KJMHS
KORDOFAN JOURNAL OF MEDICAL AND HEALTH SCIENCES

KJMHS 2026; Vol. 3 (Issue 2)
Online ISSN: 3027-5601
Manuscript ID: KUJMS-V.3.I.2.04

Management and Maternal Outcomes of Primary Postpartum Hemorrhage: A Cross-Sectional Study at Wad Medani Maternity Teaching Hospital, Sudan

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Article Type	Received	Accepted	DOI
Original Article	1st May. 2026	19 May. 2026	10.70946/KJMHS3-2-26-P-103

ABSTRACT

Background: Laparoscopic Background: Primary postpartum haemorrhage (PPH) is among the foremost contributors to maternal morbidity and mortality in sub-Saharan Africa, yet hospital-level data from Sudan remain sparse. This study examined the causes, risk factors, management modalities, and maternal outcomes of primary PPH at a major Sudanese referral centre. **Methods:** A descriptive cross-sectional study was conducted prospectively at Wad Medani Maternity Teaching Hospital, Gezira State, Sudan, from January to December 2023. A consecutive sample of 211 women with primary PPH (blood loss ≥500 mL within 24 hours of vaginal delivery, or ≥1000 mL after caesarean section) was recruited. Data were collected by structured interviewer-administered questionnaire and analysed using SPSS v.25. **Results:** Uterine atony was the predominant aetiology (76.3%), followed by genital tract trauma (12.8%) and retained placental tissue (10.0%). Prolonged third stage of labour was the most frequent risk factor (74.9%). Medical management with uterotonic agents succeeded in 83.0% of cases; the remaining 17.0% required surgical intervention. Orthostatic hypotension (73.5%), anaemia (33.6%), and dilutional coagulopathy (16.1%) were the most common maternal complications. **Conclusion:** Uterine atony driven by prolonged third-stage labour dominates the PPH burden at this centre. Timely uterotonic administration and consistent implementation of active management of the third stage of labour are the most actionable strategies to reduce maternal morbidity.

Keywords: postpartum haemorrhage; uterine atony; maternal morbidity; Sudan; obstetric emergency; active management of the third stage of labour, bariatric surgery, obesity, comorbidity resolution, long-term outcomes, Saudi Arabia.

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INTRODUCTION

Haemorrhage after delivery constitutes a major proportion of preventable maternal deaths in low- and middle-income countries, and primary postpartum haemorrhage (PPH) — defined as blood loss of 500 mL or more within 24 hours of vaginal delivery, or 1000 mL or more following caesarean section — is widely regarded as the most critical of these haemorrhagic events. [1] Globally, obstetric haemorrhage is estimated to account for roughly one quarter of all maternal deaths, with the absolute burden concentrated in sub-Saharan Africa and South Asia, where health-system capacity to manage acute blood loss is often constrained. [2,3]

Sudan carries a disproportionately heavy load of maternal mortality attributable to haemorrhage. Persistent deficits in the availability of uterotonic drugs, functioning blood banks, skilled birth attendants, and timely surgical services compound the clinical challenge of PPH in many

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Sudanese health facilities. [4] Within this context, Gezira State one of the most populous states in Sudan presents a clinical environment in which the burden of primary PPH reflects both the national pattern and the specific resource constraints of a large public referral hospital.

The aetiology of primary PPH is conventionally organised around the '4 Ts' framework: Tone (failure of uterine contractility, i.e., uterine atony), Trauma (lacerations and haematomas of the genital tract), Tissue (retained products of conception), and Thrombin (coagulation disorders). [5] Among these, impaired uterine contractility is the most prevalent mechanism globally, underpinning the rationale for oxytocin-based prevention and treatment protocols. [6] Several additional obstetric and patient-level factors have been identified as predictors of primary PPH in published literature, including prolonged third stage of labour, grand multiparity, foetal macrosomia, multiple gestation, and a previous episode of PPH. [7,8]

Early recognition of predisposing factors, accurate identification of the causative mechanism, and stepwise escalation of treatment — from uterotonic agents and fluid resuscitation through to surgical haemostasis or hysterectomy — are the cornerstones of effective PPH management. [9] Even when haemorrhage is brought under control, the haemodynamic and haematological sequelae of acute blood loss can be substantial, encompassing anaemia, coagulopathy, haemodynamic instability, and, in severe cases, ischaemic end-organ injury. [10]

Despite the magnitude of the problem, peer-reviewed hospital-based data characterising the causes, risk factors, management patterns, and maternal outcomes of primary PPH specifically within Sudanese obstetric units are scarce. An understanding of the local epidemiology is prerequisite to designing targeted quality-improvement interventions. This study was therefore undertaken to describe the causes, risk factors, management approaches, and maternal outcomes of primary PPH among women admitted to Wad Medani Maternity Teaching Hospital, Gezira State, Sudan, during 2023.

METHODOLOGY

Study design

This was a descriptive cross-sectional hospital-based study conducted prospectively at Wad Medani Maternity Teaching Hospital, Gezira State, Sudan, over a one-year period from January 2023 to December 2023.

Study setting

Wad Medani Maternity Teaching Hospital is the principal tertiary referral and teaching facility for obstetrics and gynaecology in Gezira State, situated in east-central Sudan between the Blue Nile and White Nile. The hospital serves women from Gezira State and adjacent regions, is staffed by consultant obstetricians and gynaecologists, registrars, house officers, paediatricians, nurses, and midwives, and operates round-the-clock emergency obstetric care with supporting laboratory, blood bank, pharmacy, intensive care, and antenatal and postnatal outpatient services.

Study population, inclusion and exclusion criteria

All women admitted to Wad Medani Maternity Teaching Hospital during the study period who received a diagnosis of primary PPH within 24 hours of delivery were eligible for inclusion, provided they gave written informed consent. Women without a diagnosis of primary PPH and those who declined participation were excluded.

Sample size and sampling technique

The required sample size was estimated using the finite-population correction formula:

$$n = N / [1 + N(e)^2]$$

where N = estimated population size (approximately 450 cases of primary PPH recorded at the hospital during the study period) and e = margin of error (0.05). This yielded a minimum required sample of 211 participants, who were recruited consecutively until the target was achieved.

Data collection

Data were gathered by the principal investigator, registrars, and trained house officers using a structured interviewer-administered questionnaire administered after obtaining written informed consent from each participant. The instrument captured sociodemographic characteristics (age, educational level, occupation, residence), obstetric characteristics (parity, mode of

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delivery), aetiology and risk factors of primary PPH, management approaches employed, and maternal complications recorded.

Data analysis

Data were entered, cleaned, and analysed using the Statistical Package for the Social Sciences (SPSS) version 25 (IBM Corp., Armonk, NY, USA). Categorical variables were summarised as absolute frequencies and percentages. Statistical significance was set at a p-value of <0.05 with 95% confidence intervals.

Ethical considerations

Ethical approval was obtained from the Research Ethics Committee of Wad Medani Maternity Hospital, Gezira State, Sudan, and institutional permission was granted by the hospital administration. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from every participant before enrolment. All data were anonymised and used exclusively for research purposes.

RESULTS

A total of 211 women diagnosed with primary PPH were enrolled. The mean maternal age was 31.2 ± 7.4 years; the largest age group was 31-40 years (51.1%). Most participants were housewives (65.9%), 44.1% had attained university-level education or above, and 58.8% were urban residents versus 41.2% from rural areas. The majority were multiparous (61.3%), with primigravidae accounting for 28.9% and grand multipara for 10.0%.

Risk factors

Prolonged third stage of labour was the most frequently documented risk factor, present in 158 (74.9%) women. Additional risk factors included episiotomy (10.4%), foetal macrosomia (6.2%), multiple pregnancy (4.7%), and a previous history of PPH (3.8%). **(Table 1)**

Table 1 Risk factors associated with primary postpartum haemorrhage (n = 211)

Risk Factor	Frequency	Percentage (%)
Prolonged third stage of labour	158	74.9
Episiotomy	22	10.4
Fetal macrosomia	13	6.2
Multiple pregnancy	10	4.7
Previous history of PPH	8	3.8

Causes of primary PPH

Uterine atony was identified as the cause in 161 (76.3%) of the 211 cases, making it by far the most prevalent aetiology. Genital tract trauma accounted for 12.8% of cases, retained placental tissue for 10.0%, and coagulation disorders for 0.9%. **(Table 2)**

Table 2 Causes of primary postpartum haemorrhage (n = 211)

Cause	Frequency	Percentage (%)
Uterine atony	161	76.3
Genital tract trauma	27	12.8
Retained placental tissue	21	10.0
Coagulation disorders	2	0.9

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Management outcomes

The majority of cases (175; 83.0%) were managed successfully with medical treatment alone, primarily uterotonic agents in conjunction with fluid resuscitation and supportive care. Thirty-six women (17.0%) required escalation to surgical intervention. **(Table 3)** Table 3 Management outcomes of primary postpartum haemorrhage (n = 211)

Management Outcome	Frequency	Percentage (%)
Resolved by medical management	175	83.0
Required surgical management	36	17.0

Operative interventions

Among the 36 surgically managed cases, uterine compression sutures were performed in 34 women (16.1%), bilateral uterine artery ligation in 31 (14.7%), and hysterectomy in 22 (10.4%). **(Table 4)**

Table 4 Operative interventions among surgically managed cases

Operative Intervention	Frequency	Percentage (%)
Uterine compression sutures	34	16.1
Bilateral uterine artery ligation	31	14.7
Hysterectomy	22	10.4

Maternal complications

Orthostatic hypotension was the most common maternal complication, recorded in 155 (73.5%) women. This was followed by anaemia (33.6%), fatigue (25.6%), and dilutional coagulopathy or disseminated intravascular coagulation (16.1%). Occult myocardial ischaemia occurred in three women (1.4%) and anterior pituitary ischaemia in two (0.9%). **(Table 5)**

Table 5. Maternal complications associated with primary postpartum haemorrhage (n = 211)

Complication	Frequency	Percentage (%)
Orthostatic hypotension	155	73.5
Anaemia	71	33.6
Fatigue	54	25.6
Dilutional coagulopathy / DIC	34	16.1
Occult myocardial ischaemia	3	1.4
Anterior pituitary ischaemia	2	0.9

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DISCUSSION

This hospital-based study enrolled 211 women with primary PPH at Wad Medani Maternity Teaching Hospital and characterised the aetiological distribution, associated risk factors, treatment modalities, and maternal complications encountered at this Sudanese referral centre.

The mean maternal age of 31.2 ± 7.4 years, with the predominance of women in the fourth decade, is compatible with the typical reproductive-age profile seen in Sudanese referral obstetric services. Earlier investigations by Widmer et al. and Ngwenya et al. have documented that advancing maternal age is associated with a higher susceptibility to PPH, a relationship attributed in part to progressive impairment of uterine contractile reserve and the accumulating burden of comorbid obstetric conditions with increasing parity. [11,12]

Uterine atony emerged as the underlying mechanism in 76.3% of cases in the present series. This finding closely tracks the global evidence base, in which uterine atony is consistently reported as responsible for approximately 70 to 80 percent of all primary PPH episodes.5,6 A large multicentre surveillance study conducted across thirteen public hospitals in eastern Ethiopia similarly identified uterine atony as the principal underlying cause in 77% of PPH cases, a proportion virtually identical to that recorded at our centre. [21] A case-control study from Southern Oromia hospitals in Ethiopia further confirmed that uterine atony, alongside prolonged labour and multiple gestation, was among the strongest independent predictors of primary PPH, with risk estimates consistent with those observed in the present study. [22] The alignment between our local data and these published African figures reinforces that the pathophysiology of PPH in this Sudanese setting does not differ fundamentally from that described elsewhere in sub-Saharan Africa. [13,14] At the same time, the particularly high atony rate observed here may reflect suboptimal application of prophylactic oxytocin at the time of delivery, an area that warrants audit-level scrutiny at the facility.

The distribution of the remaining aetiologies genital tract trauma (12.8%) and retained placental tissue (10.0%) is consistent with the proportions reported in comparable sub-Saharan African studies and accords with the classical '4 Ts' model. [5,7] Coagulation disorders were infrequent (0.9%), consistent with their recognised status as a rare primary cause of PPH in the absence of placental abruption or pre-existing haematological disease.

Prolonged third stage of labour was the most prevalent risk factor, present in 74.9% of cases. This finding is supported by evidence from Gedeo Zone, Southern Ethiopia, where women with a prolonged third stage of labour were five times more likely to develop primary PPH compared to those with a normal third stage (AOR = 5.6; 95% CI: 2.9–8.50). [23]

A systematic review and meta-analysis further confirmed that a third stage of labour lasting 15 minutes or more was associated with a fivefold increase in PPH risk (OR 5.55), underscoring the critical importance of timely placental delivery and consistent implementation of active management of the third stage of labour (AMTSL). [24] The present findings suggest that adherence to AMTSL protocols at this institution should be systematically evaluated and reinforced. Episiotomy, foetal macrosomia, multiple pregnancy, and prior PPH were also identified as risk factors; these associations have been consistently documented in the literature and reflect the increased mechanical stress on uterine and perineal tissues, as well as the predisposition toward atony resulting from uterine overdistension. [7,8]

Medical management with uterotonic agents principally oxytocin, supplemented by misoprostol and ergometrine was successful in 83% of cases. A Cochrane network meta-analysis of uterotonic agents confirmed that intravenous oxytocin remains the most

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effective and best-tolerated first-line agent for PPH treatment, while misoprostol serves as a valuable adjunct particularly in settings where cold-chain maintenance is unreliable. [25] The landmark E-MOTIVE randomised trial, conducted across 80 secondary-level hospitals in Kenya, Nigeria, South Africa, and Tanzania, demonstrated that early PPH detection combined with a bundled treatment approach comprising uterine massage, oxytocic drugs, tranexamic acid, and intravenous fluids resulted in a 60% reduction in severe PPH outcomes, underscoring the critical importance of timely and structured intervention in African settings comparable to ours. [26] The high medical success rate observed in our study likely reflects a similar pattern of prompt uterotonic administration, and the E-MOTIVE findings suggest that formalising detection and treatment protocols at our facility could further reduce the proportion requiring surgical escalation.

Among the 17% of cases requiring operative management, a step-wise approach was documented: uterine compression sutures and uterine artery ligation were performed before proceeding to hysterectomy, in keeping with current guidance that prioritises uterus-conserving techniques. [9,19] A recent prospective cohort study from Hong Kong confirmed that uterine compression sutures as a first-line surgical intervention successfully controlled haemorrhage in the majority of cases, with acceptable subsequent fertility and menstrual outcomes, supporting their use as a conservative measure prior to hysterectomy. [27] The hysterectomy rate of 10.4% among all cases is higher than figures reported in high-income settings but is broadly consistent with rates observed in sub-Saharan African tertiary hospitals, where delays in referral and limited availability of interventional radiology increase the likelihood that haemorrhage is already severe by the time surgical haemostasis is attempted. [20]

The pattern of maternal complications recorded in this study — with orthostatic hypotension as the most frequent finding (73.5%), followed by anaemia (33.6%), fatigue (25.6%), and dilutional coagulopathy (16.1%) reflects the expected haemodynamic and haematological consequences of acute volume depletion. The FIGO 2022 recommendations highlight that in healthy postpartum women, conventional vital signs such as blood pressure and pulse may not change until more than 1000 mL of blood has been lost, making early clinical recognition of PPH particularly challenging and explaining the high prevalence of haemodynamic complications observed in our cohort. [28]

A review of PPH management in low- and middle-income countries further noted that pre-existing anaemia substantially worsens the outcome of acute haemorrhage, a consideration particularly relevant to the Sudanese context where anaemia in pregnancy remains prevalent. [29] The occurrence, although infrequent, of severe ischaemic complications including occult myocardial ischaemia (1.4%) and anterior pituitary ischaemia Sheehan syndrome (0.9%) underscores the potential for catastrophic end-organ injury when haemorrhage is uncontrolled or treatment is delayed.

Collectively, the results indicate that primary PPH at this centre is largely manageable with medical therapy when intervention is timely, but that a material proportion of women require surgical escalation and sustain significant morbidity. The high success rate of medical management, even in a resource-constrained environment, supports investment in uterotonic availability and skills-based training as the primary quality-improvement priorities. The convergence of our findings with those of recent multicentre African studies strengthens the generalisability of these conclusions within the sub-Saharan context.

This study is strengthened by its prospective design and comprehensive clinical data collection at a single

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high-volume referral centre. Limitations include the single-site cross-sectional design, which restricts external generalisation, and the use of convenience sampling, which may introduce selection bias. Quantitative blood-loss measurement was not standardised, which may affect the precision of case ascertainment. Future multicentre prospective studies incorporating objective haemorrhage quantification and health-system delay analysis are warranted to generate nationally representative data for Sudan.

Conclusion

This cross-sectional study of 211 women with primary PPH at Wad Medani Maternity Teaching Hospital demonstrated that uterine atony most commonly associated with prolonged third stage of labour is the dominant aetiological mechanism at this referral centre. The majority of cases responded successfully to medical management with uterotonic agents, while one in six women required surgical intervention. Significant maternal morbidity, particularly haemodynamic instability and anaemia, was common. These findings highlight the need for consistent enforcement of active management of the third stage of labour, reliable availability of uterotonic medications, and investment in staff training to reduce the burden of primary PPH-related morbidity at this facility and comparable Sudanese obstetric units.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. Strengthening active management of the third stage of labour (AMTSL): Routine and consistent implementation of AMTSL including prophylactic oxytocin, controlled cord traction, and uterine massage should be enforced in all delivery rooms.
2. Availability of essential resources: Continuous supply of uterotonic drugs (particularly oxytocin), intravenous fluids, blood, and blood products must be guaranteed across all maternity units.
3. Early identification and risk assessment: Women with identifiable risk factors (prolonged labour, multiple pregnancy, macrosomia, grand multiparity, prior PPH) should receive heightened surveillance during labour and the immediate postpartum period.
4. Training and capacity building: All maternity-care providers should undertake regular simulation-based training in PPH prevention, recognition, and stepwise management, including emergency drills.
5. Standardised management protocols: Clear, up-to-date PPH management algorithms should be displayed prominently and adhered to across all obstetric units.
6. Rapid response systems: Structured teamwork, clear communication pathways, and rapid-response mechanisms within labour wards are essential to minimise treatment delays.
7. Antenatal anaemia management: Iron deficiency anaemia should be identified and treated during antenatal care to limit the severity of PPH-related haematological complications.
8. Further research: Multicentre prospective studies are needed to evaluate health-system factors, clinical practices, and socio-cultural determinants of PPH outcomes across Sudan.

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