58.63)	-138.32**	(53.99)	-135.70**	(55.87)	-135.70**	(55.87)
Black father	-47.75	(59.90)	-49.10	(60.38)				
Mother's education=O level	14.99	(8.56)	12.13	(8.53)	16.24*	(8.66)	16.24*	(8.66)
Mother's education≥ A level	44.21***	(12.17)	40.32**	(13.24)	46.76***	(12.81)	46.76***	(12.81)
Mother's age less than 20	77.05***	(19.06)	83.73***	(23.31)	47.57***	(13.17)	47.57***	(13.17)
Mother's age between 20 and 30	25.97	(19.06)	27.91	(20.74)				
Father's age less than 30	47.28**	(17.04)	46.17**	(17.12)	55.98**	(19.21)	55.98**	(19.21)
Father's age between 30 and 40	34.93*	(16.42)	33.86*	(15.77)	39.40*	(17.28)	39.40*	(17.28)
Mother married	32.80	(18.65)	27.83	(21.10)				
Father present when the baby was born	100.97**	(32.22)	99.51**	(33.41)	106.70***	(30.94)	106.70***	(30.94)
Mother living in Wales	-7.88*	(4.00)	-6.28	(4.19)				
Mother living in North Ireland	52.47***	(7.65)	35.61**	(11.86)	53.46***	(13.36)	53.46***	(13.36)
Mother living in Scotland	35.99***	(7.92)	33.42***	(8.93)	43.00***	(5.40)	43.00***	(5.40)
Number of observations	11,131		11,131		11,131		11,131	

Note: The model in Column (1) also adjusts for infant birth year/quarter, antenatal care initiation in the first trimester, maternal weight, maternal height, family income, and any alcohol use during pregnancy. The model in Column (2) additionally controls for having a job during pregnancy, receiving any benefits (jobseekers allowance, income support, working family tax credits, or disabled persons tax credits), being satisfied about the current home, religion affiliations, frequent alcohol use during pregnancy, indicators of racist and religion-based insults in the living area. The model in Column (3) applies a forward selection procedure of variables using all the control variables in the model of Column (2). Finally, the model in Column (4) applies a backward selection using all the control variables in the model of Column (2). Robust standard errors are reported in the parentheses where *** means statistically significant at 1% (P<0.01), ** significant at 5% (P<0.05), * significant at 10% (P<0.1).

Table 3 Timing of Prenatal Smoking Reduction (By Month or Trimester) and Infant Birth Weight

Variable	Infant Birth Weight							
	(1) Basic Controls		(2) Full Controls		(3) Forward Selection		(4) Backward Selection	
Smoking reduction in month 1	-14.83	(31.46)	-16.20	(29.10)				
Smoking reduction in month 2	-13.28	(30.18)	-20.10	(31.27)				
Smoking reduction in month 3	-9.64	(31.91)	-16.92	(31.81)				
Smoking reduction in month 4	-58.24**	(22.84)	-56.00**	(23.16)				
Smoking reduction in month 5	-76.75	(74.41)	-84.94	(78.60)				
Smoking reduction after month 5 or no reduction	-89.07**	(37.97)	-88.24*	(39.77)				
Smoking reduction in trimester 1					-13.03	(21.21)	-18.19	(21.28)
Smoking reduction in trimester 2					-65.17*	(28.31)	-66.20**	(27.85)
Smoking reduction in trimester 3 or no reduction					-89.79*	(43.48)	-88.19*	(44.53)
Infant male	152.97***	(14.14)	149.46***	(13.65)	152.89***	(14.14)	149.32***	(13.57)
Parity	14.64	(9.72)	21.98*	(10.00)	14.82	(9.10)	22.08**	(9.39)
Asian mother	-237.30**	(70.98)	-83.47	(122.62)	-236.44**	(72.18)	-82.98	(124.24)
Black mother	59.27	(71.05)	51.52	(76.89)	59.41	(72.00)	51.99	(77.72)
Asian father	-177.16***	(49.58)	-110.31*	(53.15)	-178.48***	(52.33)	-112.24*	(56.27)
Black father	-57.91	(62.13)	-67.41	(63.51)	-58.00	(64.02)	-67.40	(65.45)
Mother's education=O level	38.05	(22.35)	22.50	(23.97)	38.14	(23.03)	22.90	(24.66)
Mother's education≥ A level	67.19**	(27.11)	47.42	(30.21)	67.23**	(27.20)	47.70	(30.43)
Mother's age less than 20	85.75*	(41.36)	107.11**	(41.68)	86.12*	(41.33)	107.28**	(41.79)
Mother's age between 20 and 30	76.08***	(16.15)	89.90***	(15.33)	76.32***	(16.14)	90.06***	(15.32)
Father's age less than 30	-8.00	(40.09)	-16.03	(39.38)	-8.02	(39.71)	-16.15	(38.97)
Father's age between 30 and 40	-72.32	(40.50)	-75.24*	(39.51)	-72.32	(40.25)	-75.25*	(39.29)
Mother married	80.97**	(26.74)	73.70**	(29.14)	80.73**	(26.55)	73.63**	(28.87)
Father present when the baby was born	30.87	(32.69)	33.50	(34.24)	31.03	(32.99)	33.70	(34.48)
Mother living in Wales	8.91	(15.47)	7.28	(14.09)	8.70	(15.53)	7.19	(14.27)
Mother living in North Ireland	57.00***	(15.79)	16.28	(36.98)	57.15***	(15.90)	16.66	(36.82)
Mother living in Scotland	37.16	(43.50)	29.31	(43.76)	37.00	(43.23)	29.26	(43.50)
Number of observations	2,306		2,306		2,306		2,306	

Note: The models in Columns (1) and (3) also adjust for infant birth year/quarter, antenatal care initiation in the first trimester, maternal weight, maternal height, family income, and any alcohol use during pregnancy. The models in Columns (2) and (4) additionally control for having a job during pregnancy, receiving any benefits (jobseekers allowance, income support, working family tax credits, or disabled persons tax credits), being satisfied about the current home, religion affiliations, frequent alcohol use during pregnancy, indicators of racist and religion-based insults in the living area. Robust standard errors are reported in the parentheses where *** means statistically significant at 1% ($P<0.01$), ** significant at 5% ($P<0.05$), * significant at 10% ($P<0.1$).