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Placental Abruption and Subsequent Risk of Preeclampsia: A Population-Based Case-Control Study

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Abstract

Background—Preeclampsia and placental abruption may share a common pathophysiologic mechanism, namely, uteroplacental ischaemia. The aim of this study was to investigate the association between placental abruption and risk of preeclampsia in a subsequent pregnancy, and to determine whether the association differs by the gestational age at the time of abruption.

Methods—A nested case-control study among multiparous women in the Medical Birth Register of Finland from 1996–2010 was conducted. Cases of preeclampsia (n=6,487) and frequency matched controls (n=25,948) were linked to the Hospital Discharge Registry to ascertain data on prior abruption. Abruption was categorized as preterm (<37 weeks) or term (≥ 37 weeks) based on the gestational age at delivery. We fit logistic regression models to evaluate the associations between abruption and the odds of preeclampsia in the subsequent pregnancy before and after adjusting for potential confounders.

Results—Preterm abruption was associated with over a two-fold increase in risk of preeclampsia (odds ratio [OR] 2.2, 95% confidence interval [CI] 1.5, 3.3) in a subsequent pregnancy. In contrast, term abruption was not associated with preeclampsia (OR 1.1, 95% CI 0.7, 1.7). The association between preterm abruption and preeclampsia was further elevated among women with a history of preeclampsia. Associations with preterm abruption were also strengthened when the outcome was preeclampsia with early delivery (<34 weeks).

Conclusions—These findings suggest that placental abruption in a prior pregnancy is associated with a different risk profile of preeclampsia based on the gestational age of the abruption-affected pregnancy.

Keywords

ischemic placental disease; placental abruption; preeclampsia; early-onset

Preeclampsia is one of three conditions that constitute the syndrome of ischaemic placental disease (IPD), a group of pathologies that also includes placental abruption and intrauterine growth restriction.¹ A common aetiology involving poor placentation in early pregnancy has been proposed as an underlying mechanism leading to the characteristic uteroplacental underperfusion or ischaemia in these obstetrical complications.² IPD in a prior pregnancy is a risk factor for IPD in a subsequent pregnancy.^{3,4} While recurrence patterns of IPD have been well documented, little is known about the recurrence of such diseases based on the gestational age at delivery (i.e., preterm versus term gestations). Recent evidence suggests that the causative pattern of IPD may differ with respect to preterm and term gestations, with the underpinnings of ischaemic placental diseases being more homogeneous at preterm than term gestations.¹

In the United States the prevalence of abruption is 2.3% among preterm deliveries (<37 weeks) and 0.3% among term deliveries, making preterm abruption nine times more common.⁵ One study found that mean birthweight and placental weights were lower in preterm abruption births compared to preterm non-abruption births, but among term abruption births no such association was observed, indicating that preterm abruption is more consistent with uteroplacental ischaemia.⁶

Placental abruption in a prior pregnancy is associated with an approximate two-fold increase in the risk of preeclampsia in a subsequent pregnancy.³ It is not known if a different risk is conferred based on gestational timing of the abruption. The aim of this study is to explore the association of placental abruption on the subsequent risk of preeclampsia and determine if this association differs between preterm and term abruptions.

Methods

A nested case-control study of preeclampsia within the Medical Birth Register (MBR) of Finland was conducted. The MBR is a population-based register that was established in 1987 and includes all live births and stillbirths of at least 22 weeks' gestation or having a birth weight of at least 500 g. The source population for this study was restricted to singleton births in the MBR from 1996 to 2010 among multiparous women, those with at least one prior delivery. Women with missing data on parity were excluded (n=1203; 0.1%). Approval for this study was obtained from the National Institute of Health and Welfare (THL).

Preeclampsia

Preeclampsia cases were identified from the Hospital Discharge Register (HDR) and the MBR using diagnosis codes. The HDR contains information on inpatient visits to public and private hospitals (since 1967) and outpatient visits in public hospitals (since 1998). Cases were identified using ICD-10 codes (preeclampsia: O11, O14, and with seizures: O15) in the HDR (1996–2010) and the MBR (2004–2010). The MBR also includes data on hospitalization due to hypertension during pregnancy. While this may indicate the presence

of preeclampsia, these were not considered cases if diagnosis codes did not confirm the condition.

Four controls (deliveries to women without preeclampsia) from the MBR were chosen for each case and frequency-matched on year of birth. The unit of observation for this study is a unique delivery therefore a woman could contribute multiple deliveries to the study.

Placental abruption

Preeclampsia cases and frequency-matched controls were linked to the HDR using an encrypted maternal personal identity code to ascertain data on placental abruption in prior pregnancies. Diagnoses of abruption in the HDR were identified from 1987–2010, using ICD-9 coding (641.2) for years 1987–1995 and ICD-10 coding (O45) for years 1996–2010. A checkbox for abruption (1990–2005) and diagnosis codes (1987–1989, 2004–2010) included in the MBR were also used to identify abruptions. Occurrences of abruption were categorized by gestational age at the time of delivery, which is calculated based on the last menstrual period and confirmed or corrected by ultrasound screening examination at 11–13 or 18–20 weeks gestation. Preterm abruptions were those that delivered at <37 weeks and term abruptions were those that delivered at ≥37 weeks' gestation.

Covariates

Data on maternal demographic and reproductive characteristics including maternal age and parity were collected from the MBR, as were data on prenatal care visits and smoking during pregnancy. These data were recorded at the time of birth, partly using data from prenatal care records. Pre-pregnancy height and weight, as measured by healthcare personnel, have been included in the MBR beginning since 2004. Pre-pregnancy body mass index (BMI) was calculated by dividing weight in kilograms by height in meters squared. Pre-pregnancy BMI was categorized as underweight (<18.5), normal weight (18.5–24.9), overweight (25–29.9), and obese (≥30).

History of preeclampsia (1987–2010) was collected using ICD-9 codes (1987–1995) and ICD-10 codes (1996–2010) from the HDR and ICD-10 codes (2004–2010) in the MBR.

Statistical Analyses

The distributions of covariates by case status were calculated. Unconditional logistic regression models were used to calculate unadjusted and adjusted odds ratios (OR) of preeclampsia in relation to any prior abruption and abruption in the immediately preceding pregnancy. These associations were subsequently examined based on the gestational age of the abruption-affected pregnancy: preterm versus term. Women with no prior abruption were used as the referent group.

Data on pre-pregnancy height and weight were not included in the MBR until 2004; therefore approximately half of the study population did not have data on BMI. Multiple imputation methods using 10 imputed datasets were used to impute missing BMI values, along with missing values for maternal smoking during pregnancy. Variables that were correlated with BMI or the probability of missing a BMI value were used as predictor

variables. These included birth year, maternal age (<25, 25–29, 30–34, or 35), prior deliveries (1 or 2), number of prenatal care visits (<15, 15–19, or 20), any smoking during pregnancy (yes, no, or missing), history of spontaneous and induced abortions, and pre-existing hypertension and diabetes. Preeclampsia and prior preterm or term abruption were also included as predictor variables. Imputed BMI value was categorized and assessed as a potential confounder.

Covariates assessed as potential confounders were identified a priori based on associations with both abruption⁷ and preeclampsia⁸ and included maternal age (<25, 25–29, 30–34, or 35 years), parity (1 or 2), smoking during pregnancy (yes or no), chronic hypertension (yes or no) and pre-existing diabetes (yes or no). A history of preeclampsia was assessed as a potential confounder in both preterm and term models. Year of birth was also added to regression models to account for the frequency matching, but estimates did not change and it was omitted from the models.

We also examined the associations between abruption (at preterm or term gestations) and subsequent preeclampsia risk based on whether women had preeclampsia in her previous pregnancies. Births were categorized as (i) preterm abruption with preeclampsia; (ii) preterm abruption without preeclampsia; (iii) term abruption with preeclampsia; and (iv) term abruption without preeclampsia. Women with no prior abruption and no history of preeclampsia were used as the referent group.

An analysis stratified on interpregnancy interval was performed after restricting the data to women whose most recent pregnancy outcome prior to the study pregnancy was a birth (stillbirth or live birth). Data on the immediately preceding birth (1987–2010) were collected from the MBR. Information on the preceding delivery was obtained for 96% of women. Interpregnancy interval was calculated as the time between the date of the immediately preceding birth and the date of the last menstrual period for the current pregnancy and categorized as <3 years or 3 years, due to the association between intervals 3 years and an increased risk of preeclampsia among multiparous women.⁹

An analysis was conducted to assess whether the effect of prior abruption was associated with different effects based on timing of delivery of the preeclamptic pregnancy. Preeclampsia is a heterogeneous condition, with differing pathologies suspected in the development of early onset, defined as the onset of preeclampsia prior to 34 weeks gestation, and late onset disease.¹⁰ Timing of onset was either unavailable or potentially inaccurate, therefore we used preeclampsia with early delivery (<34 weeks) as a proxy for early-onset preeclampsia. A sensitivity analysis was performed using a cutoff of 35 weeks to capture preeclampsia cases that may have been early onset yet delivered after 34 weeks. Subjects with a missing gestational age at delivery were excluded from these analyses.

To assess the impact of outcome misclassification due to potential cases included in the control group, a sensitivity analysis removing those with hypertension or hospitalization due to hypertension in pregnancy was conducted.

The statistical analyses were performed using SAS 9.3 software (SAS Institute, Cary NC).

Results

A total of 6,487 cases of preeclampsia occurred among multiparous women yielding an overall prevalence of 1.3% from 1996 to 2010. Compared to controls, preeclampsia cases were more likely to be ≥35 years old and overweight or obese prior to pregnancy. Cases were more likely to have ≥20 prenatal visits and a history of preeclampsia. Pre-existing conditions, including hypertension and diabetes, were also more prevalent among cases (Table 1).

Placental abruption in any prior pregnancy was more common among preeclampsia cases than controls (1.0% vs. 0.5%; Table 2). This difference was driven by preterm placental abruption with 0.7% of cases and 0.2% of controls having a prior preterm abruption (OR 2.2, 95% CI 1.5, 3.3). In contrast, term placental abruption was not associated with subsequent risk of preeclampsia. Additional adjustment for covariates and BMI (with missing BMI values imputed) did not change results. Restricting prior abruptions to only those occurring in the immediately preceding pregnancy yielded an increased odds ratio of 2.8 for the association between preterm abruption and preeclampsia. The estimate for term placental abruption remained unchanged.

The association of abruption on subsequent odds of preeclampsia differed based on history of preeclampsia. Preterm abruption with a history of preeclampsia was associated with a 16-fold increased risk of preeclampsia (OR 16.6, 95% CI 5.3, 51.4). Among women without a history of preeclampsia, this association was reduced to a two-fold increase. The odds ratio for term abruption and history of preeclampsia was 2.1 (95% CI 1.3, 3.4), which attenuated to 1.4 (95% CI 0.8, 2.3) for those without a history of preeclampsia (Table 3).

Of the 32,435 deliveries included in this analysis, data on the preceding delivery in the MBR was available for 31,035 women (96%). Among them, 26,587 (86%) had a live birth or stillbirth immediately before the study pregnancy, 3132 (10%) had a spontaneous abortion, and 1316 (4%) had an induced abortion between deliveries. Of those with an immediately preceding birth, the associations between placental abruption and preeclampsia differed based on interpregnancy interval. Among women with an interpregnancy interval <3 years, preterm abruption was associated with an increase in the odds of preeclampsia (OR 3.6, 95% CI 1.7, 7.7), but not for term abruption (OR 0.9, 95% CI 0.3, 2.6), although this estimate was based on just six cases. Among those with an interpregnancy interval ≥3 years, the odds ratios for preterm and term abruption were 2.1 and 1.7, respectively, for preeclampsia (Table 4).

Approximately 10% (n=676) of preeclampsia cases were delivered before 34 weeks' gestation. Compared to cases delivered at ≥34 weeks, they were more likely to be ≥35 years old and multiparous. They were also more likely to have a history of preeclampsia (20% vs. 16%). Preterm abruption was more strongly associated with preeclampsia with early delivery (OR 4.3, 95% CI 2.0, 9.0) than preeclampsia without early delivery (OR 2.0 95% CI 1.3, 3.2). There was no association between prior term abruption and subsequent preeclampsia without early delivery (OR 1.0, 95% CI 0.6, 1.8) (Table 5). Results were similar using a 35-week definition (data not shown).

After removing 17% (n=1088) of cases and 3% (n=817) of controls with history of preeclampsia, the odds ratios for preterm and term abruption with incident preeclampsia were 2.0 (95% CI 1.3, 3.3) and 1.4 (95% CI 0.8, 2.4), respectively, which are similar to the results of the primary analysis. The results of a sensitivity analysis, which restricted controls to those without hospitalization due to hypertension in pregnancy, were also fairly similar.

Comment

Placental abruption was associated with increased odds of preeclampsia in a subsequent pregnancy. Our findings are similar to a prior study in the United States reporting an approximate two-fold increased risk of preeclampsia for placental abruption.³ Upon distinguishing between preterm and term placental abruptions, the increased risk of preeclampsia was confined to preterm placental abruption. To our knowledge this is the first study to distinguish between preterm and term abruptions. Studies of preeclampsia as a risk factor for abruption have distinguished between early-onset and late-onset preeclampsia and similarly reported larger relative risks (RR) of placental abruption for early-onset preeclampsia (RR 2.3 and 2.4) than for late-onset preeclampsia (RR 1.3).^{11,12} It has been suggested that preterm and term placental abruption are heterogeneous conditions, with differing risk profiles and pathologies.⁵ In addition to events preceding abruption, we demonstrated that events following abruption, specifically preeclampsia, differ by whether or not the placental abruption was preterm or term.

In addition to the gestational timing of abruption, the gestational timing of preeclampsia also altered associations. There is accumulating evidence that early-onset preeclampsia and late-onset preeclampsia represent distinct conditions, with early-onset being more severe and having a larger genetic component.^{10,13} The association between abruption and preeclampsia was most notable when both the abruption and preeclampsia occurred early in gestation. Using a definition of <34 weeks, preterm placental abruption was associated with a four-fold increased risk of preeclampsia with early delivery. While no other studies have explored the relationship between preterm abruption and preeclampsia with early delivery, recurrence rates of preeclampsia are highest when both preeclampsia events are early-onset.^{14–15}

Placental abruption and preeclampsia are both considered conditions in the syndrome of IPD. Recurrence within and across conditions of IPD has been well established,^{1,3} therefore we explored the joint effect of abruption and preeclampsia in a prior pregnancy on the risk of subsequent preeclampsia. A history of preterm abruption coupled with preeclampsia increased the risk of preeclampsia to approximately 16-fold, which was much higher than expected under an additive model of the effects of placental abruption and preeclampsia alone, indicating biologic interaction between these two events and the risk of preeclampsia. Term abruption, in the absence of other conditions of IPD, was not associated with preeclampsia.

In this study the presence of abruption at term was not associated with preeclampsia, providing support for theories suggesting that IPD is more homogeneous among preterm gestations.^{1,16} We hypothesized that term abruptions, which are less homogeneous with

respect to IPD, may reduce the risk of subsequent preeclampsia through endometrial injury. Endometrial injury has been shown to improve the invasion potential of trophoblastic cells,¹⁷ potentially through an inflammatory response that promotes improved implantation.^{18,19} Term abruptions were not associated with a reduced risk of preeclampsia in our study, except among those with shorter interpregnancy intervals (<3 years). Although this estimate was imprecise, it suggests that if there is any reduction in risk of preeclampsia due to term abruption the effect may be short-term and transient, yet research exploring such a mechanism is needed. We were unable to evaluate interpregnancy intervals using categorizations greater than 3 years due to small numbers.

The prevalence of preeclampsia among multiparous women in Finland is 1.3%. This is similar to estimates from Sweden reporting 1.7% among multiparous women¹⁴ and Norway reporting 1.4% among second pregnancies in women without a history of preeclampsia,¹⁵ but less than the 2.8% observed among multiparous women in the United States.²⁰ Differences in rates of preeclampsia may be due to differences in risk factor prevalence or diagnostic and recording practices. It is possible that the recording of preeclampsia diagnoses is poorer for stillbirths, which were included in the present study. While the specificity of preeclampsia diagnostic codes recorded in hospital discharge datasets is approximately 90%, the sensitivity is less accurate (70–88%) introducing the possibility that deliveries affected by preeclampsia were selected as controls.^{21,22} A sensitivity analysis excluding women that were hospitalized for hypertension in pregnancy yielded results that were largely similar to the overall findings, indicating that outcome misclassification was not a large source of bias.

Diagnostic bias is of potential concern due to the possibility that women with prior pregnancy complications such as placental abruption may be followed more closely in subsequent pregnancies for the development of preeclampsia. In Finland access to prenatal care is universal and frequent. In 2011, 99.7% of women in Finland received care with an average first visit at 9 weeks gestation and an average of 16 visits through the course of pregnancy.^{23,24} Therefore we would expect the potential for diagnostic bias to be greatly reduced since nearly all women are closely monitored during pregnancy, regardless of obstetrical history.

Another potential source of error is that involving misclassification of placental abruption timing by using the delivery date as a proxy for onset date of placental abruption. Abruption is most frequently considered an obstetrical emergency, therefore delivery is likely a suitable marker for onset. In addition to onset date, characterization of placental abruption by accompanying obstetric conditions (i.e. premature rupture of the membranes) was not performed. Placental abruption can be a heterogeneous condition with some presentations suggested to reflect a more ischemic state. By including all cases of placental abruption associations between specific characterizations of abruption and preeclampsia may have been underestimated. The possibility of missed or inaccurate diagnoses of placental abruption should also be considered. Lastly, incomplete information on spontaneous abortions is likely. We included data from the HDR and maternal self-report to improve ascertainment of history of spontaneous abortion, but early losses, especially those among pregnancies not yet clinically recognized would have been missed.²⁵ While this limitation

did not impact our overall findings, interpregnancy intervals may have been slightly overestimated among women with missed spontaneous abortions between pregnancies.

A strength of this study is use of the Finnish registry data. Data on both exposure and outcome as well as several covariate data were ascertained from the HDR and MBR and therefore eliminated reliance on self-reported data. Data in both the HDR and MBR has been validated and the recording of variables has generally been good, with positive predictive values of at least 90% for many outcomes in the HDR and more than 99% for variables in the MBR.^{26–28} The use of multiple imputation for a large proportion of missing BMI data was justified due to the quality of existing variables. Additional strengths of this study included a large sample size, control for several covariates, and data linkages with unique personal identity codes available in all Finnish registers. Lastly, data on the prior birth was available for 96% of women, allowing for the ability to capture information on prior abruption for virtually all preeclampsia cases and controls.

In conclusion, preterm placental abruption is associated with an increased risk of preeclampsia in a subsequent pregnancy. Associations were most pronounced among women with a history of IPD in addition to abruption and among cases of preeclampsia with early delivery. In contrast, term abruption, which is less homogenous with respect to IPD, was not associated with subsequent preeclampsia. Our findings support the notion that IPD may be a syndrome of preterm gestations. Clinical implications may include different recommendations for the monitoring and treatment of subsequent pregnancies based on the presence of IPD and timing of delivery of a prior pregnancy. Future work is needed to corroborate our findings and better characterize conditions of IPD.

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Table 1

Distribution of Selected Characteristics of Preeclampsia Cases and Controls, Medical Birth Register of Finland, 1996–2010

	Preeclampsia Cases (n=6,487)		Controls (n=25,948)	
	n	%	n	%
Year of birth				
1996–2000	1,726	26.6	6,904	26.6
2001–2005	2,238	34.5	8,952	34.5
2005–2010	2,523	38.9	10,092	38.9
Maternal age (years)				
<25	496	7.6	2,802	10.8
25–29	1,518	23.4	7,383	28.5
30–34	2,303	35.5	9,305	35.9
35	2,170	33.5	6,458	24.9
Previous deliveries				
1	3,834	59.1	14,758	56.9
2	2,653	40.9	11,190	43.1
Body-mass index (kg/m ²) ^a				
Underweight (<18.5)	51	1.4	441	3.1
Normal (18.5–24.9)	1,411	40.0	8,048	57.0
Overweight (25.0–29.9)	895	25.3	3,043	21.5
Obese (≥ 30.0)	861	24.4	1,609	11.4
Unknown	313	8.9	983	7.0
Socioeconomic status based on maternal occupation during pregnancy				
Upper white-collar	953	14.7	4,252	16.4
Lower white-collar	2,735	42.2	9,808	37.8
Blue collar	1,038	16.0	4,061	15.7
Other ^b	582	9.0	2,660	10.3
Unknown	1,179	18.2	5,167	19.9
Prenatal visits				
<15	1,633	25.2	10,290	39.7
15–19	2,257	34.8	10,511	40.5
20	2,445	37.7	4,726	18.2
Unknown	152	2.3	421	1.6
Smoked during pregnancy				
Yes	736	11.3	3,351	12.9
No	5,547	85.6	21,828	84.1
Missing	204	3.1	769	3.0
History of preeclampsia ^c	1,088	16.8	817	3.1
Chronic hypertension ^c	250	3.9	187	0.7
Pre-existing diabetes ^c	140	2.2	116	0.4

^a Available beginning in 2004

^b Other includes entrepreneur, farmer, unemployed, self-employed, and housemother

^c Ascertained from 1987–2010

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Table 2

Association between Prior Placental Abruption and Preeclampsia

Prior Placental Abruption	Preeclampsia Cases (n=6,487) n (%)	Control (n=25,948) n (%)	Odds Ratio (95% Confidence Interval) for Preeclampsia		
			Unadjusted	Adjusted ^b	Adjusted ^c
Any previous pregnancy ^a	67 (1.0)	140 (0.5)	1.9 (1.4, 2.6)	1.7 (1.2, 2.3)	1.7 (1.2, 2.3)
Preterm (<37 weeks)	43 (0.7)	64 (0.2)	2.7 (1.8, 4.0)	2.2 (1.5, 3.3)	2.2 (1.4, 3.4)
Term (≥ 37 weeks)	22 (0.3)	73 (0.3)	1.2 (0.8, 2.0)	1.1 (0.7, 1.8)	1.1 (0.7, 1.7)
Immediate prior pregnancy ^a	45 (0.7)	84 (0.3)	2.2 (1.5, 3.1)	1.9 (1.3, 2.8)	1.9 (1.3, 2.9)
Preterm (<37 weeks)	31 (0.5)	36 (0.1)	3.5 (2.1, 5.6)	2.8 (1.7, 4.7)	2.8 (1.6, 4.8)
Term (≥ 37 weeks)	13 (0.2)	47 (0.2)	1.1 (0.6, 2.1)	1.1 (0.6, 2.1)	1.1 (0.6, 2.2)
No prior abruption	6,420 (99.0)	25,808 (99.5)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)

^a Previous placental abruption ascertained from 1987–2010^b Adjusted for history of preeclampsia^c Adjusted for maternal age, parity, BMI (with imputation), smoking during pregnancy, history of preeclampsia, chronic hypertension, and preexisting diabetes

Table 3

Associations between Placental Abruption in a previous pregnancy with and without a History of Preeclampsia, and Preeclampsia

Prior Placental Abruption and Prior Preeclampsia	Preeclampsia cases (n=6,487) n (%)	Controls (n=25,948) n (%)	Odds Ratio (95% Confidence Interval) for Preeclampsia	
			Unadjusted	Adjusted ^a
Preterm abruption				
Preeclampsia	17 (0.3)	4 (0.0)	19.9 (6.7, 59.0)	16.6 (5.3, 51.4)
No preeclampsia	26 (0.4)	60 (0.2)	2.0 (1.3, 3.2)	2.1 (1.3, 3.4)
Term abruption				
Preeclampsia	3 (0.0)	6 (0.0)	2.4 (0.6, 9.4)	2.1 (0.5, 9.1)
No preeclampsia	19 (0.3)	67 (0.3)	1.3 (0.8, 2.2)	1.4 (0.8, 2.3)
No prior abruption but preeclampsia only	1,068 (16.5)	807 (3.1)	6.2 (5.6, 6.8)	5.6 (5.1, 6.2)
No prior abruption or preeclampsia	5,352 (82.5)	25,001 (96.4)	1.0 (Reference)	1.0 (Reference)

^a Adjusted for maternal age, parity, smoking during pregnancy, imputed BMI, chronic hypertension and preexisting diabetes

Table 4

Odds Ratios for the Association between Placental Abruption and Preeclampsia, Stratified by Interpregnancy Interval, Prior Birth Only

Interpregnancy interval	Preeclampsia Cases (n=5,030) n (%)	Controls (n=21,492) n (%)	Odds Ratio (95% Confidence Interval) for Preeclampsia		
			Unadjusted	Adjusted ^a	Adjusted ^b
<3 years					
Preterm placental abruption	17 (0.3)	19 (0.1)	4.5 (2.3, 8.7)	3.4 (1.7, 7.0)	3.6 (1.7, 7.7)
Term placental abruption	5 (0.1)	28 (0.1)	0.9 (0.4, 2.3)	0.9 (0.3, 2.4)	0.9 (0.3, 2.6)
No abruption	3,074 (61.1)	15,463 (71.9)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)
3 years					
Preterm placental abruption	10 (0.2)	13 (0.1)	2.4 (1.1, 5.5)	2.1 (0.9, 4.9)	2.1 (0.9, 5.2)
Term placental abruption	6 (0.1)	11 (0.1)	1.7 (0.6, 4.6)	1.8 (0.6, 4.8)	1.7 (0.6, 5.0)
No abruption	1,918 (38.1)	5,958 (27.7)	1.0 (Reference)	1.0 (Reference)	1.0 (Reference)

^a Adjusted for history of preeclampsia

^b Adjusted for maternal age, parity, smoking during pregnancy, history of preeclampsia, and preexisting hypertension or diabetes, imputed BMI

Table 5

Association between Placental Abruption and Preeclampsia with and without Early Delivery using a Definition of 34 weeks

Placental Abruption	Controls (n=25,918) n (%)	Preeclampsia with Early Delivery (<34 weeks)		Preeclampsia without Early Delivery (≥ 34 weeks)	
		Cases (n=676) n (%)	Odds Ratio (95% confidence interval)	Cases (n=5,803) n (%)	Odds Ratio (95% confidence interval)
Any previous pregnancy ^a	140 (0.5)	15 (2.2)	3.0 (1.6, 5.4)	52 (0.9)	1.5 (1.1, 2.2)
Preterm (<37 weeks)	64 (0.2)	11 (1.6)	4.3 (2.0, 9.0)	32 (0.6)	2.0 (1.3, 3.2)
Term (≥ 37 weeks)	73 (0.3)	4 (0.6)	1.8 (0.6, 5.2)	18 (0.3)	1.0 (0.6, 1.8)
No previous abruption	25,778 (99.5)	661 (97.8)	1.0 (Reference)	5,751 (99.1)	1.00 (Reference)

^aPrevious placental abruption ascertained from 1987–2010.

Odds ratios are adjusted for maternal age, parity, smoking during pregnancy, history of preeclampsia, imputed BMI, chronic hypertension and preexisting diabetes.