BJOG: An International Journal of Obstetrics & Gynaecology

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BJOG An International Journal of Obstetrics and Gynaecology

RESEARCH ARTICLE OPEN ACCESS

Outcomes of Postpartum Preeclampsia: A Retrospective Cohort Study of 1.3 Million Pregnancies

Sam Amar[1] | Brian J. Potter[2,3] | Gilles Paradis[4,5] | Antoine Lewin[6] | Amanda Maniraho[2,4] | Émilie Brousseau[2,4] | Nathalie Auger[2,4]

[1]Faculty of Medicine, McGill University, Montreal, Quebec, Canada | [2]University of Montreal Hospital Research Centre, Montreal, Quebec, Canada | [3]Division of Cardiology, Department of Medicine, University of Montreal, Montreal, Quebec, Canada | [4]Institut national de santé publique du Québec, Montreal, Quebec, Canada | [5]Department of Epidemiology, Biostatistics and Occupational Health, McGill University, Montreal, Quebec, Canada | [6]Medical Affairs and Innovation, Hema-Quebec, Montreal, Quebec, Canada

Correspondence: Nathalie Auger (nathalie.auger@inspq.qc.ca)

Received: 25 July 2024 | **Revised:** 4 November 2024 | **Accepted:** 19 November 2024

Funding: This work was external peer reviewed and awarded by the Heart and Stroke Foundation of Canada [grant number G-22-0031974] and the Fonds de recherche du Québec-Santé [grant number 296785]. The study sponsors were not involved in conducting research and writing the paper.

Keywords: hypertension | placental abruption | postpartum period | preeclampsia | pregnancy outcome | premature birth

ABSTRACT

Objective: We assessed the association between postpartum preeclampsia and the risk of adverse maternal and neonatal outcomes. Evidence suggests that postpartum preeclampsia is initiated antenatally, but the impact on birth outcomes is unclear.

Design: Retrospective cohort study.

Setting: All deliveries in hospitals of Quebec, Canada.

Population: 1 317 181 pregnancies between 2006 and 2022.

Methods: We identified patients who developed preeclampsia in the postpartum period. Using log-binomial regression models, we estimated adjusted risk ratios (RR) and 95% confidence intervals (CI) for the association of postpartum or antepartum preeclampsia with adverse pregnancy outcomes relative to no preeclampsia.

Main Outcome Measures: Preterm birth, placental abruption, severe maternal morbidity and recurrent preeclampsia.

Results: Postpartum preeclampsia was less frequent than antepartum preeclampsia ($n = 4123$ [0.3%] vs. 51 269 [3.9%]). Postpartum preeclampsia was associated with preterm birth (RR 1.45, 95% CI 1.34–1.57), placental abruption (RR 1.36, 95% CI 1.16–1.59) and severe maternal morbidity (RR 6.48, 95% CI 5.87–7.16) compared with no preeclampsia. Antepartum preeclampsia was also associated with these outcomes. Moreover, patients with postpartum preeclampsia in a first pregnancy were at risk of adverse outcomes in a subsequent pregnancy, particularly recurrent preeclampsia (RR 7.77, 95% CI 6.54–9.23).

Conclusions: Postpartum preeclampsia is associated with adverse outcomes at delivery, despite being detected only postnatally. Our findings suggest that patients with adverse birth outcomes may benefit from blood pressure measurements up to 6 weeks following delivery.

1 | Introduction

Preeclampsia is a leading cause of maternal and perinatal morbidity [1], but little is known about the consequences of preeclampsia that develops in the postpartum period. Preeclampsia affects 3%–5% of pregnancies and is characterised by a new onset of hypertension with proteinuria or other evidence of maternal organ or uteroplacental dysfunction after

Linked article: This article is commented on by Conti-Ramsden et al., pp. 760–761 in this issue. To view this article visit https://doi.org/10.1111/1471-0528.18056.

20 weeks of gestation [2]. Maternal consequences of preeclampsia include cerebrovascular bleeding, eclampsia, respiratory distress syndrome, disseminated intravascular coagulation and renal failure [3, 4]. Adverse neonatal outcomes associated with preeclampsia include preterm birth, stillbirth, low birth weight and intrauterine growth restriction [5, 6]. However, few studies have investigated these outcomes in the setting of postpartum preeclampsia, even though evidence suggests that the underlying physiological mechanisms are initiated antenatally [7, 8].

As many as 6% of cases of preeclampsia occur postpartum [9]. There is no consensus on the definition of postpartum preeclampsia, although hypertension can arise in the immediate postpartum period (< 48 h) or between 48 h and 6 weeks following delivery [10]. Prior research has mostly focused on identifying risk factors such as older maternal age, Black race and obesity [10, 11], or clarifying the clinical presentation of postpartum preeclampsia [10, 12]. While most patients are thought to have self-limited symptoms such as headache, abnormal vision, nausea and occasionally seizures [10, 12], data are beginning to suggest that adverse outcomes may be more frequent than previously understood. A retrospective study of 184 patients from the US found that foetal growth restriction, placental abruption and caesarean delivery were just as frequent among patients with postpartum preeclampsia as patients with antenatal preeclampsia [12]. We examined the maternal and neonatal outcomes of patients who developed postpartum preeclampsia using data from a large cohort of patients in Canada.

2 | Methods

2.1 | Study Design and Population

We carried out a retrospective cohort study of 1 317 181 in-hospital deliveries in Quebec, Canada, between April 1, 2006 and March 31, 2022 (Figure S1). We extracted the data from the Maintenance and Use of Data for the Study of Hospital Clientele registry, which includes 98% of deliveries in Quebec, including subsequent readmissions of mothers and neonates [13]. Data on exposures, outcomes and covariates are obtained from antenatal, delivery and neonatal charts. Clinical diagnoses are documented using codes from the 10th revision of the International Classification of Diseases for Canada (ICD-10-CA), while procedures are coded with the Canadian Classification of Health Interventions. Hospital records are rigorously validated and have high agreement with medical charts [14]. We excluded mothers with invalid patient identifiers who could not be followed over time.

2.2 | Preeclampsia

The main exposure measure was postpartum preeclampsia, defined as inpatient or outpatient hypertension (140/90 mmHg) with new onset of proteinuria or end-organ dysfunction after delivery and up to 42 days postpartum [9]. We identified preeclampsia diagnosed in the postnatal ward or upon readmission for symptoms developing up to 42 days after delivery using ICD-10-CA codes. We included new-onset postpartum preeclampsia among patients with no prior history of antepartum preeclampsia. The ICD-10 documents preeclampsia by means of a diagnostic code regardless of onset time. In the ICD-10-CA, the onset is noted through an additional digit at the end of the code that specifies the timing in the postnatal ward or during readmissions (Figure S2). However, we could not determine if the onset of postpartum preeclampsia occurred within 48 h of delivery or later. We included antepartum preeclampsia as an additional comparison group in this study [15, 16].

We used the ICD-10-CA to assess the severity of preeclampsia (mild; severe; superimposed). Mild preeclampsia corresponded to hypertension under 160/110 mmHg [17]. Severe preeclampsia included patients with hypertension levels at or above 160/110 mmHg or with eclampsia or HELLP syndrome (haemolysis, elevated liver enzymes, low platelets) [16]. Superimposed preeclampsia included preexisting chronic hypertension (140/90 mmHg) with new onset of proteinuria or end-organ dysfunction.

2.3 | Birth Outcomes

We examined the following maternal outcomes at delivery [18]: placental abruption, placenta praevia, antepartum haemorrhage, postpartum haemorrhage, caesarean delivery and severe maternal morbidity (embolism or shock; cardiac, renal and cerebrovascular complications; severe haemorrhage; hysterectomy; surgical complication; intensive care unit admission; assisted ventilation; other) [19] (Table S1).

We also assessed adverse outcomes in the newborn, including preterm birth (< 37 weeks of gestation), congenital anomalies, jaundice, sepsis and complications of prematurity (respiratory distress syndrome; bronchopulmonary dysplasia; necrotising enterocolitis; intracranial haemorrhage; retinopathy of prematurity) (Table S1) [19].

2.4 | Covariates

We accounted for factors that could potentially affect the relationship between preeclampsia and birth outcomes, including maternal age (< 25; 25–34; ≥ 35 years), parity (0; 1; ≥ 2 previous deliveries), comorbidity (gestational or preexisting diabetes; preexisting dyslipidaemia; obesity; antiphospholipid syndrome; systemic lupus erythematosus; use of assisted reproductive techniques), substance use disorders (tobacco; alcohol; other substance), multiple birth (yes; no), socioeconomic disadvantage (yes; no; unknown), place of residence (rural; urban; unknown) and time period (2006–2011; 2012–2016; 2017–2022). Socioeconomic disadvantage corresponded to the most deprived quintile of an index derived from census data measuring neighbourhood-level income, employment rates and education levels [20]. We placed patients with missing data on socioeconomic disadvantage and rurality in separate categories for analysis.

2.5 | Data Analysis

We began by examining patient characteristics, the frequency of antepartum and postpartum preeclampsia, and the rate of adverse birth outcomes per 1000 deliveries. In primary analyses,

we estimated risk ratios (RR) and 95% confidence intervals (CI) for each outcome using log-binomial regression models, comparing postpartum and antepartum preeclampsia against no preeclampsia. We adjusted the models for maternal age, parity, comorbidity, substance use disorders, multiple birth, socioeconomic disadvantage, place of residence and time period as categorical variables. We used generalised estimating equations with robust error estimators to account for women who had more than one pregnancy during the study.

In secondary analyses, we examined whether postpartum preeclampsia at a first pregnancy was associated with adverse outcomes at a second pregnancy. We also restricted the analysis to patients that had a second delivery and determined if postpartum preeclampsia was associated with the recurrence of postpartum preeclampsia, occurrence of antepartum preeclampsia or occurrence of other adverse outcomes at the second pregnancy.

In sensitivity analyses, we examined postpartum preeclampsia that was detected prior to discharge separately from postpartum preeclampsia requiring readmission. We performed the analysis using SAS version 9.4 (SAS Institute Inc., Cary, NC). The data were anonymised and the study conformed to the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans. As informed consent was not needed, the University of Montreal Hospital Centre institutional review board waived ethics review. Patients were not involved in the development of this research. A core outcome set was not used in this research.

3 | Results

In this study of 1 317 181 deliveries between 2006 and 2022, 4123 (0.3%) patients developed postpartum preeclampsia and 51 269 (3.9%) antepartum preeclampsia (Table 1). Mean gestational age was 38.1 weeks (SD 2.2) for patients with postpartum preeclampsia, compared with 37.3 weeks (SD 2.6) for antepartum and 38.8 weeks (SD 2.0) for no preeclampsia. Patients with postpartum preeclampsia were more likely to be aged 35 years or more (32.5%) compared with antepartum (21.5%) and no preeclampsia (18.8%). Patients with postpartum preeclampsia were also more likely to have multiple pregnancies (12.9%) than patients with antepartum (8.8%) and no preeclampsia (2.8%). Patients with readmissions for postpartum preeclampsia presented an average of 6.5 days after delivery (SD 3.7). Patients with preeclampsia detected in the postnatal ward had an average length of stay of 5.1 days (SD 5.2), while patients who required readmission had an initial length of stay of 2.8 days (SD 2.5) after delivery.

Postpartum preeclampsia was associated with adverse maternal outcomes at the preceding delivery, with many of the associations comparable to those for antepartum preeclampsia (Table 2). Relative to no preeclampsia, patients with postpartum preeclampsia were more likely to have had placental abruption (RR 1.36, 95% CI 1.16–1.59) and postpartum haemorrhage (RR 1.48, 95% CI 1.36–1.61). Antepartum preeclampsia was also associated with these outcomes. In some cases, postpartum preeclampsia was an even stronger determinant of adverse outcomes than antepartum preeclampsia. For example, postpartum preeclampsia was strongly associated with severe maternal morbidity (RR 6.48, 95% CI 5.87–7.16) and antepartum haemorrhage (RR 1.30, 95% CI 1.13–1.51) compared with no preeclampsia. Antepartum preeclampsia was associated with these outcomes but to a lesser extent.

Neonates of mothers with postpartum preeclampsia also had an increased risk of adverse outcomes at birth (Table 3). Compared with no preeclampsia, postpartum preeclampsia was associated with preterm birth (RR 1.45, 95% CI 1.34–1.57) and congenital anomalies (RR 1.15, 95% CI 1.03–1.28). However, the magnitude of associations was not as great as for antepartum preeclampsia.

Mild, severe and superimposed variants of postpartum preeclampsia were all associated with adverse delivery outcomes (Table 4). For some outcomes, however, associations were stronger with severe forms of preeclampsia. Compared with no preeclampsia, severe postpartum preeclampsia was associated with placental abruption (RR 2.03, 95% CI 1.47–2.79), while mild postpartum preeclampsia was not associated with this outcome. Severe postpartum preeclampsia was particularly associated with postpartum haemorrhage (RR 2.61, 95% CI 2.23–3.06) and severe maternal morbidity (RR 21.71, 95% CI 19.21–24.54). Mild (RR 4.45, 95% CI 3.82–5.20) and superimposed postpartum preeclampsia (RR 4.44, 95% CI 2.55–7.74) were also associated with severe maternal morbidity.

Patients with postpartum preeclampsia in a first pregnancy were at risk of adverse outcomes in the next pregnancy (Table S2). Compared with no preeclampsia, postpartum preeclampsia in a first pregnancy was associated with the recurrence of postpartum preeclampsia (RR 26.22, 95% CI 20.21–34.01), as well as the occurrence of antepartum preeclampsia at the next pregnancy (RR 4.76, 95% CI 3.76–6.02). Postpartum preeclampsia was particularly associated with severe maternal morbidity at the next pregnancy (RR 2.80, 95% CI 2.01–3.90), although it was not clear if the associations were due to the recurrence of preeclampsia. Antepartum preeclampsia was just as strongly associated with these outcomes. Patients with postpartum or antepartum preeclampsia were neither more nor less likely to have a second pregnancy.

In sensitivity analyses, patients with postpartum preeclampsia detected during the delivery admission were just as likely to have adverse birth outcomes as patients with postpartum preeclampsia requiring readmission, although we could not distinguish cases that developed within 48 h of delivery from cases that developed later (Table S3).

4 | Discussion

4.1 | Main Findings

In this cohort study of 1.3 million deliveries, postpartum preeclampsia detected up to 42 days after delivery was associated with consistently elevated risks of adverse maternal and neonatal outcomes. Compared with no preeclampsia, patients with postpartum preeclampsia were more likely to have severe obstetric complications at delivery, including placental abruption, postpartum haemorrhage and other complications. Postpartum preeclampsia was not only associated with the likelihood of morbidity at birth and during maternity, but also adverse outcomes

TABLE 1 | Characteristics of patients with and without preeclampsia.

	No. deliveries (%)		
	Antepartum preeclampsia (*N* = 51 269)	**Postpartum preeclampsia (*N* = 4123)**	**No preeclampsia (*N* = 1 261 789)**
Age at first pregnancy, years			
< 25	8657 (16.9)	386 (9.4)	185 294 (14.7)
25–34	31 594 (61.6)	2396 (58.1)	838 660 (66.5)
≥ 35	11 018 (21.5)	1341 (32.5)	237 835 (18.8)
Parity			
0	34 626 (67.5)	2459 (59.6)	609 865 (48.3)
1	10 817 (21.1)	1039 (25.2)	440 785 (34.9)
≥ 2	5826 (11.4)	625 (15.2)	211 139 (16.7)
Comorbidity			
Any	8070 (15.7)	611 (14.8)	81 236 (6.4)
Gestational/preexisting diabetes	1480 (2.9)	101 (2.4)	8457 (0.7)
Dyslipidaemia	135 (0.3)	11 (0.3)	1172 (0.1)
Obesity	4995 (9.7)	324 (7.9)	48 183 (3.8)
Antiphospholipid syndrome	68 (0.1)	< 5	1177 (0.1)
Systemic lupus erythematosus	86 (0.2)	6 (0.1)	885 (0.1)
Assisted reproductive technique[a]	2132 (4.2)	217 (5.3)	25 581 (2.0)
Substance use disorder	1476 (2.9)	95 (2.3)	30 791 (2.4)
Multiple birth			
Yes	4514 (8.8)	531 (12.9)	35 322 (2.8)
No	46 755 (91.2)	3592 (87.1)	1 226 467 (97.2)
Socioeconomic disadvantage			
Yes	11 591 (22.6)	963 (23.4)	254 205 (20.1)
No	37 539 (73.2)	2959 (71.8)	951 373 (75.4)
Place of residence			
Rural	10 155 (19.8)	541 (13.1)	227 747 (18.0)
Urban	40 404 (78.8)	3512 (85.2)	1 012 280 (80.2)

[a]Deliveries from 2008 to 2022.

at a subsequent pregnancy. Moreover, postpartum preeclampsia was just as strongly and sometimes more strongly associated with adverse outcomes than antepartum preeclampsia. Our findings suggest that postpartum preeclampsia is a risk factor for obstetric morbidity even though cases are detected only after delivery. Postpartum preeclampsia may be just as harmful and possibly represent the same disease process as antepartum preeclampsia.

4.2 | Strengths and Limitations

We used a validated data set, but misclassification of exposures and outcomes may nevertheless have diluted the difference between groups and underestimated the risk ratios. We adjusted for potential confounders but did not have information on ethnicity and medication use. We could not account for the use of assisted reproductive techniques during the first 2 years of the study. We did not know the exact body mass index of patients with obesity. We could not rule out the possibility that patients with adverse birth outcomes had closer blood pressure monitoring after delivery compared with patients who had normal deliveries, although all postpartum patients have routine blood pressure screening in hospital. We could not determine the exact time of onset for preeclampsia detected in the postnatal ward or distinguish immediate versus delayed onset postpartum preeclampsia. Although 98% of deliveries occur in hospital [13], patients with healthy pregnancies who developed preeclampsia

TABLE 2 | Association between postpartum preeclampsia and adverse maternal outcomes.

	No. deliveries (rate per 1000)			Risk ratio (95% CI)[a]	
	Antepartum preeclampsia (*N* = 51 269)	Postpartum preeclampsia (*N* = 4123)	No preeclampsia (*N* = 1 261 789)	Antepartum preeclampsia	Postpartum preeclampsia
Placental abruption	1695 (33.1)	163 (39.5)	32 693 (25.9)	1.25 (1.19–1.31)	1.36 (1.16–1.59)
Placental praevia	246 (4.8)	34 (8.2)	9003 (7.1)	0.64 (0.56–0.73)	0.95 (0.68–1.33)
Antepartum haemorrhage	1885 (36.8)	189 (45.8)	38 948 (30.9)	1.16 (1.10–1.22)	1.30 (1.13–1.51)
Postpartum haemorrhage	6381 (124.5)	537 (130.2)	95 852 (76.0)	1.50 (1.47–1.54)	1.48 (1.36–1.61)
Caesarean delivery	20 241 (394.8)	1831 (444.1)	304 861 (241.6)	1.24 (1.23–1.26)	1.25 (1.20–1.29)
Severe maternal morbidity	4399 (85.8)	451 (109.4)	16 731 (13.3)	5.36 (5.17–5.56)	6.48 (5.87–7.16)

[a]Risk ratio for preeclampsia relative to no preeclampsia, adjusted for maternal age, parity, maternal comorbidity, substance use disorders, multiple birth, socioeconomic disadvantage, place of residence and time period.

TABLE 3 | Association between postpartum preeclampsia and adverse neonatal outcomes.

	No. infants (rate per 1000)			Risk ratio (95% CI)[a]	
	Antepartum preeclampsia (*N* = 51 269)	Postpartum preeclampsia (*N* = 4123)	No preeclampsia (*N* = 1 261 789)	Antepartum preeclampsia	Postpartum preeclampsia
Preterm birth	13 057 (254.7)	646 (156.7)	81 932 (64.9)	2.79 (2.74–2.85)	1.45 (1.34–1.57)
Congenital anomaly	3667 (71.5)	297 (72.0)	73 198 (58.0)	1.17 (1.13–1.21)	1.15 (1.03–1.28)
Neonatal jaundice	13 107 (255.7)	611 (148.2)	157 242 (124.6)	1.70 (1.67–1.73)	1.10 (1.02–1.19)
Neonatal sepsis	1788 (34.9)	161 (39.0)	27 086 (21.5)	1.28 (1.22–1.34)	1.39 (1.19–1.64)
Complication of prematurity	2753 (53.7)	123 (29.8)	18 672 (14.8)	2.61 (2.49–2.73)	1.24 (1.03–1.50)

[a]Risk ratio for preeclampsia relative to no preeclampsia, adjusted for maternal age, parity, maternal comorbidity, substance use disorders, multiple birth, socioeconomic disadvantage, place of residence and time period.

after delivery may not be included if they delivered in birthing centres or at home. Further data are needed to determine the extent to which gestational hypertension is a precursor to postpartum preeclampsia. The study design was observational, which prevented us from ascertaining causality. The findings should be interpreted with caution due to potential biases and limitations inherent in retrospective administrative data. The findings can likely be generalised to diverse populations with publicly funded health care, but may not apply to other settings.

4.3 | Interpretation

Postpartum preeclampsia is unique because symptoms are established upon placentation but appear only after delivery of the placenta. Yet, very little is known about the outcomes of patients with postpartum preeclampsia. Most research focuses on risk factors and clinical presentation, which tend to be similar to antepartum preeclampsia [8, 10, 11, 21]. The major difference between the two relates to the onset time of hypertension and related clinical manifestations, which are usually diagnosed before delivery in patients with antepartum preeclampsia but after delivery in patients with postpartum preeclampsia [10]. Because hypertension may be detected up to 6 weeks after delivery [10], prior research has not adequately investigated the possibility that adverse outcomes occurring at delivery or earlier could be related to preeclampsia.

Nevertheless, a number of studies are beginning to suggest that adverse birth outcomes may be prevalent in patients with postpartum preeclampsia [12, 22, 23]. An analysis of 20 000 women who were readmitted for postpartum hypertension or preeclampsia after a normotensive delivery in the US found that cerebrovascular disorders were frequent compared with patients who developed hypertension antenatally [22]. A retrospective study of 120 women reported that postpartum preeclampsia was associated with higher hospital readmission rates [23], while a study of 184 patients from a single centre demonstrated that placental abruption rates were as high as rates found in patients with antepartum preeclampsia [12]. However, these studies were small

TABLE 4 | Severity of postpartum preeclampsia and risk of adverse birth outcomes.

	Mild preeclampsia ($N=3261$)		Severe preeclampsia ($N=693$)		Superimposed preeclampsia ($N=169$)	
	No. events (%)	Risk ratio (95% CI)[a]	No. events (%)	Risk ratio (95% CI)[a]	No. events (%)	Risk ratio (95% CI)[a]
Maternal						
Placental abruption	113 (3.5)	1.22 (0.99–1.49)	41 (5.9)	2.03 (1.47–2.79)	9 (5.3)	1.76 (0.93–3.36)
Placental praevia	28 (0.9)	0.87 (0.57–1.34)	5 (0.7)	0.91 (0.37–2.20)	< 5	0.55 (0.08–3.87)
Antepartum haemorrhage	135 (4.1)	1.20 (1.00–1.44)	45 (6.5)	1.87 (1.38–2.53)	9 (5.3)	1.41 (0.74–2.68)
Postpartum haemorrhage	370 (11.3)	1.43 (1.29–1.59)	147 (21.2)	2.61 (2.23–3.06)	20 (11.8)	1.42 (0.94–2.16)
Caesarean delivery	1460 (44.8)	1.35 (1.29–1.41)	309 (44.6)	1.29 (1.16–1.43)	62 (36.7)	1.11 (0.91–1.35)
Severe maternal morbidity	204 (6.3)	4.45 (3.82–5.20)	235 (33.9)	21.71 (19.21–24.54)	12 (7.1)	4.44 (2.55–7.74)
Neonatal						
Preterm birth	402 (12.3)	1.19 (1.07–1.33)	215 (31.0)	1.97 (1.71–2.27)	29 (17.2)	1.81 (1.32–2.48)
Congenital anomaly	222 (6.8)	1.16 (1.02–1.33)	62 (8.9)	1.37 (1.07–1.76)	13 (7.7)	1.22 (0.73–2.06)
Neonatal jaundice	410 (12.6)	0.99 (0.90–1.10)	170 (24.5)	1.38 (1.18–1.61)	31 (18.3)	1.52 (1.08–2.13)
Neonatal sepsis	125 (3.8)	1.45 (1.20–1.77)	24 (3.5)	0.99 (0.64–1.52)	12 (7.1)	2.77 (1.55–4.94)
Complication of prematurity	81 (2.5)	1.13 (0.89–1.43)	31 (4.5)	1.31 (0.89–1.95)	11 (6.5)	2.65 (1.40–5.01)

[a]Risk ratio for preeclampsia relative to no preeclampsia, adjusted for maternal age, parity, maternal comorbidity, substance use disorders, multiple birth, socioeconomic disadvantage, place of residence and time period.

and could not examine other outcomes. Moreover, risks may be underestimated as postpartum preeclampsia was compared against antepartum preeclampsia, rather than a normotensive comparison group. In our study, postpartum preeclampsia was strongly associated with pregnancy complications compared with no preeclampsia, while associations were less pronounced for antepartum preeclampsia. The findings align with the possibility that adverse outcomes at delivery may be just as frequent or possibly even more frequent than in patients with antepartum preeclampsia.

Recent pathological studies suggest that postpartum preeclampsia may be initiated prenatally. A histological analysis of 60 patients found that levels of CD45+ immune cells were elevated in the placentas of women who eventually developed postpartum preeclampsia compared with no preeclampsia [7]. A retrospective study of 988 women with caesarean deliveries found that pro- and antiangiogenic factors were imbalanced in the intrapartum blood samples of 184 patients who subsequently developed postpartum hypertension [8]. Although the study could not confirm that patients had preeclampsia [8], the results support the possibility that postpartum hypertensive disorders are initiated prenatally.

The likelihood of a prenatal onset of postpartum preeclampsia is supported by the pathophysiology of antepartum preeclampsia, which is known to begin before its clinical manifestations appear. In patients with antepartum preeclampsia, it is believed that placental malperfusion caused by defective spiral artery remodelling results in oxidative stress and release of proinflammatory mediators [24]. The increase in proinflammatory biomarkers leads to maternal endothelial dysfunction and the systemic manifestations of preeclampsia [25]. Although placentation occurs in the first trimester, the clinical signs and symptoms of antepartum preeclampsia only become apparent after 20 weeks of gestation [25]. The number of patients with preeclampsia increases progressively from that point on, with most cases in fact detected at term [25]. As hypertension is a late manifestation of disease beginning much earlier, it is likely that postpartum preeclampsia is an extension of the same disease spectrum. Preeclampsia detected after delivery may simply be on the same continuum or be missed cases of antepartum preeclampsia.

There may be different reasons why postpartum cases are detected only after delivery, including the clinical criteria used to diagnose preeclampsia antenatally. One of the obligatory criteria is the lower limit of hypertension that is currently defined as a blood pressure of 140/90 mmHg [10]. In some patients, these criteria may be too strict. A few studies have described patients with atypical presentations who have symptoms and laboratory findings consistent with preeclampsia, but do not experience hypertension [26–28]. A study of 152 women with hypertensive disorders found that patients with postpartum preeclampsia had lower blood pressures in the intrapartum period than patients with antepartum preeclampsia [21]. Postpartum elevations in blood pressure also tended to be more modest than in patients with antenatal preeclampsia [21]. The findings raise the possibility that some patients may have low prepregnancy blood pressure, with clinically significant increases that are insufficient to pass the 140/90 mmHg threshold during pregnancy. In these patients, the absolute change in blood pressure between the start and end of pregnancy may be a better indicator. Errors in measurement or the challenge of monitoring blood pressure during labour may also result in missed cases. Criteria for detection may need to be improved to not miss or misdiagnose postpartum preeclampsia, as patients may benefit from prophylaxis and scanning in subsequent pregnancies.

In our study, patients with postpartum preeclampsia were considerably more likely to experience antepartum and even postpartum preeclampsia at their next pregnancy, as well as severe maternal morbidity and a range of other adverse birth outcomes. Other studies have established that antepartum preeclampsia is a risk factor for the recurrence of preeclampsia and other adverse obstetric outcomes [29, 30]. Our findings suggest that these risks may extend to patients with postpartum preeclampsia in a first pregnancy.

5 | Conclusion

This population-wide study suggests that preeclampsia presenting in the postpartum period may be associated with severe morbidity and adverse birth outcomes among mothers and neonates. Both antepartum and postpartum preeclampsia may be on the same spectrum of disease, with postpartum cases either being missed at the time of delivery or developing afterwards. Current guidelines for the diagnosis of preeclampsia should consider enhancing blood pressure measurements in the postpartum period and ensuring that antepartum cases are not missed.

Author Contributions

All authors conceived and designed the study. A.M. performed the data analysis, and S.A., É.B. and N.A. helped interpret the results. S.A., A.M. and N.A. drafted the manuscript, and B.J.P., G.P., A.L. and É.B. revised it critically for important intellectual content. All authors approved the version to be published.

Acknowledgements

The authors have nothing to report.

Ethics Statement

The institutional review board at the University of Montreal Hospital Centre issued an ethics waiver for this study, as the data were anonymised.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the Institut de la statistique du Québec data repository [https://statistique.quebec.ca/recherche/#/accueil].

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.