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Postpartum Hemorrhage in Labor: Analyzing Risk Factors Across Demographic Groups

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Abstract

Postpartum hemorrhage (PPH) is a critical obstetric emergency and a major contributor to maternal mortality. Understanding risk factors across demographic groups is essential for guiding clinical surveillance. This study aimed to analyze the association between demographic and clinical factors, including maternal hemoglobin level, age, parity, weight, neonatal birth weight, and clinical causes of PPH based on the 4T framework (Tone, Tissue, Trauma, Thrombin), and the incidence of PPH among postpartum women. An observational cross-sectional study was conducted on 40 postpartum women who delivered vaginally at a Midwife Independent Practice (PMB) in Banda Aceh, Indonesia, between February and September 2021. Total sampling was applied. Data were collected through direct observation and clinical records. PPH was defined as estimated blood loss ≥500 mL within two hours after delivery. Statistical analysis included chi-square tests and odds ratio (OR) calculations. The prevalence of PPH in this sample was 42.5%. Perineal rupture was the most common clinical finding (77.5%), followed by retained placenta (12.5%) and uterine atony (10%). A significant association was found between clinical causes and the incidence of PPH ($p = 0.001$). Maternal anemia (Hb <12 g/dL) was significantly associated with PPH ($p = 0.018$; OR = 7.5), indicating a high-risk subgroup. Other demographic factors, age, parity, maternal weight, and neonatal birth weight were not significantly associated with PPH ($p > 0.05$). PPH was significantly associated with clinical causes, particularly uterine atony and retained placenta, as well as maternal anemia. These findings support the need for routine antenatal hemoglobin screening and strengthened postpartum monitoring in midwife-led clinical settings to improve early detection and response to bleeding risks.

1. Introduction

Postpartum hemorrhage (PPH) is an emergency and complication during childbirth. It is one of the causes of maternal death, contributing to over two-thirds of maternal mortalities in low- and middle-income countries (LMICs) [1, 2]. WHO data estimate that PPH occurs in 1–10% of all deliveries, with 1–2% classified as severe, posing serious health threats. In Indonesia, PPH accounts for around 30% of direct maternal deaths [3]. Critically, PPH can occur unpredictably, even in pregnancies and labors that appear normal [3].

The causes of PPH are highly varied and multifactorial. Most cases are attributed to the underlying causes summarized by the "4T" framework: Tone (uterine atony), Trauma (birth canal rupture or lacerations), Tissue (retained placenta), and Thrombin (coagulopathy) [4]. Usually, the most common cause is uterine atonia, affecting around 80% of cases [5], followed by other underlying causes, including placenta previa, perineal rupture, lacerations, and coagulopathy [5, 6].

In almost every vaginal delivery, perineal rupture is estimated to be around 85% [7]. This case will have both short- and long-term impacts. Typically, the mother experiences pain and dyspareunia [8]. It is aggravated when perineal rupture occurs at levels three and four; it can result in anal incontinence and pelvic organ prolapse [9]. The incidence of anal incontinence is about 50% [10] and worsens the mother's condition [11].

Various other risk factors contributed to the increase in income tax, including old age, multiple pregnancies, and history of Sectio Caesaria (SC), history of past income tax, anemia, and less than optimal officers in implementing existing service procedures. Cohort data from the WOMAN-2 trial further confirm that lower pre-delivery hemoglobin levels strongly correlate with a higher risk of PPH, even after controlling for confounders [12]. Most PPH cases are exacerbated by delays in identifying the source of bleeding and delays in making clinical decisions [13]. Cohort data from the WOMAN-2 trial further confirm that lower pre-delivery hemoglobin levels strongly correlate with a higher risk of PPH, even after controlling for confounders [12].

Similarly, while macrosomia and prolonged labor have been associated with PPH via uterine overdistension and fatigue, meta-analyses report only modest associations (OR ≈ 1.4–1.5), with significant heterogeneity across studies [10]. These findings underscore the need for research that contextualizes demographic risk within actual clinical presentations, especially in settings with limited diagnostic resources.

Thus, it is essential to make efforts to save mothers by identifying the causative factors and determining the source of PPH [14], as well as by screening for and mitigating the risk of bleeding [15]. Additionally, it is crucial to continually increase maternal awareness [16, 17]. No less important is the need to improve skills in recognizing and finding the source of PPH [13].

Although numerous studies have investigated the causes and risk factors of postpartum hemorrhage (PPH), there remains a lack of integrated analyses that examine the simultaneous influence of maternal demographic characteristics and clinical etiologies, particularly in resource-limited settings such as Banda Aceh, Indonesia. Furthermore, studies that include objective observation and measurement within the first two hours postpartum are still limited, despite this period being the most critical for maternal monitoring.

This research aims to address these gaps by providing practical, evidence-based insights to support early recognition and management of PPH in local clinical practice. In 2016, data from Dr. Zainoel Abidin Hospital in Banda Aceh reported that 15.2 percent of 146 complication-related deliveries involved PPH. Maternal age and parity showed significant associations with PPH, with p-values of 0.07 and 0.01, respectively [13].

Building on this context, the present study seeks to analyze the relationship between maternal demographic characteristics and the primary clinical causes of PPH within the first two hours following vaginal delivery. It focuses on key demographic variables, including maternal age, parity, hemoglobin level, maternal weight, and neonatal birth weight. It examines their association with three major clinical causes of PPH: uterine atony, perineal rupture, and retained placenta.

While previous studies have explored these factors separately, few have investigated how demographic risk factors interact with direct clinical causes during the immediate postpartum period, especially in midwife-led care settings. This integrated approach is crucial for the early identification of women at risk and for guiding timely, evidence-based interventions.

Despite a broad awareness of the mechanisms that contribute to PPH, there remains a lack of empirical data that captures both demographic and clinical factors within the critical two-hour postpartum window, particularly in low-resource environments. In response to this need, the study was designed to explore how selected demographic factors relate to the incidence of PPH and to examine how these same factors are associated with specific clinical causes of bleeding, using the 4T framework.

It is hypothesized that women with anemia, advanced maternal age, and abnormal infant birth weight are at greater risk of experiencing PPH, particularly in cases involving uterine atony or retained placenta. The findings from this study are expected to support the development of targeted preventive strategies and inform clinical decision-making during early postpartum care, thereby contributing to improved maternal outcomes and reduced morbidity in similar clinical settings.

2. Materials and Methods

2.1. Study Design

This research was designed as an observational, cross-sectional study aimed at identifying associations between PPH and demographic as well as clinical risk factors.

2.2. Study Setting and Participants

The study was conducted at a Midwife Independent Practice (PMB) in Banda Aceh, Indonesia, over seven months, from February to September 2021. The study population included all women who gave birth at the selected PMB during the study period. A total of 40 postpartum mothers were recruited using a total sampling approach. Eligible participants were women in the first stage of labor (in partu) who delivered vaginally and provided written informed consent.

2.3. Data Collection

Data collection occurred in two phases. In the first phase (before delivery), participants were informed about the study and asked to sign a written informed consent form. Biodata, maternal weight, and hemoglobin (Hb) levels were recorded. Hb levels were measured using a portable hemoglobin test kit.

In the second phase (during and after delivery), postpartum bleeding was continuously observed for two hours using direct visual estimation and absorbent materials. Observations were recorded at six time points: every 15 minutes in the first hour and every 30 minutes in the second hour. In addition to estimated blood volume, the visual characteristics of the blood (color, presence of clots, and consistency) were documented. Neonatal weight and height were measured immediately after delivery using standard calibrated equipment.

Mothers were excluded if they had a history of cesarean section, multiple pregnancies, known obstetric complications such as preeclampsia, placenta previa, or abruptio placentae, hematologic disorders, or suspected coagulopathy, or if they declined to participate or had incomplete data. These criteria ensured the sample represented low-risk vaginal deliveries and minimized confounding clinical factors.

2.4. Variables Measured

This study measured several independent variables: maternal age (<20 or >35 years as high risk), parity (primiparous or multiparous), maternal weight (<60 kg or ≥60 kg), neonatal birth weight (<4000 g or ≥4000 g), and hemoglobin level (<12 g/dL as anemic, ≥12 g/dL as normal).

The dependent variable was the incidence of PPH, defined as blood loss ≥500 mL within two hours postpartum. PPH severity was categorized as mild (500–999 mL) or severe (≥1000 mL), based on visual estimation supported by observations of soaked materials and measurements of tools.

PPH causes were classified using the 4T framework: uterine atony (soft uterus with continued bleeding), retained placenta (incomplete expulsion or >30 minutes to deliver), perineal trauma (visible lacerations requiring suturing), and suspected coagulopathy (persistent bleeding without tone, tissue, or trauma).

3. Results and Discussion

This study examines the demographic factors of 40 mothers who gave birth with vaginal delivery. Among the 40 postpartum women included in this study, the majority were within the low-risk reproductive age range (20–35 years), multiparous, had normal hemoglobin levels (≥12 g/dL), had a maternal weight of≥60 kg, and gave birth to infants weighing <4000 g. These characteristics are summarized in Table 1.

The association between maternal characteristics and the occurrence of PPH based on bleeding volume during the first two hours after delivery is presented in Table 2. The data show that mothers of at-risk age experienced abnormal PPH in 42.9% of cases; however, there was no statistically significant relationship between maternal age and the amount of PPH ($p = 0.346$, $p > 0.05$). Despite this, mothers of at-risk age were found to be 2.00 times more likely to develop abnormal PPH compared to those of non-at-risk age.

Mothers with multiparity experienced abnormal PPH in 70.8% of cases, but there was no significant relationship between parity and PPH volume ($p = 0.580$, $p > 0.05$). The odds of experiencing abnormal PPH in multiparous mothers were 0.906 times compared to primiparous mothers.

Among mothers with anemia, 52.9% experienced abnormal PPH, and a significant relationship was found between hemoglobin (Hb) levels and PPH volume ($p = 0.018$, $p < 0.05$). Anemic mothers had a 7.500 times greater chance of experiencing abnormal PPH compared to non-anemic mothers.

Mothers weighing ≥60 kg experienced abnormal PPH in 31.3% of cases; however, no significant relationship was observed between maternal weight and PPH volume ($p = 0.548$, $p > 0.05$). These mothers had a 1.364 times higher chance of experiencing abnormal PPH compared to those weighing less than 60 kg.

Table 1. Frequency distribution of respondent characteristics.

Characteristic	F	%
Age		
1. High risk	7	17.5
2. Not high risk	33	82.5
Parity		
1. Primiparity	16	40
2. Multiparity	24	60
Hemoglobin (Hb)		
1. Anemia	17	42.5
2. No anemia	23	57.5
Mother's Weight		
1. ≥60 kg	32	80
2. < 60 kg	8	20
Baby Weight		
1. ≥ 4000 kg	2	5
2. <4000 kg	38	95

Table 2. Relationship of Maternal Characteristics with Amount of Bleeding.

Variable	Amount of Bleeding				OR	CI	*p*
	Normal		Abnormal				
	F	%	F	%			
Age							
High risk	4	57.1	3	42.9	2	0.372-10.748	0.346
No risk	24	72.7	9	27.3			
Parity							
Primiparity	11	31.3	5	68.8	0.906	0.229-3.585	0.58
Multiparity	17	29.2	7	70.8			
Hemoglobin							
Anemia	8	47.1	9	52.9	7.5	1.604-35.075	0.018
No anemia	20	87	3	13			
Mother's Weight							
≥60 kg	22	68.8	10	31.3	1.364	0.233-7.976	0.548
<60 kg	6	75	2	25			
Baby Weight							
≥4000 kg	0	0	2	100	3.8	2.232-6.469	0.085
<4000 kg	28	73.7	10	26.3			

Finally, mothers who delivered babies weighing ≥4000 g experienced abnormal PPH in 100% of cases. Despite this high rate, there was no statistically significant relationship between infant birth weight and PPH volume ($p = 0.085$, $p > 0.05$). However, these mothers had a 3.800 times greater chance of experiencing abnormal PPH compared to those who delivered babies weighing less than 4000 g.

Based on Table 3, out of 40 respondents, 42.5% experienced PPH with blood loss between 500–1000 mL. The majority, 57.5%, had blood loss of less than 499 mL. Notably, no respondents experienced blood loss greater than 1000 mL.

Among the identified causes of PPH, the most common was perineal rupture, accounting for 77.5% of cases, followed by retained placenta (12.5%) and uterine atony (10.0%), as shown in Table 4. These findings indicate that perineal rupture is the most dominant cause of PPH in the studied population.

A significant relationship was found between the cause of PPH and the amount of bleeding, as presented in Table 5. Perineal rupture was mostly associated with normal bleeding, with 90.3% of cases classified as normal and only 9.7% as abnormal. In contrast, all cases of uterine atony and retained placenta resulted in abnormal bleeding (100% each). The analysis yielded a p-value of 0.001, indicating a statistically significant association between the cause of PPH and the volume of blood loss.

This study investigated PPH and its association with various demographic and clinical factors among 40 women who underwent vaginal delivery. The overall prevalence of PPH (blood loss 500–1000 mL) in this sample was 42.5%, underscoring the importance of early detection and treatment.

Table 3. Prevalence of PPH.

Blood loss (mL)	Total	%
< 499	23	57.5
500-1000	17	42.5
1000-1500	0	0.0
>1500	0	0.0

Table 4. Frequency of causes of PPH.

Causes of PPH	F	%
Ruptur perineum	31	77.5
Atonia Uteri	4	10.0
Retensio Placenta	5	12.5

Table 5. The relationship between the cause and the amount of bleeding.

Causes of Bleeding	Bleeding				*P*
	Normal		Abnormal		
	F	%	F	%	
Rupture Perineum	28	90.3	3	9.7	
Atonia Uteri	0	0.0	4	100	0.001
Retensio Placenta	0	0.0	5	100	

The most common clinical cause of PPH was perineal rupture (77.5%), followed by retained placenta (12.5%) and uterine atony (10%). These findings are consistent with previous literature, which reports high rates of perineal trauma during vaginal birth, occurring in up to 85% of deliveries [7], and highlights the need for skilled perineal management and appropriate repair techniques. However, it is critical to note that not all perineal ruptures result in significant hemorrhage. As shown in our data, the majority of ruptures were not associated with abnormal bleeding. This suggests that while common, perineal trauma alone may not always indicate a high risk of PPH unless accompanied by other complicating factors.

Uterine atony, although less frequent in our cohort, remains a leading cause of life-threatening PPH globally [15]. It is characterized by a failure of the uterus to contract effectively post-delivery, often resulting in rapid and severe blood loss. Retained placenta, also significantly associated with abnormal bleeding in our study, is a condition where the placenta fails to separate and expel within 30 minutes postpartum. If not addressed promptly, it can lead to massive bleeding and maternal morbidity [18]. Our results confirmed a strong association between these causes and abnormal bleeding (p = 0.001), aligning with clinical expectations.

Regarding demographic risk factors, the hemoglobin level was the only variable that showed a statistically significant association with PPH (p = 0.018). Women with anemia (Hb <12 g/dL) had a 7.5 times greater likelihood of experiencing abnormal PPH compared to those with normal Hb levels. This finding reinforces the clinical relevance of routine antenatal Hb screening and the management of anemia during pregnancy. Similar results were reported in prior studies showing that anemia reduces maternal physiological reserve, exacerbating the impact of blood loss. However, conflicting evidence exists; some studies suggest that anemia does not necessarily correlate with the severity of PPH in cases of uterine atony [14]. These inconsistencies highlight the multifaceted nature of PPH and underscore the need for individualized clinical evaluation.

Other demographic variables, including maternal age, parity, maternal weight, and infant birth weight, were not significantly associated with PPH in this study (all p > 0.05). While mothers aged <20 or >35 years had a higher odds ratio (OR = 2.0), the association was not statistically significant. This aligns with studies indicating that maternal age alone is not a reliable predictor of PPH [19], [20], though some research links advanced maternal age with increased obstetric complications [21, 22].

In contrast, a significant relationship was found between hemoglobin levels and the occurrence of PPH (p = 0.018). Mothers with anemia had a markedly increased risk (OR = 7.5) of experiencing abnormal PPH. This supports the existing literature, which highlights anemia as a modifiable risk factor that compromises maternal tolerance to blood loss. However, the clinical implications depend on the severity of anemia and the primary cause of PPH. For instance, some studies suggest that while anemia exacerbates the effects of bleeding, it may not directly influence the volume of blood loss in cases caused by uterine atony [16].

Mothers with anemia (Hb <12 g/dL) were 7.5 times more likely to experience significant postpartum bleeding compared to those with normal hemoglobin levels. Clinically, this indicates that undiagnosed or untreated anemia can substantially increase the severity of hemorrhage, especially when combined with uterine atony or placental retention. For healthcare providers, this reinforces the importance of routine antenatal hemoglobin screening and timely nutritional interventions to correct anemia before delivery, as such measures may meaningfully reduce both the likelihood and severity of PPH.

Parity also did not show a significant relationship with bleeding (p=0.580), although multiparous women slightly predominated among those with PPH. Some literature has linked both primiparity and grand multiparity to PPH risk, but findings remain inconsistent across populations [20, 23, 24]. Similarly, maternal weight (≥60 kg) and infant birth weight (≥4000 g) showed elevated odds ratios. Still,

they did not reach statistical significance, potentially due to the small number of overweight participants or macrosomic infants in the sample. This limits generalizability and may obscure real associations seen in larger studies [25, 26].

Due to the large number of cases of uterine atonia, placenta retention and perineal rupture, it is very important to identify the initial risk of bleeding [15] accompanied by extra strict surveillance to protect the perineum [10] including it is very important to assess blood loss measurably and objectively [27].

This study has several limitations. First, the sample size (n = 40) limits statistical power, particularly in detecting modest associations. Second, the observational cross-sectional design restricts causal inferences. Third, potential measurement bias may exist in visually estimating blood loss, a common challenge in low-resource settings. Fourth, selection bias cannot be ruled out, as the sample was drawn from a single clinical setting, which limits generalizability.

Despite its limitations, this study underscores the importance of meticulous postpartum monitoring and the early detection of bleeding risk. The significant association between anemia and PPH underscores the importance of optimizing maternal nutrition and hemoglobin levels during prenatal care. Furthermore, recognition of clinical signs such as uterine tone and placental retention remains critical for timely intervention. Accurate quantification of blood loss, training in PPH management, and structured postnatal surveillance are essential strategies to reduce maternal morbidity and mortality.

4. Conclusions

This study found a relatively high incidence of PPH at 42.5% among vaginal deliveries in a midwife-led setting. Among the clinical causes assessed, retained placenta and uterine atony were significantly associated with PPH, whereas perineal rupture, although frequently observed, was not statistically linked to abnormal blood loss. In addition, maternal anemia (hemoglobin <12 g/dL) was significantly associated with a higher risk of PPH, suggesting that low hemoglobin levels may compromise maternal tolerance to bleeding.

While these findings do not evaluate specific interventions, they underscore the potential value of antenatal anemia screening and clinical vigilance during the early postpartum period, especially within the first two hours after delivery, when most PPH events are likely to occur. Our findings support these recommendations and align with global evidence that most PPH events occur within the first two hours postpartum and that maternal anemia significantly increases bleeding risk. Further interventional studies are needed to determine the actual effectiveness of such strategies in reducing PPH incidence.

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Data Availability Statement: The data are available upon request.

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