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Preterm placental abruption and its association with adverse maternal and neonatal outcomes: a retrospective study

Li Zhang[1], Hong Yang[1], Yong Sun[1] and Shasha Liu[1*]

Abstract

Background Placental abruption (PA), a severe obstetric complication, defined as the partial or complete detachment of a normally situated placenta from the uterine wall before birth, after 20 weeks of gestation, is associated with significant maternal and neonatal morbidity and mortality. Despite its clinical importance, the pathogenesis of PA remains unclear, and there is limited research specifically comparing outcomes in term and preterm pregnancies with PA. This study aimed to evaluate maternal and neonatal outcomes in pregnancies complicated by PA on basis of the timing of PA onset, with a focus on differences between term and preterm deliveries.

Methods This retrospective study included a total of 757 singleton pregnant women with confirmed PA from a tertiary obstetrics hospital care center between June 2020 to March 2024, who were classified into the preterm group ($n=300$) and the full-term group ($n=457$) based on their gestational age of PA onset. The baseline characteristics, maternal and newborn outcomes were collected from electronic health records in hospital information system, and further analyzed between two groups. The adjusted odds ratios (aORs) for the risk of adverse pregnancy outcomes on basis of term or preterm delivery in women with PA were analyzed by using multivariate logistic regression models.

Results Women with preterm delivery had about 3 times greater risk for uterus-placenta apoplexy (aOR: 2.93, 95% CI 1.33–6.47, $P=0.01$), 3 times greater risk for fetal growth restriction (aOR: 3.47, 95% CI 1.45–8.30, $P=0.01$), 3 times greater risk for adult intensive care unit (ICU, aOR: 3.28, 95% CI 1.27–8.46, $P=0.01$), and less chances to use oxytocin (aOR: 0.21, 95% CI 0.13–0.32, $P<0.01$). Premature newborns had less chances to use forceps (aOR: 0.09, 95% CI 0.01–0.76, $P=0.02$), but about 10 times greater risk for stillbirth (aOR: 9.38, 95% CI 1.10 – 79.68, $P<0.01$).

Conclusions Preterm pregnancies with PA are associated with higher risks of severe maternal complications and adverse neonatal outcomes, underscoring the need for enhanced clinical surveillance and timely intervention. Future research should focus on elucidating underlying mechanisms and developing effective prevention strategies, while long-term follow-up is essential to assess the health outcomes of affected infants.

Clinical trial number Not applicable.

Keywords Plcental abruption, Premature birth, Term birth, High-risk pregnancy

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Background

Placental abruption (PA), a severe obstetric complication, was defined the partial or complete detachment of a normally situated placenta from the uterine wall before birth, after 20 weeks of gestation [1]. In developing countries, PA incidence may be influenced by overall healthcare quality, necessitating careful control group selection. An incidence rate of PA was reported approximately 0.46–1% in pregnancies [2, 3]. In China, the incidence rate of PA ranged from 0.46 to 2.1% in 2017, showing an increasing tendency [4, 5]. In developing countries, PA accounted for 10–15% of perinatal deaths [6]. Epidemiologically, PA is associated with significant maternal and neonatal morbidity and mortality, including preterm birth, hemorrhagic shock, and fetal distress [7]. The typical clinical manifestations of PA include changes in fetal heart rate, vaginal bleeding, abdominal pain and uterine tenderness. However, the onset is often sudden and the condition can be insidious and difficult to detect in its early stages. PA can lead to severe adverse pregnancy outcomes, such as intrauterine infection, hemorrhagic shock, disseminated intravascular coagulation (DIC), massive obstetric hemorrhage, fetal distress, and even maternal and fetal death, imposing a heavy burden on families and society [8]. A study by Mei et al., the clinical presentation of PA was significantly associated with poorer outcomes such as preterm birth, preeclampsia for both mothers and fetuses [9]. The onset-to-delivery timing of PA is a critical factor influencing maternal and neonatal outcomes. Studies have shown that early identification of PA can significantly improve outcomes, with the majority of PA cases occurring in the third trimester and often leading to preterm birth [10], highlighting the importance of timely medical intervention to mitigate these risks.

To date, the exact causes of PA are still not fully understood. It's clear that pregnant women with PA are a high-risk group in obstetrics, and the risk factors for PA have been intensively studied [6]. Studies have shown that factors such as advanced maternal age, pregnancy-induced hypertension, smoking, alcohol consumption, mechanical trauma, cocaine use, preterm premature rupture of membranes (PROM), and uterine anomalies, placenta previa, and oligohydramnios were all risk factors for PA [3, 7, 11, 12]. Both advanced maternal age and teenage pregnancies were associated with an increased risk of PA, especially when the age of ≤ 20 or ≥ 35 years old [13, 14]. There is still inconsistency in many aspects of the risk factors for PA. For instance, a history of PA—one of the strongest and most undeniable risk factors—has been reported with variability across studies [15, 16]. Notably, the association between PA and preterm birth is particularly significant and deserves special attention. Studies have reported that lower gestational age at delivery is the most important risk factor for poor neonatal outcomes in African American women with PA [12]. Bączkowska et al. reported that women with PA had significantly lower gestational age and birth weight compared to the control group [7]. These findings emphasize the importance of early identification and timely medical intervention for PA to improve maternal and neonatal outcomes. Healthcare providers must be aware of these risks and implement strategies to prevent preterm birth, ensuring the best possible outcomes for both mother and child.

However, despite the extensive research on PA, several critical gaps remain. First, most studies have focused on the overall risk factors and outcomes of PA, but limited research has specifically compared the differences in maternal and neonatal outcomes between term and preterm pregnancies with PA. Second, the management strategies for PA in preterm pregnancies are not well-defined, particularly regarding how to optimize outcomes for both mothers and newborns. Third, the long-term health implications for infants born preterm with PA are not fully understood. Addressing these gaps is essential to improve clinical practice and enhance the prognosis for affected pregnancies.

In this retrospective study, we compared the pregnancy outcomes in full-term and preterm women with PA. The odds ratios for the risk of adverse maternal and neonatal outcomes in pregnancies complicated by PA were also explored.

Materials and methods

Participants

A total of 757 eligible participants with confirmed PA were finally included in the study. Over the study period, approximately 25,000 pregnancies per year were screened in our center, with a PA incidence rate of about 0.76% observed. PA was defined by the partial or complete separation of normally positioned placenta from the uterine wall before birth after 20 weeks of gestation. The PA grading used in this study is based on clinical progression of severity and is widely accepted in obstetric practice. PA Grading Standards [5] were as follows: Grade 0: Retrospective postpartum diagnosis after delivery in asymptomatic women. Grade I: External bleeding, a soft uterus, and no fetal distress. Grade II: Fetal distress or intrauterine fetal demise. Grade III: Maternal shock symptoms, with or without DIC.

All participants with confirmed PA were further divided into preterm ($n = 300$, gestational age < 37 weeks) and full-term (gestational age ≥ 37 weeks, $n = 457$) groups based on their gestational age of PA onset. The study was approved by the Ethics Committee of Maternal and Child Health Hospital of Hubei Province (No. 2024-088-01). Informed consents were waived by the Ethics Committee of Maternal and Child Health Hospital of Hubei Province due to the nature of the retrospective study. The study

was conducted in accordance with the ethical standards of the Declaration of Helsinki and its later amendments.

Inclusion criteria and exclusion criteria

The inclusion criteria were as follows: (1) PA was confirmed by classical clinical findings of abdominal pain, vaginal bleeding, fetal distress, or ultrasound examination, which were recorded in medical records after delivery; (2) Gestational age ≥ 20 weeks; (3) Singleton pregnancy; (4) The medical record during pregnancy were complete.

The exclusion criteria were as follows: (1) Women with gestational age < 20 weeks; (2) Women with multiple pregnancies; (3) Women with placenta previa.

Data collection

All data were continuously collected from June 2020 to March 2024 in the Maternal and Child Health Hospital of Hubei Province. The maternal baseline characteristics, including maternal age, maternal height, maternal weight at pre-pregnancy and delivery, gestational age, gravidity, number of delivery, number of cesarean sections, assisted reproductive technology, preeclampsia, gestational hypertension, gestational diabetes, PROM, polyhydramnios, oligohydramnios, meconium-stained amniotic fluid, trauma, hypothyroidism, malpresentation, uterine malformation were collected. Clinical symptoms of PA such as abdominal pain, vaginal bleeding, fetal distress, or ultrasound examination results were collected. Maternal outcomes (placenta accreta, uterine atony, induced abortion, uterus-placenta apoplexy, fetal growth restriction, blood transfusion, bleeding volume, delivery method, adult ICU admission) and neonatal outcomes (Apgar 1 min, Apgar 5 min, newborn weight, newborn length, usage of forceps, stillbirth, NICU admission) were included.

Statistical analysis

Statistical analyses were performed using SPSS version 23.0 (IBM, Chicago, US). Continuous data were presented as means ± standard deviation (SD), which were analyzed by using the *t* test (two-sided). Categorical data were combined to obtain frequencies and percentages, which were analyzed by using the Chi-square test if their expected contingency table meeting the pre-requisites of chi-square; otherwise, using Fisher's exact test. The risk of adverse pregnancy outcomes was analyzed using the odds ratio (OR) and 95% confidence interval (CI) by multivariate logistic regression models. Adjustment was made for baseline characteristics of maternal age, height, pre-pregnancy weight, pre-delivery weight, gravidity, delivery number, cesarean delivery number, preeclampsia, meconium-stained amniotic fluid and malpresentation. A *P* value < 0.05 was considered statistically significant.

Results

This study finally included a total of 757 eligible pregnancy women with PA (Table 1), who were divided into preterm group ($n = 300$) and full-term group ($n = 457$). Notably, the preterm group exhibited a significantly lower gestational age of 33.2 ± 3.0 weeks compared to the full-term group's 38.8 ± 0.9 weeks (t=-36.19; $P < 0.01$). Baseline characteristic analysis unveiled that the preterm group had a higher gravidity count, delivery frequency, and cesarean section incidence. Moreover, preeclampsia and malpresentation were more prevalent in the preterm group, while meconium-stained amniotic fluid was less common (all $P < 0.05$).

Clinical symptomatology of PA revealed that asymptomatic cases (Grade 0) were more frequent in the full-term group (45.1%) than in the preterm group (24.7%), which was consistent with ultrasound findings (Table 2). Specifically, positive ultrasound findings were less prevalent in the full-term group (4.4%) than in the preterm group (18.7%, $P < 0.01$). In contrast, the preterm group reported higher incidences of vaginal bleeding (40.7% vs. 19.3%, $P < 0.01$) and abdominal pain (10.3% vs. 5.7%, $P = 0.02$).

Analysis of maternal outcome analysis (Table 3) demonstrated that the preterm group had higher rates of placenta accreta (10.0% vs. 4.6%, $P < 0.01$), uterus-placenta apoplexy (6.7% vs. 2.6%, $P = 0.01$), fetal growth restriction (8.0% vs. 2.0%, $P < 0.01$), blood transfusion (5.3% vs. 2.2%, $P = 0.02$), and adult ICU admissions (7.0% vs. 1.5%, $P < 0.01$). However, oxytocin usage was notably lower in the preterm group (9.0% vs. 35.7%, $P < 0.01$).

Compared with full-term newborns, preterm newborns displayed the characteristics of a lower 1-min Apgar score (8.4 ± 1.8 vs. 9.5 ± 0.9, $P < 0.01$), 5-min Apgar score (9.4 ± 1.7 vs. 9.9 ± 0.7, $P < 0.01$), lighter newborn weight (2072.7 ± 610.2 vs. 3131.6 ± 358.8, $P < 0.01$), lower newborn length (43.5 ± 5.6 vs. 49.7 ± 1.0, $P < 0.01$). Analysis of neonatal outcomes also revealed that the preterm group had less forceps use (0.3% vs. 2.6%, $P = 0.02$) and vaginal deliveries (39.7% vs. 47.7%, $P = 0.03$); but more cesarean delivery (60.3% vs. 52.3%, $P = 0.03$), more stillbirth (2.7% vs. 0.2%, $P < 0.01$) and more neonatal intensive care unit (NICU) admission (68.7% vs. 4.2%, $P < 0.01$) than full-term group, respectively (Table 4).

The odds ratios for the risk of adverse pregnancy outcomes on basis of term or preterm delivery in women with PA were analyzed by using univariate and multivariate logistic regression models (Table 5**)**. After adjustment for baseline characteristics of maternal age, height, pre-pregnancy weight, pre-delivery weight, gravidity, delivery number, cesarean delivery number, preeclampsia,

Table 1 Comparison of baseline characteristics between term and preterm pregnancies with PA

Variables	Preterm group($n=300$)	Full-term group ($n=457$)	t/χ^2	*P* value
Maternal age (year)	31.3 ± 4.0	31.2 ± 3.9	0.43	0.67
Maternal height (cm)	161.1 ± 4.8	161.1 ± 4.6	-0.44	0.66
Pre-pregnancy weight (kg)	55.8 ± 8.0	54.7 ± 8.0	1.87	0.06
Pre-delivery weight (kg)	67.1 ± 8.9	67.9 ± 8.7	-1.33	0.18
Gestational age (week)	33.2 ± 3.0	38.8 ± 0.9	-36.19	< 0.01
Gravidity	2.2 ± 1.3	1.9 ± 1.0	3.64	< 0.01
Delivery number	0.53 ± 0.6	0.40 ± 0.5	2.96	< 0.01
Cesarean delivery number	0.2 ± 0.4	0.1 ± 0.2	5.28	< 0.01
Smoking status				
Yes	27(9.0)	40(8.8)	0.01	0.91
No	273(91.0)	417(91.2)		
Advanced age				
Yes	57(19.0)	88(19.3)	0.01	0.93
No	243(81.0)	369(80.7)		
ART				
Yes	14(4.7)	25(5.5)	0.24	0.63
No	286(95.3)	432(94.5)		
Preeclampsia				
Yes	24(8.0)	13(2.8)	10.35	< 0.01
No	276(92.0)	444(97.2)		
Gestational hypertension				
Yes	52(17.3)	64(14.0)	1.55	0.21
No	248(82.7)	393(86.0)		
Gestational diabetes				
Yes	75(25.0)	109(23.9)	0.13	0.72
No	225(75.0)	348(76.1)		
Anemia				
Yes	27(9.0)	35(7.7)	0.43	0.51
No	273(91.0)	422(92.3)		
PROM				
Yes	54(18.0)	65(14.2)	1.95	0.16
No	246(82.0)	392(85.8)		
Polyhydramnios				
Yes	10(3.3)	13(2.8)	0.15	0.70
No	290(96.7)	444(97.2)		
Oligohydramnios				
Yes	5(1.7)	16(3.5)	2.26	0.13
No	295(98.3)	441(96.5)		
Meconium-stained amniotic fluid				
Yes	0(0.0)	7(1.5)	NA	< 0.05
No	300(100.0)	450(98.5)		
Trauma				
Yes	0(0.0)	1(0.2)	NA	1.00
No	300(100.0)	456(99.8)		
Hypothyroidism				
Yes	28(9.3)	59(12.9)	2.28	0.13
No	272(90.7)	398(87.1)		
Malpresentation				
Yes	29(9.7)	5(1.1)	31.03	< 0.01
No	271(90.3)	452(98.9)		
Uterine malformation				
Yes	4(1.3)	3(0.7)	NA	0.44
No	296(98.7)	454(99.3)		

PA: Placental abruption; ART: assisted reproductive techniques; PROM: premature rupture of membranes. Categorical data were expressed as n (%)

Table 2 Clinical symptoms of PA between term and preterm pregnancies

Variables	Preterm group ($n=300$)	Full-term group ($n=457$)	t/χ^2	*P* value
PA grading				
Grade 0	74(24.7)	206(45.1)	36.07	< 0.01
Grade 1	161(53.7)	195(42.7)		
Grade 2	60(20.0)	54(11.8)		
Grade 3	5(1.7)	2(0.4)		
Ultrasound findings				
Positive	56(18.7)	20(4.4)	40.95	< 0.01
Negative	244(81.3)	437(95.6)		
Vaginal bleeding				
Yes	122(40.7)	88(19.3)	41.42	< 0.01
No	178(59.3)	369(80.7)		
Abdominal pain				
Yes	31(10.3)	26(5.7)	5.61	0.02
No	269(89.7)	431(94.3)		
Fetal distress				
Yes	51(17.0)	82(17.9)	0.11	0.74
No	249(83.0)	375(82.1)		
Bloody amniotic fluid				
Yes	68(22.7)	109(23.9)	0.14	0.71
No	232(77.3)	348(76.1)		

PA: Placental abruption. Ultrasonographic criteria for the diagnosis of PA include the presence of abnormal echoes between the placenta and uterine wall (such as liquid dark areas, low echoes, or strong echoes), increased placental thickness (> 5 cm), or the display of placental retro-hemorrhage

Table 3 Maternal outcomes comparison between term and preterm pregnancies with PA

Variables	Preterm group ($n=300$)	Full-term group ($n=457$)	t/χ^2	*P* value
Placenta accreta				
Yes	30(10.0)	21(4.6)	8.42	< 0.01
No	270(90.0)	436(95.4)		
Uterine atony				
Yes	17(5.7)	18(3.9)	1.23	0.27
No	283(94.3)	439(96.1)		
Oxytocin use				
Yes	27(9.0)	163(35.7)	68.51	< 0.01
No	273(91.0)	294(64.3)		
Uterus-placenta apoplexy				
Yes	20(6.7)	12(2.6)	7.30	0.01
No	280(93.3)	445(97.4)		
Fetal growth restriction				
Yes	24(8.0)	9(2.0)	15.80	< 0.01
No	276(92.0)	448(98.0)		
Hemoglobin (g/L)	108.1 ± 21.3	106.6 ± 14.4	1.07	0.287
Blood loss (mL)	385.1 ± 269.2	367.4 ± 171.6	1.11	0.27
PPH				
Yes	14(4.7)	24(5.3)	0.13	0.72
No	286(95.3)	433(94.7)		
Blood transfusion				
Yes	16(5.3)	10(2.2)	5.40	0.02
No	284(94.7)	447(97.8)		
Adult ICU				
Yes	21(7.0)	7(1.5)	15.20	< 0.01
No	279(93.0)	450(98.5)		

PA: Placental abruption; PPH: Postpartum hemorrhage; ICU: Intensive Care Unit. Categorical data were expressed as n (%)

Table 4 A comparison of baseline characteristics and outcomes between preterm and full-term newborns

Variables	Preterm group ($n=300$)	Full-term group ($n=457$)	t/χ^2	*P* value
Apgar 1 min	8.4 ± 1.8	9.5 ± 0.9	-10.33	< 0.01
Apgar 5 min	9.4 ± 1.7	9.9 ± 0.7	-5.62	< 0.01
Newborn weight (g)	2072.7 ± 610.2	3131.6 ± 358.8	-30.01	< 0.01
Newborn weight				
< 2500 g	210(70.0)	13(2.8)	393.16	< 0.01
2500–4000 g	89(29.7)	441(96.5)		
>4000 g	1(0.3)	3(0.7)		
Newborn length (cm)	43.5 ± 5.6	49.7 ± 1.0	-22.98	< 0.01
Delivery mode				
Vaginal delivery	119(39.7)	218(47.7)	4.74	0.03
Cesarean delivery	181(60.3)	239(52.3)		
Forceps use				
Yes	1(0.3)	12(2.6)	NA	0.02
No	299(99.7)	445(97.4)		
Stillbirth				
Yes	8(2.7)	1(0.2)	NA	< 0.01
No	292(97.3)	456(99.8)		
NICU admission				
Yes	206(68.7)	19(4.2)	360.81	< 0.01
No	94(31.3)	438(95.8)		

NICU: neonatal intensive care unit. Categorical data were expressed as n (%)

Table 5 The results for the odds ratios for the risk of adverse pregnancy outcomes on basis of term or preterm delivery in women with PA

	OR (95% CI)	*P* value	aOR (95% CI)	*P* value
Maternal variables				
Placenta accreta	2.31(1.29–4.11)	< 0.01	1.55(0.80-3.00)	0.20
Uterine atony	1.47(0.74–2.89)	0.27	1.39(0.67–2.92)	0.38
Oxytocin use	0.18(0.11–0.28)	< 0.01	0.21(0.13–0.32)	< 0.01
Uterus-placenta apoplexy	2.65(1.28–5.50)	< 0.01	2.93(1.33–6.47)	0.01
Fetal growth restriction	4.33(1.98–9.45)	< 0.01	3.47(1.45–8.30)	0.01
PPH	0.88(0.45–1.74)	0.72	0.91(0.44–1.91)	0.81
Blood transfusion	2.52(1.13–5.63)	0.02	1.81(0.75–4.35)	0.19
Adult ICU	4.84(2.03–11.53)	< 0.01	3.28(1.27–8.46)	0.01
Neonatal variables				
Vaginal delivery	0.72(0.54–0.97)	0.03	0.87(0.63–1.22)	0.42
Forceps use	0.12(0.02–0.96)	0.05	0.09(0.01–0.76)	0.03
Stillbirth	12.49(1.55-100.41)	0.02	9.38(1.10-79.68)	0.04
NICU admission	50.52(30.03–84.98)	< 0.01	47.17(27.23–81.70)	< 0.01

PA: Placental abruption; CI: confidence interval; PPH: Postpartum hemorrhage; ICU: Intensive Care Unit; NICU: neonatal intensive care unit; OR: odds ratio; aOR: adjusted odds ratio. The risk of adverse pregnancy outcomes on basis of term or preterm delivery in women with PA using the OR and 95% CI by univariate and multivariate logistic regression models. Adjustment was made for baseline characteristics of maternal age, height, pre-pregnancy weight, pre-delivery weight, gravidity, delivery number, cesarean delivery number, preeclampsia, meconium-stained amniotic fluid and malpresentation

meconium-stained amniotic fluid and malpresentation, the aORs for the risk of adverse pregnancy outcomes were presented. Women with preterm delivery had about a 3-fold risk for uterus-placenta apoplexy (aOR: 2.93, 95% CI 1.33–6.47, $P=0.01$), a 3-fold risk for fetal growth restriction (aOR: 3.47, 95% CI 1.45–8.30, $P=0.01$), a 3-fold risk for adult ICU admissions (aOR: 3.28, 95% CI 1.27–8.46, $P=0.01$), and less chances to use oxytocin (aOR: 0.21, 95% CI 0.13–0.32, $P<0.01$). Premature newborns was associated with a reduced likelihood of forceps use (aOR: 0.09, 95% CI 0.01–0.76, $P=0.02$), but about a10-fold risk for stillbirth (aOR: 9.38, 95% CI 1.10 – 79.68, $P<0.01$) and a 47-fold risk for developing NICU admission (aOR: 47.17, 95% CI 27.23–81.70, $P<0.01$). These findings underscore the profound impact of PA timing on maternal and neonatal health outcomes.

Discussion

The timing of PA onset significantly influences maternal and neonatal outcomes. PA, an obstetric emergency with an unclear etiology, is a significant contributor to premature births, which accounts for 15 million births worldwide each year, and the second leading risk factor for death in children under 5 years old [17, 18]. It is believed that premature birth be a clinical syndrome resulting from various pathological processes [19]. In this retrospective study, our findings underscored the significant impact of PA on both maternal and neonatal health, particularly in the context of preterm deliveries. Compared with full-term women with PA, preterm pregnancies with PA showed much higher risk of uterus-placenta apoplexy (aOR: 2.93, 95% CI 1.33–6.47, $P = 0.01$), fetal growth restriction (aOR: 3.47, 95% CI 1.45–8.30, $P = 0.01$), and adult ICU (aOR: 3.28, 95% CI 1.27–8.46, $P = 0.01$), accompanied by higher risk of neonatal stillbirth (aOR: 9.38, 95% CI 1.10 – 79.68, $P < 0.01$) and NICU admission (aOR: 47.17, 95% CI 27.23–81.70, $P < 0.01$). This study provides more valuable insights into the management of PA, and may pave the way for enhanced outcomes for pregnant women and newborns.

The differences in outcomes between term and preterm pregnancies with PA can be attributed to the distinct clinical presentations and management challenges associated with PA at different gestational ages. Preterm PA often presents with more severe symptoms and requires urgent intervention, which may explain the higher incidence of maternal complications such as uterus-placenta apoplexy and fetal growth restriction. In preterm pregnancies, clinical decisions often need to balance the risks of preterm birth with the potential benefits of early intervention, which can lead to higher rates of ICU admissions and resource utilization. Conversely, full-term PA may be more likely to present with subtle or asymptomatic features, allowing for more controlled management strategies. In full-term pregnancies, clinical decisions may focus more on minimizing maternal and neonatal risks associated with prolonged labor or complications such as hemorrhage. This interplay highlights the importance of tailored clinical strategies based on gestational age and available resources to optimize outcomes for both mothers and infants.

We initially compared the baseline characteristics between term and preterm pregnancies with PA. Among the 757 women with PA included in our study, preterm pregnancies accounted for 39.6% (300/757) of the cases, which aligns with findings from Ananth et al.'s study [10]. Notably, the incidence of PA has been shown to decrease significantly as gestational age increases [10]. In developed countries, approximately 10% of premature births were attributed to PA [18], which was lower than that of our study. This discrepancy be attributed to a combination of factors, including racial and ethnic disparities, socioeconomic differences, and variations in healthcare access and quality. the higher gravidity and delivery numbers, as well as the higher number of cesarean deliveries in the preterm group may reflect a higher likelihood of previous obstetric complications and suggest an increased risk of PA in multiparous women [20]. Socioeconomic factors such as limited access to prenatal care and nutritional support may contribute to the higher incidence of PA in certain populations. The elevated proportion of malpresentation observed in the preterm group of our study is linked to an increased risk of PA [21], which may be attributed to altered uteroplacental dynamics and heightened mechanical stress on the placenta [22]. In Sheiner E et al.'s study, malpresentation was proved to be an independent risk factor for PA [21]. However, the direct relationship between malpresentation and PA risk requires further research. The lower proportion of meconium-stained amniotic fluid in the preterm group was intriguing and may suggest a differential response to fetal distress in pregnancies complicated by PA. Meconium staining was often associated with fetal hypoxia and increased risk of adverse neonatal outcomes [23]. These findings above underscore the multifactorial nature of PA and the importance of considering maternal and fetal characteristics in the assessment and management of pregnancies at risk.

The higher proportion of asymptomatic women (Grade 0) in the full-term group in our study, suggested that PA may be more likely to present with clinical symptoms in preterm pregnancies. This is supported by the lower proportion of positive ultrasound findings in the full-term group, which is in line with the study by Ni et al. (2019) that reported a higher sensitivity of ultrasound in detecting PA in preterm pregnancies [24]. Contrarily, full-term women were more asymptomatic. This aligns with the understanding that the clinical presentation of PA can vary widely, and asymptomatic cases are not uncommon, particularly in the context of full-term pregnancies. A study by Bączkowska et al. from a Polish tertiary center also noted the varied clinical presentation of PA and its serious perinatal complications [7]. In recent years, the increasing diagnosis of atypical PA doesn't present with typical heavy bleeding and severe pain, but instead shows chronic or recurring light bleeding, making prenatal detection harder [8]. As clinical pathology advances, obstetricians find it more challenging to spot these cases during routine prenatal checks, with some only confirmed postpartum via placental histopathology or fetal monitoring data review. This highlights the complexity of diagnosing atypical PA and emphasizes the need for ongoing efforts to improve prenatal detection, postpartum evaluation, and overall management strategies to optimize maternal and fetal outcomes.

The timing of PA onset is a critical factor in determining the severity of maternal and neonatal outcomes. Our findings suggest that early PA onset is associated with higher risks of adverse outcomes, which was consistent with recent studies. Preterm PA was associated with a higher risk of maternal complications, including FGR and uteroplacental apoplexy [25, 26]. Similarly, a systematic review by Downes et al. identified preterm delivery as a significant risk factor for maternal and perinatal mortality in cases of PA [27]. The higher incidence of these complications in the preterm group emphasizes the need for heightened surveillance in women with PA, especially those at risk of preterm delivery.

The study also revealed that preterm newborns had lower Apgar scores, lighter birth weight, and shorter length, which aligns with the known association between preterm birth and adverse neonatal outcomes. These findings align with the known association between preterm birth and adverse neonatal outcomes. A study by Ananth et al. found that PA was a significant predictor of perinatal mortality and preterm birth [28]. Furthermore, the increased risk of stillbirth and the necessity for NICU admission in preterm newborns, as highlighted in the study, underscored the critical nature of PA on neonatal health. These findings are echoed in a recent study by Ni et al., which compared the outcomes of PA with and without preeclampsia and/or intrauterine growth restriction, noting poorer neonatal outcomes in the presence of these complications [24].

The adjusted odds ratios derived from multivariate logistic regression in the study provide valuable insights into the independent risk factors associated with adverse outcomes in pregnancies complicated by PA. The increased risk of uterus-placenta apoplexy, fetal growth restriction, and adult ICU admission in preterm deliveries, as well as the increased risk of stillbirth and NICU admission in preterm newborns, are particularly concerning. All these above reflect a cautious management approach to prevent exacerbating uteroplacental bleeding, which is often necessary in high-risk pregnancies complicated by PA. These findings align with the previous reports that emphasize the complex interplay between preterm PA and severe maternal and neonatal outcomes [24, 27, 29]. Wada et al. showed increased maternal morbidity in cases of PA with intrauterine fetal death [29]. The less use of oxytocin in women with preterm PA (aOR: 0.21) may reflect the cautious management approach in these high-risk pregnancies to avoid exacerbating uteroplacental bleeding or other complications. Additionally, the markedly increased risk of stillbirth (aOR: 9.38) and NICU admission for premature newborns (aOR: 47.17) is not surprising given the increased vulnerability of these infants to respiratory distress, infections, and other related complications, which highlights the urgent need for specialized postnatal care. These findings are consistent with Lee et al.'s study, which identified PA as a significant risk factor for neonatal intensive care admission [30]. Of course, prematurity is a significant factor influencing neonatal outcomes in pregnancies complicated by PA. While PA increases the risk of preterm birth, the adverse outcomes observed may be largely attributable to the complications of prematurity itself. These findings underscore the critical nature of preterm PA and its association with severe maternal and neonatal complications, emphasizing the necessity for vigilant prenatal surveillance and timely intervention to mitigate the risks associated with this condition. It is crucial for healthcare providers to be aware of these risks and to implement specific medical interventions, such as multiple micronutrient supplementation, midwifery-led care, the implementation of for pregnancy care, to prevent preterm birth and ensure the best possible outcomes for both mother and child.

Several limitations of this study must be issued. This retrospective study included a cohort of patients with PA who were from a single tertiary center, which may introduce inevitable selection bias and limit the generalizability of the findings, such as resource utilization. We acknowledge the wide CIs in some of our findings, which suggest uncertainty in estimating the exact risk associated with PA. This is likely due to the relatively small number of cases and the heterogeneity of outcomes in this population. Multicenter, prospective studies with large sample size are still needed to validate our findings. Additionally, long-term follow-up of preterm infants and those with PA is necessary to assess their growth, development, and long-term health outcomes. Although PA is a rare complication, it morbidity can't be precisely estimated. Future research should focus on the mechanisms of identified risk factors and developing more effective screening and prevention strategies for PA, particularly in high-risk populations.

In summary, our study provides critical insights into the management of PA administration in both term and preterm pregnancies, underscoring the profound impact of PA timing on maternal and neonatal health outcomes. Preterm PA is associated with a significantly higher risk of severe maternal complications, including uterus-placenta apoplexy, fetal growth restriction, and adult ICU admission These maternal complications, in turn, contribute to adverse neonatal outcomes, such as increased rates of stillbirth and NICU admission. Clinical strategies should focus on proactive surveillance and timely intervention to mitigate the risks associated with PA. This includes enhanced prenatal monitoring, early recognition of PA symptoms, and individualized management plans tailored to gestational age and maternal risk factors. Future research should focus on elucidating underlying

mechanisms and developing effective prevention strategies, while long-term follow-up is essential to assess the health outcomes of affected infants.

Abbreviations

PA	Placental abruption
ART	Assisted reproductive techniques
CI	Confidence interval
DIC	Disseminated intravascular coagulation
ICU	Intensive care unit
NICU	Neonatal intensive care unit
OR	Odds ratio
aORs	Adjusted odds ratios
PPH	Postpartum hemorrhage
PROM	Premature rupture of membranes

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ZL conceived and designed the experiments. ZL, YH and SY collected and analyzed the data. ZL and LS wrote the manuscript. YH, SY and LS critically revised the manuscript. All authors have read and approved the final version at the time of submission.

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Data availability
The data that support the findings of this study are available upon request from the corresponding author after acceptance.

Declarations

Ethics approval and consent to participate
The study was approved by the Ethics Committee of Maternal and Child Health Hospital of Hubei Province (No. 2024-088-01). Informed consents from patients were waived by the Ethics Committee of Maternal and Child Health Hospital of Hubei Province due to the nature of the retrospective study. The study was conducted in accordance with the ethical standards of the Declaration of Helsinki and its later amendments.

Consent for publication
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Competing interests
The authors declare no competing interests.

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