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RESEARCH ARTICLE

Burden and outcomes of postpartum haemorrhage in Nigerian referral-level hospitals

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Abstract

Objective: To determine the prevalence of primary postpartum haemorrhage (PPH), risk factors, and maternal and neonatal outcomes in a multicentre study across Nigeria.

Design: A secondary data analysis using a cross-sectional design.

Setting: Referral-level hospitals (48 public and six private facilities).

Population: Women admitted for birth between 1 September 2019 and 31 August 2020.

Methods: Data collected over a 1-year period from the Maternal and Perinatal Database for Quality, Equity and Dignity programme in Nigeria were analysed, stratified by mode of delivery (vaginal or caesarean), using a mixed-effects logistic regression model.

Main outcome measures: Prevalence of PPH and maternal and neonatal outcomes.

Results: Of 68 754 women, 2169 (3.2%, 95% CI 3.07%–3.30%) had PPH, with a prevalence of 2.7% (95% CI 2.55%–2.85%) and 4.0% (95% CI 3.75%–4.25%)

for vaginal and caesarean deliveries, respectively. Factors associated with PPH following vaginal delivery were: no formal education (aOR 2.2, 95% CI 1.8–2.6, $P < 0.001$); multiple pregnancy (aOR 2.7, 95% CI 2.1–3.5, $P < 0.001$); and antepartum haemorrhage (aOR 11.7, 95% CI 9.4–14.7, $P < 0.001$). Factors associated with PPH in a caesarean delivery were: maternal age of >35 years (aOR 1.7, 95% CI 1.5–2.0, $P < 0.001$); referral from informal setting (aOR 2.4, 95% CI 1.4–4.0, $P = 0.002$); and antepartum haemorrhage (aOR 3.7, 95% CI 2.8–4.7, $P < 0.001$). Maternal mortality occurred in 4.8% (104/2169) of deliveries overall, and in 8.5% (101/1182) of intensive care unit admissions. One-quarter of all infants were stillborn (570/2307), representing 23.9% (429/1796) of neonatal intensive care unit admissions.

Conclusions: A PPH prevalence of 3.2% can be reduced with improved access to skilled birth attendants.

KEYWORDS
maternal mortality, maternal outcomes, neonatal outcomes, obstetric haemorrhage

1 | INTRODUCTION

Postpartum haemorrhage (PPH) continues to be a great source of concern in obstetric practice, as it contributes to a quarter of maternal mortalities globally, with the majority occurring in low- to middle-income countries.[1–4] Although PPH occurs in 5%–6% of deliveries globally, adverse outcomes such as mortality and morbidity are more prevalent in Africa and Asia.[4] The causes of PPH include uterine atony, trauma to the genital tract, tissue factors and thrombotic phenomena.[5] However, the majority of patients who develop PPH have no predisposing factors.[6,7] Therefore, as a preventive measure, every woman should be managed as a potential case of PPH to reduce morbidity and mortality.

Factors such as the low numbers of skilled health personnel, high proportions of deliveries in rural areas, inadequate transfusion services and a lack of health insurance contribute to the occurrence of PPH and the associated poor outcomes.[8] In addition, the use of effective uterotonics for the prevention of PPH during the third stage of labour is recommended for all births.[9]

Maternal mortality is the most severe complication of PPH, but the number of morbidities outweigh the mortalities. Morbidities include hypovolemic shock, multiorgan failure, disseminated intravascular coagulopathy and Sheehan's syndrome. The death of the mother has consequences on the family resources and has grave implications for the survival of the baby.[10] Maternal death has a socio-economic impact on the family and the community, with long-term effects on quality of life.

The Maternal and Perinatal Database for Quality, Equity and Dignity (MPD-4-QED) programme is a nationwide scheme established in 54 referral-level centres across Nigeria to collect data on women and their babies at the time of birth and during the postpartum period. The harmonised method of data collection and the inclusion of all women admitted for delivery (not just women with complications) provides an opportunity to examine the prevalence and risk factors for PPH across Nigeria, and to closely examine the occurrence of PPH after vaginal and caesarean births. These prospectively collected data provide an accurate current reflection of these facilities, against which findings from previous retrospective single-centre data may be compared. The findings will also provide a robust basis for resource allocation, planning and policymaking.

The aim of this secondary data analysis was to determine the prevalence and risk factors for primary postpartum haemorrhage in a nationwide network of Nigerian hospitals over a 1-year period. Finally, we reviewed the maternal and neonatal outcomes for women who developed primary PPH in this network.

2 | METHODS

2.1 | Study design

This is a secondary analysis of the MPD-4-QED programme. The programme involved collecting maternal and perinatal data in a nationwide network of 54 referral-level tertiary hospitals (48 public and six private) across the six geopolitical zones of Nigeria. These hospitals provided consent and participated in and successfully implemented the study. The protocol and main findings of this study have been published elsewhere.[11]

The MPD-4-QED programme used an electronic database that was developed by customising the open-source District Health Information Software (DHIS-2), and was approved by the Feral Ministry of Health of Nigeria. The programme captures data from women (and their babies) who deliver in participating facilities or were admitted on account of complications within 42 days of delivery or termination of pregnancy. The information obtained included sociodemographic, medical, antenatal, labour and delivery data for the mothers, as well as the clinical condition and immediate postpartum observations of the babies.

2.2 | Study population

The study population was all women who delivered in the participating hospitals (with information on PPH

and mode of birth) and their newborn babies, admitted between 1 September 2019 and 31 August 2020. Primary PPH was defined as bleeding from the genital tract within 24 h of birth: >500 mL following a vaginal birth or >1000 mL for caesarean section (during and after the procedure).[12]

The visual estimation of blood loss made by the attending healthcare providers was accepted for our study, in accordance with normal practice in our referral-level obstetric centres. This information was recorded from medical records by data collectors and then entered into the database.

A prolonged hospital stay was defined as the admission of a woman for more than 2 days for vaginal deliveries and 5 days for caesarean sections.

2.3 | Statistical analysis

The prevalence of PPH was calculated as the number of PPH cases divided by the population of woman who gave birth. This was stratified by vaginal and caesarean section (CS) birth.

To evaluate risk factors for PPH in CS and vaginal births, a mixed-effects logistic regression model with random intercepts by facility was used to construct a bivariate and a hierarchical multivariate model.[13] In the hierarchical model, the more distal determinants, such as sociodemographic characteristics, may influence outcomes either directly or indirectly through other more proximate determinants, such as obstetric history or current pregnancy care or complications. The hierarchical model had three levels: sociodemographic factors; previous obstetric characteristics; and current pregnancy characteristics. In the first step, all variables at the first level were entered and all statistically significant variables were retained. The variables entered at the first level were: age, marital status, woman's education level, woman's occupation and partner's occupation. The variables in the second level were then added, retaining only those that were significant. The variables entered at the second level were: parity, previous CS, previous miscarriage and chronic medical disorder in pregnancy. A similar procedure was repeated for the variables for the remaining level. The variables entered at the third level were: antenatal care booking, gestational age estimated at booking, referral status, cadre of attending healthcare provider, multiple pregnancy, partograph use, episiotomy, pregnancy-induced hypertension, antepartum haemorrhage, prophylactic uterotonics, type of delivery and birthweight. In all cases, a variable was considered statistically significant when $P < 0.05$. Crude and adjusted odds ratios and their 95% confidence intervals were calculated.

The uterotonic options used for the prevention of PPH were described for all women with PPH (frequency and percentage use), whether they survived or died.

The frequency of maternal and perinatal outcomes of PPH were described by mode of delivery, calculating the frequency and percentage of each outcome occurrence.

3 | RESULTS

There were 76 563 women enrolled into the database during the 1-year period. The records of 69 662 women who delivered in the participating hospitals were available for review. Of these, 68 754 had information on mode of delivery and PPH. A total of 2169 women had PPH, giving an overall prevalence of PPH of 3.2% (95% CI 3.07–3.30). The prevalence of PPH was 2.7% (95% CI 2.55–2.85) and 4.0% (95% CI 3.75–4.25) among women who delivered with vaginal birth and CS, respectively.

A review of the sociodemographic characteristics (Tables 1 and 2) showed that, compared with women with no PPH, the PPH group included more women aged over 35 years, with no formal education, who were grand multiparas, who received no antenatal care, or received antenatal care at another health facility or informal setting, and who had a multiple pregnancy. More of the women with PPH had partners who were in low-skilled employment.

For women who had a vaginal birth, the factors associated with PPH were: no education (aOR 2.2, 95% CI 1.8–2.6, $P < 0.001$) or primary-level education (aOR 1.6, 95% CI 1.2–2.1, $P < 0.001$); a partner with a sales/trading occupation (aOR 1.5, 95% CI 1.3–1.8, $p < 0.001$) or who was not gainfully employed (aOR 2.0, 95% CI 1.7–2.3, $P < 0.001$); being a grand multipara (aOR 1.7, 95% CI 1.4–2.1, $P < 0.001$); and history of a previous CS (aOR 1.8, 95% CI 1.4–2.3, $P < 0.001$). Other factors associated with PPH among women who had vaginal delivery included: no antenatal care (aOR 2.0, 95% CI 1.6–2.4, $P < 0.001$) or antenatal care at another health facility (not one of the study facilities) (aOR 1.8, 95% CI 1.5–2.3, $p < 0.001$); referral from an informal setting (aOR 2.4, 95% CI 1.4–4.0, $P = 0.004$); multiple pregnancy (aOR 2.7, 95% CI 2.1–3.5, $P < 0.001$); antepartum haemorrhage (aOR 11.7, 95% CI 9.4–14.7, $P < 0.001$); and assisted vaginal birth (aOR 2.1, 95% CI 1.5–3.1, $P < 0.001$) (Table 3).

For women who had a CS birth, the risk factors for PPH were: maternal age of >35 years (aOR 1.7, 95% CI 1.5–2.0, $P < 0.001$); primary-level education (aOR 1.2, 95% CI 1.2–1.6, $P < 0.001$); partner with sales/trading occupation (aOR 1.3, 95% CI 1.0–1.5, $P = 0.003$) or who was not gainfully employed (aOR 1.3, 95% CI 1.1–1.6, $P = 0.003$); grand multipara (aOR 1.5, 95% CI 1.2–2.0, $P < 0.001$); and previous miscarriage (aOR 1.2, 95% CI 1.0–1.4, $P < 0.001$). Other risk factors for PPH among women who had a vaginal delivery included: referral from an informal setting (aOR 2.4, 95% CI 1.4–4.0, $P = 0.002$); multiple pregnancy (aOR 1.7, 95% CI 1.3–2.1, $P < 0.001$); antepartum haemorrhage (aOR 3.7, 95% CI 2.8–4.7, $P < 0.001$); and emergency CS (aOR 1.3, 95% CI 1.1–1.5, $P = 0.003$) (Table 4).

TABLE 1 Sociodemographic and obstetric characteristics of the women included in the study by occurrence of postpartum haemorrhage.

	Vaginal birth				Caesarean section			
	PPH (*N* = 1253)		No PPH (*N* = 44 658)		PPH (*N* = 916)		No PPH (*N* = 21 927)	
	n/*N*	%	*n*/*N*	%	*n*/*N*	%	*n*/*N*	%
Sociodemographic characteristics								
Age								
<20 years	66/1253	5.3	1722/44 658	3.9	13/916	1.4	627/21 927	2.9
20–35 years	997/1253	79.6	37 187/44 658	83.3	640/916	69.9	17 172/21 927	78.3
>35 years	190/1253	15.2	5749/44 658	12.9	263/916	28.7	4128/21 927	18.8
Marital status								
Single	17/1249	1.4	462/44 512	1	11/914	1.2	246/21 854	1.1
Married/cohabitating	1229/1249	98.4	43 988/44 512	98.8	903/914	98.8	21 576/21 854	98.7
Separated/divorced	3/1249	0.2	56/44 512	0.1	0/914	0	30/21 854	0.1
Widowed	0/1249	0	6/44 512	0	0/914	0	2/21 854	0
Woman's education level								
No formal education	240/1169	20.5	4148/41 227	10.1	73/875	8.3	2042/20 687	9.9
Completed primary education	80/1169	6.8	1502/41 227	3.6	43/875	4.9	781/20 687	3.8
Completed secondary education	475/1169	40.6	17 940/41 227	43.5	307/875	35.1	7722/20 687	37.3
Completed post-secondary education	374/1169	32	17 637/41 227	42.8	452/875	51.7	10 142/20 687	49
Woman's occupation								
Not gainfully employed	607/1235	49.1	17 466/43 535	40.1	195/902	21.6	6847/21 517	31.8
Professional/technical/managerial	191/1235	15.5	9820/43 535	22.6	258/902	28.6	5873/21 517	27.3
Sales/trading	247/1235	20	9776/43 535	22.5	283/902	31.4	5466/21 517	25.4
Manual labour/other	190/1235	15.4	6473/43 535	14.9	166/902	18.4	3331/21 517	15.5
Partner's occupation								
Not gainfully employed	32/1203	2.7	446/42 772	1	8/884	0.9	245/21 091	1.2
Professional/technical/managerial	392/1203	32.6	19 244/42 772	45	327/884	37	9028/21 091	42.8
Sales/trading	326/1203	27.1	11 038/42 772	25.8	234/884	26.5	5767/21 091	27.3
Manual labour/other	453/1203	37.7	12 044/42 772	28.2	315/884	35.6	6051/21 091	28.7
Previous obstetric characteristics								
Parity								
Nullipara	350/1253	27.9	13 334/44 656	29.9	219/916	23.9	6911/21 927	31.5
Multipara (1–4)	664/1253	53	27 367/44 656	61.3	603/916	65.8	13 401/21 927	61.1
Grand multipara (5 or more)	239/1253	19.1	3955/44 656	8.9	94/916	10.3	1615/21 927	7.4
Women has had previous caesarean section								
No	779/869	89.6	28 578/30 417	94	337/680	49.6	7144/14 441	49.5
Yes	90/869	10.4	1839/30 417	6	343/680	50.4	7297/14 441	50.5
Woman has had previous miscarriage								
No	897/1237	72.5	32 863/44 089	74.5	563/906	62.1	15 002/21 450	69.9
Yes	340/1237	27.5	11 226/44 089	25.5	343/906	37.9	6448/21 450	30.1
Chronic medical disorder (pre-pregnancy)[a]								
Yes	1150/1245	92.4	41 006/44 021	93.2	809/912	88.7	19 357/21 695	89.2
No	95/1245	7.6	3015/44 021	6.8	103/912	11.3	2338/21 695	10.8

[a]Diabetes, asthma, sickle cell anaemia, tuberculosis, HIV, hepatitis, cardiac disease, renal disease, thyroid disease, epilepsy or other medical disorder.

(Continues)

TABLE 2 Current pregnancy characteristics by occurrence of postpartum haemorrhage.

	Vaginal birth				CS			
	PPH (*N* = 1253)		No PPH (*N* = 44 658)		PPH (*N* = 916)		No PPH (*N* = 21 927)	
	n/*N*	%	*n*/*N*	%	*n*/*N*	%	*n*/*N*	%
Current pregnancy characteristics								
Antenatal care booking (ANC)								
No ANC	244/1250	19.5	4124/44 224	9.3	112/914	12.3	2640/21 720	12.2
ANC at the same facility	608/1250	48.6	34 458/44 224	77.9	557/914	60.9	14 838/21 720	68.3
ANC at another health facility	389/1250	31.1	5491/44 224	12.4	237/914	25.9	4135/21 720	19
ANC with traditional birth attendant or informal setting	9/1250	0.7	151/44 224	0.3	8/914	0.9	107/21 720	0.5
Estimated gestational age at booking								
<13 weeks	70/567	12.3	2898/31 471	9.2	69/506	13.6	1695/13 980	12.1
13–26 weeks	298/567	52.6	17 696/31 471	56.2	281/506	55.5	7408/13 980	53
>26 weeks	199/567	35.1	10 877/31 471	34.6	156/506	30.8	4877/13 980	34.9
Referral status								
Not referred or self-referred	876/1253	69.9	40 001/44 657	89.6	665/916	72.6	17 717/21 925	80.8
Referred from public or private hospital	354/1253	28.3	4420/44 657	9.9	224/916	24.5	3982/21 925	18.2
Referred from informal setting	23/1253	1.8	236/44 657	0.5	27/916	2.9	226/21 925	1
Multiple pregnancy								
Yes	90/1253	7.2	964/44 653	2.2	86/916	9.4	1216/21 925	5.5
No	1163/1253	92.8	43 689/44 653	97.8	830/916	90.6	20 709/21 925	94.5
Prolonged labour[a]								
Yes	127/1158	11	3680/41 815	8.8	–	–	–	–
No	1031/1158	89	38 135/41 815	91.2	–	–	–	–
Partograph use[b]								
Yes	991/1224	81	38 024/43 831	86.8	205/376	54.5	4688/7020	66.8
No	233/1224	19	5807/43 831	13.2	171/376	45.5	2332/7020	33.2
Episiotomy[c]								
Yes	302/1229	24.6	13 546/43 573	31.1	4/389	1	187/7136	2.6
No	927/1229	75.4	30 027/43 573	68.9	385/389	99	6949/7136	97.4
Pregnancy-induced hypertension								
Yes	70/1245	5.6	1183/43 920	2.7	43/912	4.7	1277/21 683	5.9
No	1175/1245	94.4	42 737/43 920	97.3	869/912	95.3	20 406/21 683	94.1
Antepartum haemorrhage								
Yes	216/1245	17.3	396/43 920	0.9	105/912	11.5	668/21 683	3.1
No	1029/1245	82.7	43 524/43 920	99.1	807/912	88.5	21 015/21 683	96.9
Prophylactic uterotonics								
Yes	1135/1201	94.5	39 393/42 273	93.2	735/831	88.4	16 601/19 398	85.6
No	66/1201	5.5	2880/42 273	6.8	96/831	11.6	2797/19 398	14.4
Type of delivery								
Spontaneous vaginal birth	1205/1253	96.2	44 263/44 658	99.1	0/916	0	0/21 927	0
Assisted vaginal birth	48/1253	3.8	395/44 658	0.9	0/916	0	0/21 927	0
Elective caesarean section	0/1253	0	0/44 658	0	280/916	30.6	8223/21 927	37.5
Emergency caesarean section	0/1253	0	0/44 658	0	636/916	69.4	13 704/21 927	62.5
Birthweight								
<2499 g	357/1312	27.2	5462/45 056	12.1	259/989	26.2	4544/22 883	19.9
2500–3999 g	894/1312	68.1	37 587/45 056	83.4	636/989	64.3	16 691/22 883	72.9
≥4000 g	61/1312	4.6	2007/45 056	4.5	94/989	9.5	1648/22 883	7.2

[a]Missing data on *n* = 12 516.

[b]CS only includes emergency caesarean section.

[c]Considering only vaginal birth.

TABLE 3 Sociodemographic and clinical risk factors for postpartum haemorrhage following vaginal birth.

	OR (95% CI)	P[a]	aOR (95% CI)	P[a]
Sociodemographic characteristics				
Age				
<20 years	1.24 (0.96–1.60)	0.012	–	–
20–35 years	1		–	
>35 years	1.24 (1.06–1.45)		–	
Marital status				
Single/separated/divorced/widowed	1.25 (0.8–1.97)	0.325	–	–
Married/cohabitating	1		–	
Woman's education level				
No formal education	2.6 (2.17–3.11)	<0.001	2.17 (1.8–2.61)	<0.001
Completed primary education	1.86 (1.46–2.38)		1.6 (1.24–2.06)	
Completed secondary education or more	1		1	
Woman's occupation				
Professional/technical/managerial	1	<0.001	–	–
Sales/trading	1.41 (1.16–1.71)		–	
Not gainfully employed/manual labour/other	1.57 (1.33–1.86)		–	
Partner's occupation				
Professional/technical/managerial	1	<0.001	1	<0.001
Sales/trading	1.6 (1.38–1.86)		1.52 (1.3–1.78)	
Not gainfully employed/manual labour/other	2.3 (1.99–2.66)		1.98 (1.7–2.31)	
Previous obstetric characteristics				
Parity				
Nullipara	1.07 (0.94–1.22)	<0.001	1.07 (0.93–1.23)	<0.001
Multipara (1–4)	1		1	
Grand multipara (5 or more)	2.23 (1.9–2.62)		1.73 (1.44–2.07)	
Women has had previous caesarean section				
No	1	<0.001	1	<0.001
Yes	1.71 (1.36–2.15)		1.79 (1.41–2.27)	
Woman has had previous miscarriage				
No	1	0.265	–	–
Yes	1.08 (0.95–1.22)		–	
Chronic medical disorder (pre-pregnancy)[b]				
Yes	1.06 (0.85–1.31)	0.604	–	–
No	1		–	
Current pregnancy				
Antenatal care booking (ANC)				
No ANC	3.42 (2.91–4.02)	<0.001	1.95 (1.59–2.4)	<0.001
ANC at the same facility	1		1	
ANC at another health facility	3.3 (2.86–3.8)		1.82 (1.46–2.26)	
ANC with traditional birth attendant or informal setting	2.81 (1.43–5.52)		1.21 (0.51–2.9)	
Booking estimated gestational age				
<13 weeks	1	0.148	–	–
13–26 weeks	0.83 (0.68–1.00)		–	
>26 weeks	0.86 (0.70–1.06)		–	

(Continues)

TABLE 3 (Continued)

	OR (95% CI)	P[a]	aOR (95% CI)	P[a]
Referral status				
Not referred or self-referred	1	<0.001	1	0.004
Referred from public or private hospital	3.17 (2.76–3.64)		1.21 (0.98–1.49)	
Referred from informal setting	5.15 (3.28–8.1)		2.35 (1.37–4.02)	
Multiple pregnancy				
Yes	3.24 (2.58–4.06)	<0.001	2.7 (2.10–3.47)	<0.001
No	1		1	
Prolonged labour[c]				
Yes	1.21 (1.00–1.47)	0.054	–	–
No	1		–	
Partograph use				
Yes	1	<0.001	–	–
No	1.7 (1.42–2.02)		–	
Episiotomy				
Yes	0.78 (0.68–0.9)	<0.001	–	–
No	1		–	
Pregnancy-induced hypertension				
Yes	1.73 (1.34–2.23)	<0.001	1.45 (1.10–1.93)	0.009
No	1		1	
Antepartum haemorrhage				
Yes	19.91 (16.44–24.1)	<0.001	11.74 (9.41–14.66)	<0.001
No	1		1	
Prophylactic uterotonics				
Yes	1	0.542	–	–
No	0.92 (0.69–1.21)		–	
Type of delivery				
Spontaneous vaginal birth	1	<0.001	1	<0.001
Assisted vaginal birth	3.66 (2.67–5.00)		2.13 (1.48–3.06)	
Birthweight				
<2499 g	2.44 (2.15–2.78)	<0.001	–	–
2500–3999 g	1		–	
≥4000 g	1.34 (1.03–1.74)		–	

[a]*P*-value obtained from the generalised linear mixed model (GLMM) model.
[b]Diabetes, asthma, sickle cell anaemia, tuberculosis, HIV, hepatitis, cardiac disease, renal disease, thyroid disease, epilepsy or other medical disorder.
[c]Only for women who underwent labour.

The main prophylactic uterotonic used was oxytocin, followed by a combination of oxytocin and misoprostol (Table 5).

Maternal mortality occurred in 104 women (104/2169, 4.8%), and a prolonged hospital stay was recorded in 45.7% (992/2169), with 8.5% (101/1182) admitted into the intensive care unit. The most common indications for intensive care unit admission were disseminated intravascular coagulopathy for vaginal birth (12.5%) and anaemia for CS birth (24.6%) (Table 6). One-quarter of infants were stillborn (570/2307), with 66.4% antepartum and 33.6% intrapartum stillbirths (Table 7). About one-fifth (429/1796, 23.9%) of the neonates were admitted into neonatal intensive care units. The most common indications for neonatal intensive care unit admission were birth asphyxia, prematurity and presumed sepsis (Table 7).

4 | DISCUSSION

4.1 | Main findings

The overall prevalence of PPH in our study was 3.2%, whereas the prevalence was 2.7% and 4.0% for vaginal and CS births, respectively. Factors associated with primary PPH included maternal age of >35 years, high parity, fewer

TABLE 4 Sociodemographic and clinical risk factors for postpartum haemorrhage following caesarean section.

	OR (95% CI)	P[a]	aOR (95% CI)	P[a]
Sociodemographic characteristics				
Age				
<20 years	0.64 (0.36–1.12)	<0.001	0.55 (0.29–1.04)	<0.001
20–35 years	1		1	
>35 years	1.67 (1.43–1.94)		1.71 (1.46–2.00)	
Marital status				
Single/separated/divorced/widowed	0.72 (0.39–1.33)	0.295	–	–
Married/cohabitating	1		–	
Woman's education level				
No formal education	2.14 (1.56–2.94)	<0.001	2.03 (0.40–2.81)	<0.001
Completed primary education	1.21 (0.87–1.68)		1.16 (1.22–1.63)	
Completed secondary education or more	1		1	
Woman's occupation				
Professional/technical/managerial	1	0.038	–	–
Sales/trading	1.19 (1.00–1.42)		–	
Not gainfully employed/manual labour/other	0.96 (0.81–1.14)		–	
Partner's occupation				
Professional/technical/managerial	1	0.001	1	0.003
Sales/trading	1.25 (1.05–1.49)		1.25 (1.04–1.49)	
Not gainfully employed/manual labour/other	1.35 (1.15–1.60)		1.34 (1.13–1.60)	
Previous obstetric characteristics				
Parity				
Nullipara	0.67 (0.57–0.79)	<0.001	0.71 (0.60–0.93)	<0.001
Multipara (1–4)	1		1	
Grand multipara (5 or more)	1.92 (1.51–2.46)		1.51 (1.16–1.98)	
Women has had previous caesarean section				
No	1	0.043	–	–
Yes	0.85 (0.72–1.00)		–	
Woman has had previous miscarriage				
No	1	0.014	1	0.027
Yes	1.2 (1.04–1.38)		1.18 (1.02–1.37)	
Chronic medical disorder (pre-pregnancy)[b]				
Yes	0.83 (0.67–1.03)	0.098	–	–
No	1		–	
Current pregnancy				
Antenatal care booking (ANC)				
No ANC	1.57 (1.26–1.96)	<0.001	–	–
ANC at the same facility	1		–	
ANC at another health facility	1.31 (1.11–1.54)		–	
ANC with traditional birth attendant or in informal setting	1.58 (0.75–3.30)		–	
Estimated gestational age at booking				
<13 weeks	1	0.968	–	–
13–26 weeks	1.04 (0.79–1.36)		–	
>26 weeks	1.03 (0.76–1.39)		–	

(Continues)

TABLE 4 (Continued)

	OR (95% CI)	P[a]	aOR (95% CI)	P[a]
Referral status				
Not referred or self-referred	1	<0.001	1	0.002
Referred from public or private hospital	1.27 (1.08–1.50)		1.14 (0.95–1.37)	–
Referred from informal setting	2.52 (1.63–3.89)		2.4 (1.44–3.99)	–
Cadre of attending accoucher				
Consultant	1.49 (1.07–2.07)	0.008	1.63 (1.14–2.33)	0.002
House/Medical Officer	1		1	
Resident Doctor	1.1 (0.81–1.50)		1.12 (0.81–1.56)	
Nurse/Midwife/other	0.85 (0.44–1.62)		1.04 (0.53–2.04)	
Multiple pregnancy				
Yes	1.77 (1.40–2.23)	<0.001	1.65 (1.28–2.13)	<0.001
No	1		1	
Partograph use[c]				
Yes	1	<0.001	–	–
No	1.72 (1.32–2.23)		–	
Episiotomy[b]				
Yes	0.65 (0.23–1.82)	0.411	–	–
No	1		–	
Pregnancy-induced hypertension				
Yes	0.72 (0.53–0.99)	0.042	–	–
No	1		–	
Antepartum haemorrhage				
Yes	4.28 (3.39–5.40)	<0.001	3.65 (2.83–4.70)	<0.001
No	1		1	
Prophylactic uterotonics				
Yes	1	0.824	–	–
No	0.97 (0.75–1.26)		–	
Type of delivery				
Elective caesarean section	1	0.005	1	0.003
Emergency caesarean section	1.24 (1.07–1.44)		1.3 (1.09–1.54)	
Birthweight				
<2499 g	1.42 (1.22–1.66)	<0.001	–	–
2500–3999 g	1		–	
≥4000 g	1.3 (1.04–1.63)		–	

[a] *P*-value obtained from the generalised linear mixed model (GLMM) model.

[b] Diabetes, asthma, sickle cell anaemia, tuberculosis, HIV, hepatitis, cardiac disease, renal disease, thyroid disease, epilepsy or other medical disorder.

[c] Variable not considered in the adjusted model owing to the lack of partograph use in elective CS.

years of formal education and low-skilled employment. Associated antenatal characteristics and peripartum events include previous caesarean delivery, place of antenatal care or delivery, presence of antepartum haemorrhage and mode of delivery.

4.2 | Strengths and weaknesses

This study had several strengths. The harmonised nature of the data collection across the six geopolitical regions of Nigeria resulted in a large sample size that included uncomplicated pregnancies, allowing the risk factors for PPH to be explored as well as allowing stratification by mode of birth. One limitation was the estimation of blood loss by visual estimation. We did not include haemodynamic changes in the definition of PPH. This could have resulted in the under-reporting of PPH. In addition, the data collection involved many hospitals and researchers, and some degree of heterogeneity in the interpretation of clinical terms cannot be completely excluded, despite the training provided before and during the study.

The findings from this study did not capture women who did not access care at the participating hospitals. In Nigeria, a significant proportion of home deliveries still occur. Thus, the findings are not generalisable to lower-level facilities or community settings.

TABLE 5 Prophylactic uterotonic options utilised for postpartum haemorrhage in women with postpartum haemorrhage (PPH).

	Women with PPH (*N* = 1880)	
	n/*N*	%
Uterotonic options		
Oxytocin alone	856/1880	45.5
Ergometrine alone	7/1880	0.4
Misoprostol alone	45/1880	2.4
Cabetocin alone	5/1880	0.3
Oxytocin + ergometrine	76/1880	4
Oxytocin + misoprostol	809/1880	43
Oxytocin + ergometrine + misoprostol	38/1880	2
Cabetocin + oxytocin	3/1880	0.2
Cabetocin + misoprostol	8/1880	0.4

4.3 | Interpretation

In this study, the overall prevalence of 3.2% was higher than the 1.6% reported from Zimbabwe,[4] but was lower than the 6.3%, 9.0% and 9.4% reported from Zambia, Uganda and Ethiopia, respectively.[14,15,16] The study conducted in Zambia maintained higher figures when further disaggregated to 4.6% and 13.8% for vaginal delivery and CS, respectively.[14] On the other hand, a lower figure of 1.3% was quoted for vaginal deliveries in Cameroon.[17] One possible reason for the low prevalence observed in our study may be the method of blood loss estimation, which is usually a visual estimation in these facilities. Photospectometry and the gravimetric method are more accurate, but are more expensive and cumbersome.[18]

Women older than 35 years had a higher risk of PPH, whether they had a vaginal or CS delivery. In the literature, advanced maternal age is associated with an increased risk of complications such as hypertensive disorders, instrumental delivery and macrosomia, which are all conditions that predispose the mother to PPH.[19,20] However, Lao et al. were able to show that advanced maternal age was actually associated with a decreased incidence of PPH, reporting a progressive decrease from 25–29 to 40 years of age, on account of age-dependent decreased uterine perfusion and endometrial

TABLE 6 Maternal outcomes of postpartum haemorrhage.

	Vaginal birth		Caesarean section		
	n/*N*	%	*n*/*N*	%	*P*[a]
Maternal outcome					
Death					
Yes	48/1253	3.8	56/916	6.1	<0.001
No	1205/1253	96.2	860/916	93.9	
Morbidity after birth[b]					
Yes	799/1253	63.8	420/916	45.9	<0.001
No	454/1253	36.2	496/916	54.1	
Prolonged hospital stay[c]					
Yes	606/1107	54.7	386/805	48	<0.001
No	501/1107	45.3	419/805	52	
Admission to intensive care unit (ICU)					
Yes	32/771	4.2	69/411	16.8	<0.001
No	739/771	95.8	342/411	83.2	
Reason for admission to ICU					
Sepsis[d]	3/32	9.4	2/69	2.9	–
Anaemia necessitating ICU admission[d]	3/32	9.4	17/69	24.6	–
Disseminated intravascular coagulopathy[d]	4/32	12.5	3/69	4.3	–
Renal failure[d]	4/32	12.5	5/69	7.2	–
Liver failure[d]	0/32	0	0/69	0	–

[a] *P*-value obtained from the generalised linear mixed model (GLMM) model.

[b] No maternal complication between delivery and hospital discharge.

[c] Prolonged stay is defined as occurring when the number of days between the date of admission and the date of discharge is greater than 2 days for vaginal deliveries and 5 days for caesarean sections.

[d] Owing to the low number of cases the model could not be used.

TABLE 7 Perinatal outcomes of postpartum haemorrhage.

	Vaginal birth		Caesarean section		
	n/N	%	*n/N*	%	*P*[a]
Perinatal outcome					
Alive at birth					
Yes	944/1349	70	856/1021	83.8	<0.001
No	405/1349	30	165/1021	16.2	
Stillbirth					
Antepartum	258/405	63.7	119/163	73	<0.001
Intrapartum	147/405	36.3	44/163	27	
Neonatal death[b]					
Yes	22/945	2.3	28/858	3.3	<0.001
No	923/945	97.7	830/858	96.7	
Admission to neonatal intensive care unit (NICU)					
No	784/940	83.4	583/856	68.1	<0.001
Yes	156/940	16.6	273/856	31.9	
NICU indication					
Birth asphyxia	50/156	32.1	74/273	27.1	<0.001
Trauma[c]	1/156	0.6	4/273	1.5	–
Jaundiced	5/156	3.2	20/273	7.3	<0.001
Congenital anomaly[c]	2/156	1.3	6/273	2.2	–
Prematurity	45/156	28.8	80/273	29.3	<0.001
Presumed neonatal sepsis	28/156	17.9	26/273	9.5	<0.001
Hypoxic ischaemic encephalopathy	10/156	6.4	19/273	7	<0.001
Other	40/156	25.6	89/273	32.6	–

[a]*P*-value obtained from the generalised linear mixed model (GLMM) model.
[b]Baby died before discharge from hospital.
[c]Owing to the low number of cases the model could not be used.

blood flow.[21] This was the result of sclerotic lesions and longitudinally oriented smooth muscle replacing the normal circularly oriented smooth muscle in the media of the uterine intramyometrial arteries.[21] Lao et al. concluded that the increased PPH seen in advanced maternal age was merely the result of an increased occurrence of complications and interventions seen in this group of parturients.[21] Such pregnancies are deemed to be at high risk and are best managed in settings with appropriate personnel and resources.

Characteristics such as fewer years of formal education and low-skilled employment have a considerable impact on a woman's choice of place for antenatal care and delivery.[22,23] The women with PPH were less likely to have registered for antenatal care and were more likely to have been referred.[23] Health facilities that offer maternity services should have well-trained personnel, appropriate infrastructure and an adequate supply of consumables and essential drugs to prevent poor outcomes.[24,25] Increasing health literacy improves public knowledge of the benefits of using skilled health care.[26]

The obstetric history of women in our study revealed that women with PPH had more cases of previous CS or multiple pregnancies. Lauterbach et al. reported an increased risk of PPH with previous caesarean delivery,[27] whereas studies in Zambia and Uganda have reported an increased risk of PPH with multiple pregnancies.[14,15] There has been a global increase in the rate of caesarean delivery, with a concomitant encouragement of trial of labour after caesarean delivery (TOLAC),[28,29] which may be complicated by uterine rupture, PPH and the need for blood transfusion.[29,30] On the other hand, the overdistension of the uterus in multiple pregnancies may result in impaired myometrial contractility and an increased incidence of uterine atony.[31]

The occurrence of antepartum haemorrhage (APH), assisted vaginal delivery or emergency CS was also associated with PPH. Placenta praevia and abruptio placenta account for over 50% of cases of APH,[32,33] and are associated with an increased risk of CS, uterine atony and coagulation failure.[32] Women with risk factors for PPH (including APH, previous uterine scar or anterior placenta) should have a care plan covering the third stage of labour and should be attended by experienced obstetricians and anaesthetists in units with adequate blood transfusion facilities.[34]

The management of PPH has evolved with the advent of better drugs for prophylaxis and therapeutic purposes. Oxytocin is the first-line drug, and the addition

of misoprostol improves its effectiveness.[35] In our study, oxytocin was the most commonly used prophylactic uterotonic, followed by its combination with misoprostol. Carbetocin, a heat-stable and long-lasting agonist,[36] is expensive and not readily available. Only 16 women in the current study with PPH were administered carbetocin.

With a maternal mortality ratio (MMR) as high as 1000 per 100 000 live births, PPH not only accounts for 30% of maternal deaths in Africa and Asia,[37,38] but it is also associated with significant long-term complications. For example, it has been estimated that 12% of survivors develop severe anaemia postpartum, and a woman who has a PPH near miss has a significant risk of dying in the following year from the effects of PPH.[39] Indeed, in our study, anaemia as a result of PPH was the most common reason for intensive care unit admission postpartum. Phase-3 delays (i.e. a delay in accessing care on arrival at a health facility) owing to deficiencies in the availability, timeliness and appropriateness of emergency obstetric care are factors that determine survival when PPH occurs.[40,41] The initiation of resuscitation, with volume expanders, non-pneumatic antishock garments and uterotonics, in lower-level hospitals before and during referral to tertiary hospitals will improve the survival of women with organ dysfunction. The availability of specialist care during obstetric emergencies has been shown to be associated with better maternal outcomes.[41,42]

One possible next step is the implementation of a PPH protocol and planning the appropriate place of delivery for women, especially when risk factors are identified. Clinicians at all levels of the maternity service need training and resources to be skilled and prepared to recognise and manage PPH.

5 | CONCLUSION

The burden of primary PPH in this obstetric population remains considerable. Several associated factors are modifiable and preventable. Training and the rational distribution of resources will improve these poor outcomes.

AUTHOR CONTRIBUTIONS

All authors were involved in the data collection for the study, the development of the concept note for the analysis and the interpretation of the results (through a series of virtual meetings). TA and O. Adesina wrote the first draft of the article. All authors reviewed the draft for intellectual content and approved the final version of the article for publication.

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CONFLICT OF INTEREST STATEMENT

All authors declare that they have no competing interests associated with the conduct of this research.

DATA AVAILABILITY STATEMENT

All relevant data are available from within the article.

ETHICS APPROVAL

The scientific content of the study was approved by the WHO Human Reproduction Programme (HRP) Research Project Review Panel (A65930, 6 May 2018). The WHO Ethics Review Committee (A65930, 5 June 2018) and the Nigerian National Health Research and Ethics Committee (NHREC/01/01/2007, 5 September 2018) approved the study. The authorities of all participating hospitals granted written institutional approval to participate in the data collection, periodic analyses and reporting for the programme. Individual-level written consent was not required as the study did not involve direct interaction with women, or their babies, or interviews with medical staff.

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