RESEARCH ARTICLE

Risk factors for composite adverse outcomes of postpartum haemorrhage, Mpilo Central Hospital, Bulawayo, Zimbabwe [version 2; peer review: 1 approved, 1 approved with reservations, 1 not approved]

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Abstract

Background
Globally, primary postpartum haemorrhage continues to cause considerable maternal morbidity and mortality. The aim of this study was to determine the risk factors for composite adverse outcomes of postpartum haemorrhage. The findings could potentially be used to anticipate and prevent composite adverse outcomes of postpartum haemorrhage.

Methods
This was a retrospective cross-sectional study carried out at Mpilo Central Hospital, a government tertiary referral centre, covering the period 1 July 2016 to 30 November 2019. Participants were included in the study if they had a diagnosis of postpartum haemorrhage. Those variables that had a p<0.2 from the univariate logistic regression analyses were considered for multivariable logistic regression. The association between independent variables and the dependent variable was assessed using odds ratio with 95% confidence intervals, to identify independent risk factors for composite adverse outcomes of postpartum haemorrhage. A p<0.05 was taken as statistically significant.

Results
The independent risk factors for composite adverse outcomes of postpartum haemorrhage were place of dwelling (AOR 4.57, 95% CI 1.87-11.12, p=0.01), prior Caesarean section (AOR 2.57, 95% CI 1.10-6.00, p=0.03), antepartum haemorrhage (AOR 5.45, 95% CI 2.23-13.27, p<0.0001), antenatal haemoglobin level (AOR 19.64, 95% CI 1.44-268.50, p=0.03), and current delivery by Caesarean section (AOR 10.21, 95% CI 4.39-23.74, p<0.0001).

Blood loss was also an independent risk factor for composite adverse
outcomes of postpartum haemorrhage with the following blood loss; 1001-1500ml (AOR 9.94, 95% CI 3.68-26.88, \( p<0.0001 \)), 500-1000ml (AOR 41.27, 95% CI 11.32-150.54, \( p<0.0001 \)), and 2001ml (AOR 164.77, 95% CI 31.06-874.25, \( p<0.0001 \)).

**Conclusion**

This study found that the independent predictors for composite adverse outcomes of PPH were rural dwelling, prior Caesarean section, antenatal haemoglobin level, current delivery by Caesarean section, and blood loss. In low- and middle-income countries such information could help in increasing clinical vigilance and policy making, and preventing maternal deaths.

**Keywords**

Postpartum haemorrhage, risk factors, composite adverse outcomes, low-resource settings

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**Introduction**

The definition of primary postpartum haemorrhage (PPH) is that of blood loss from the genital tract of ≥500 mL or more following a normal vaginal delivery or ≥1,000 mL or more following a cesarean section within 24 hours of delivery as evidenced by a rise in the pulse rate, and falling blood pressure\(^1\). PPH is an obstetric emergency. Prevention of PPH should be the aim with each delivery. The active management of the third stage of labour done routinely reduces the incidence of PPH, and the administration of oxytocin after delivery of the anterior shoulder being the most important and effective component of the active management practice\(^2\). The management of PPH include the use of additional oxytocic agents, multiple blood transfusions, uterine packing, balloon tamponade, B-Lynch sutures\(^3\), and peripartum hysterectomy\(^4\).

Every day in 2017, approximately 810 women died from all causes related to pregnancy and childbirth, and 94% of all maternal deaths occurred in low and lower middle-income countries\(^5\). Researchers have reported in a systematic analysis that low- and middle income countries accounted for 480,000 maternal deaths (32%) compared with 1200 (8%) in the developed regions\(^6\). PPH is the leading cause of maternal deaths in Sub-Saharan Africa\(^7\).

The multi-country Survey on Maternal and Newborn Health reported the prevalence of PPH to be 1.2%, with higher rates in developing countries than developed ones\(^8\). Other studies in Sub-Saharan Africa reported rates of 1.6% in Zimbabwe, 16.6% in Southern Ethiopia, 9% in Uganda and 23.6% in Cameroon\(^9\)\(^10\)\(^11\), respectively. Ford et al. reported increasing PPH rates from 6.1% in 2003 to 8.3% in 2011 (p<0.0001) in Australia due to better recording of PPH\(^12\).

Two-third of women with PPH having no identifiable risk factors\(^13\). Recognized risk factors for PPH include previous PPH, twin gestation, large baby, induction of labour, prolonged labour, operative delivery, preeclampsia, caesarean delivery, grand multiparity, maternal age 35 or above, and postdates\(^14\)\(^15\)\(^16\).

Tort et al. found the following factors were significantly associated with PPH maternal mortality: age over 35 years, living in Mali, residing outside the region location of the hospital, pre-existing chronic disease before pregnancy, prepartum severe anemia, forceps or vacuum delivery, birth weight greater than 4000 grams, transfusion, transfer to another hospital. They also reported that there was a smaller risk of PPH maternal death in hospitals with gynecologist-obstetrician\(^17\).

Women suffering a PPH can face significant risks. Serious maternal morbidity include multiple blood transfusions, and their associated risks peripartum hysterectomy\(^18\), utliple organ failure, maternal collapse, and maternal mortality.

**Methods**

**Study type, setting and participants**

This was a retrospective cross-sectional study carried out at Mpilo Central Hospital, a government tertiary referral centre, covering the period 1 July 2016 to 30 November 2019. Mpilo Central Hospital is situated in the township of Mzilikazi in Bulawayo. Bulawayo, is the second largest city in Zimbabwe after the capital city Harare, with a population of 653,337 as of the 2012 census\(^19\). Participants were included in the study if they had a diagnosis of postpartum haemorrhage within 24 hours of delivery at Mpilo Central Hospital. Mpilo Central Hospital delivers an average of 10 000 babies per year. It has a 20 bedded, consultant-led labour ward. There are 150 midwives and 30 medical personnel that work in it. A single-centre study was chosen so that to exposure women to one standardized care so that risk factors could be determined without other confounding factors. Therefore, women that delivered outside the hospital were excluded from the study to control for confounding factors.

**Independent variables**

The independent variables included socio-demographic factors, mode of delivery, fetal characteristics, blood loss, laboratory tests, causes of PPH and the management of PPH.

**Main outcome measure**

The main outcome of interest for the study was the composite adverse outcome which included maternal death or serious morbidity (either of hypovolaemic shock or haemoglobin <4g/dL or massive blood transfusion >4 units or hysterectomy or admission to ICU or coagulopathy or major organ dysfunction), similar to the the Delphi consensus study on PPH\(^20\).

**Data collection**

Data was collected for the period 1 July 2016 to 30 November 2019, recording all the women that met the criteria during the study period. Data collection was done by using a paper data collection tool, that was used to collect secondary data from the labour ward delivery registers, and mortality
Data analysis
Data were cleaned, coded and entered into a Microsoft Excel spreadsheet, then exported to SPSS Version 20 (IBM, Armonk, NY, USA) for analysis. Descriptive statistical analyses were performed and presented as frequencies and percentages for categorical variables. Bivariate correlations of association between main independent variables and the outcome measures were performed using Pearson 2-tailed chi-square test. A p value of <0.05 was considered to be statistically significant, and these were considered for the univariate logistic regression. Those variables that had a p<0.2 from the univariate logistic regression analyses were considered for multivariable logistic regression. The association between independent variables and the dependent variable was assessed using odds ratio with 95% confidence intervals, to identify independent risk factors for composite adverse outcomes in PPH, holding other variables constant and adjusting for co-variates. The Hosmer-Lemeshow goodness-of-fit was used to check if the model fitted well. A p< 0.05 was taken as statistically significant.

Ethical approval
The Ethics Committee at Mpilo Central Hospital made a ruling for all retrospective studies to go ahead in the institution from 2016 onwards as long as the data remained anonymous. No individual patient consent was necessary as the study was retrospective and the data was anonymous. No ethical issues will arise during the study as all the data will remain anonymous with no identifying personal data. Minutes of the Committee’s inaugural meeting held on the 13th October 2016 set out the requirements of all the studies at the institution.

Results
Socio-demographic characteristics of participants
A total of 386 cases of PPH were recorded during the period 1 July 2016 to 30 October 2019. The summary of maternal and fetal characteristics are shown Table 1–Table 5. The majority (27.7%) of women were aged 25–29 years. 60.1% of women were of gestational age of 37–40 weeks. 87.0% of women were from urban dwelling. More than three-thirds (67.9%) had normal vaginal delivery. The commonest risk factor present for PPH was preeclampsia (25.1%). 71.7% of the babies weighed 2501–4000g. 73.6% of women lost 500-1000ml of blood. The commonest cause of PPH was uterine atony (78.8%). The maternal mortality rate was 2.8%, and the composite adverse outcome rate was 11.1%. Table 6 shows the bivariate correlations. De-identified results are available for each patient as Underlying data.

Risk factors for composite adverse outcomes
Table 7 and Table 8 show the results of the multivariable logistic regression. Rural women were 4.6 times more likely to be statistically significantly associated with composite adverse outcomes compared to women from urban areas (AOR 4.57, 95% CI 1.87-11.12, p=0.01).

History of Caesarean section
Women with a prior Caesarean section were statistically significantly associated with composite adverse outcomes of PPH.

### Table 1. Maternal and fetal characteristics.

| Variable                           | Median | Interquartile range |
|------------------------------------|--------|--------------------|
| Maternal age (years)               | 28     | 23–33              |
| Gravidity                          | 3      | 2–4                |
| Parity                             | 1      | 1–2                |
| Gestational age (weeks)            | 139    | 37–40              |
| Antenatal haemoglobin (g/dL)       | 11.3   | 10.3–12.2          |
| Platelet count (x10^9/L)           | 205    | 160–266            |
| Blood loss (ml)                    | 800    | 600–1100           |
| Birth weight (g)                   | 3200   | 2700–3550          |

Only the post-delivery haemoglobin level was normally distributed with a mean of 9.6 g/dL (SD±2.4).

NB: Blood loss is estimated blood loss plus measured blood loss as protocol for the unit in all PPH cases.

### Table 2. Socio-demographic characteristics of study patients.

| Characteristic         | Frequency | Percentage (%) |
|------------------------|-----------|----------------|
| Age (years)            | n=386     |                |
| 14–20                  | 61        | 15.8           |
| 21–24                  | 67        | 17.4           |
| 25–29                  | 107       | 27.7           |
| 30–34                  | 77        | 19.9           |
| 35 and above           | 74        | 19.2           |
| Gestational age (weeks)| n=386     |                |
| 24–30                  | 19        | 4.9            |
| 31–34                  | 18        | 4.7            |
| 35–36                  | 40        | 10.4           |
| 37–40                  | 232       | 60.1           |
| 41 and above           | 77        | 19.9           |
| HIV status             | n=385     |                |
| Negative               | 293       | 76.1           |
| Positive               | 79        | 20.5           |
| Unknown                | 13        | 3.4            |
| Place of dwelling      | n=386     |                |
| Urban                  | 336       | 87.0           |
| Rural                  | 50        | 13.0           |
| Mode of delivery       | n=386     |                |
| Normal vaginal delivery| 262       | 67.9           |
| Vacuum                 | 2         | 0.5            |
| Forceps                | 1         | 0.3            |
| LSCS                   | 121       | 31.3           |

LSCS, lower segment caesarean section; HIV; human immunodeficiency virus
Antenatal haemoglobin count

Antenatal haemoglobin count was also statistically significantly associated with composite adverse outcomes of PPH. Women with haemoglobin counts of 0–5.99 g/dL were 19.6 times more likely to be statistically significantly associated with composite adverse outcomes of PPH compared with women with haemoglobin counts of 11 g/dL and above (AOR 19.64, 95% CI 1.44-268.50, p=0.03).

Current delivery by Caesarean section

Current delivery by Caesarean section was statistically significantly associated with composite adverse outcomes of PPH. Women who had a Caesarean section were 10.2 times more likely to be statistically significantly associated with composite adverse outcomes of PPH compared to women who delivered vaginally (AOR 10.21, 95% CI 4.39-23.74, p<0.0001).

Blood loss

Blood loss was statistically significantly associated with composite adverse outcomes of PPH. The odds rose significantly higher as the amount of blood loss increased. Women who lost 1001–1500 ml of blood were 9.9 times more likely to be statistically significantly associated with composite adverse outcomes, compared to women that lost 500–1000 ml (AOR 9.94, 95% CI 3.68-26.88, p<0.0001). The odds rose to 41.3 times more likely to be associated with composite adverse outcomes in those women who lost 1501–2000ml compared to those women who lost 500–1000 ml (AOR 41.27, 95% CI 11.32-150.54, p<0.0001). Whereas women who lost 2001 ml and above were 164.8 times more likely to be statistically significantly associated with composite adverse outcomes.

### Table 3. Present risk factors for PPH.

| Risk factors                  | Frequency (n=386) | Percentages (%) |
|-------------------------------|-------------------|-----------------|
| Past history of PPH          | 8                 | 2.1             |
| Past history of APH           | 4                 | 1.0             |
| Previous LSCS                 | 55                | 14.3            |
| Preeclampsia                  | 97                | 25.1            |
| APH                           | 46                | 11.9            |
| Presence of fibroids          | 4                 | 1.0             |
| Large for dates               | 31                | 8.0             |
| Intrauterine death (IUD)      | 37                | 9.7             |
| Induction of labour (IOL)     | 8                 | 2.1             |
| Prolonged labour (>18 hours)  | 54                | 14.0            |
| Oxytocin augmentation         | 4                 | 1.0             |
| Multiple risk factors         | 76                | 21.8            |

**APH; antepartum haemorrhage**

### Table 4. Fetal birth weight, blood loss and causes of PPH.

| Variable               | Frequency (n=414) | Percentages (%) |
|------------------------|-------------------|-----------------|
| Fetal birth weight (g) |                   |                 |
| 0–1500                 | 25                | 6.0             |
| 1501–2500              | 71                | 17.1            |
| 2501–4000              | 297               | 71.7            |
| 4001 and above         | 21                | 5.1             |
| Blood loss (ml)        | n=386             |                 |
| 500–1000               | 284               | 73.6            |
| 1001–1500              | 67                | 17.4            |
| 1501–2000              | 21                | 5.4             |
| 2001 and above         | 14                | 3.6             |
| Causes of PPH          | n=386             |                 |
| Perineal trauma        | 49                | 12.7            |
| Retained placenta      | 22                | 5.7             |
| Uterine atony          | 304               | 8.8             |
| Bleeding disorder      | 1                 | 2.6             |
| Ruptured uterus        | 10                | 0.2             |

| Variable               | Frequency (n=386) | Percentages (%) |
|------------------------|-------------------|-----------------|
| Management             |                   |                 |
| Additional oxytocic doses | 355             | 92.0            |
| Rectal misoprostol     | 16                | 4.1             |
| Intravenous fluids     | 367               | 95.1            |
| Blood transfusion      | 105               | 27.2            |
| FFP/platelet transfusion | 10               | 2.6             |
| Vaginal packing        | 10                | 2.6             |
| Perineal repair        | 36                | 9.3             |
| Manual removal of placenta | 22             | 5.7             |
| Outcomes               |                   |                 |
| Hypovolaemic shock     | 15                | 3.9             |
| Haemoglobin of <4g/dL  | 5                 | 1.3             |
| Massive blood transfusion | 24              | 6.2             |
| Coagulopathy           | 1                 | 0.3             |
| Hysterectomy           | 22                | 5.7             |
| Admission to ICU       | 22                | 5.7             |
| Mortality              | 11                | 2.8             |
| Composite adverse outcomes | 43              | 11.1            |

**FFP; fresh frozen plasma, ICU; intensive care unit**

Such women were 2.6 times more likely to be statistically significantly associated with composite adverse outcomes of PPH, compared to women without such history (AOR 2.57, 95% CI 1.10-6.00, p=0.03).

Antepartum haemorrhage

Antepartum haemorrhage (APH) was statistically significantly associated with composite adverse outcomes of PPH. Women who presented with APH were 5.5 times more likely to be statistically significantly associated with composite adverse outcomes of PPH compared to women who had no APH (AOR 5.45, 95% CI 2.23-13.27, p<0.0001).
of PPH compared to women who lost 500–1000 ml (AOR 164.77, 95% CI 31.06-874.25, p<0.0001).

Discussion
The strengths of this study include the fact that it used a large homogenous cohort of women with PPH that could make the findings generalizable to other places with similar populations in Sub-Saharan Africa, a region where PPH continues to contribute significantly to global mortality and morbidity. Secondly, using data from a single-centre meant that women received standardized care reducing confounding factors. Thirdly, this study is one of the few and unique ones in that it calculated risk factors for composite adverse outcomes of PPH unlike the previous ones that calculated risk factors for PPH. Therefore, the study adds new information on risk factors for composite adverse outcomes.

PPH rates have been reported to be rising in both low-income and high-income countries11,12. Hence PPH will remain an important global subject. There are few studies in the literature that specifically determined risk factors for composite adverse outcomes of primary PPH, rather there are many studies on risk factors for primary PPH.

Rural dwelling was associated with composite adverse outcomes. National governments need to made healthcare accessible to rural women so that the Sustainable Development Goals on Maternal Mortality to reduce global maternal mortality ratio to less than 70 per 100 000 live births by 2030, could be achievable.

Women with a prior Caesarean section were associated with composite adverse outcomes of PPH. The means that women with a prior Caesarean section should receive extra clinical vigilance. Women who had a current Caesarean section were also associated with composite adverse outcomes of PPH. Women with a prior Caesarean sections, and those with current Caesarean sections should be closely monitored post-operatively to reduce the risks of adverse outcomes.

Antepartum haemorrhage was statistically significantly associated with composite adverse outcomes of PPH. Low haemoglobin levels were associated with composite adverse outcomes of PPH. Comparatively, a study in Senegal and Mali by Tort et al. found prepartum severe anaemia was associated with maternal mortality in PPH13. This was similar to the findings of this study. Hence anaemia should be screened for antenatally and women should receive treatment so that they enter labour with normal haemoglobin counts. This will also cover up for possible complications like antepartum haemorrhage.

Massive blood loss was as expected associated with composite adverse outcomes of PPH. The amount of blood loss was found to be related to adverse maternal outcomes14. Prompt, effective prevention and management of PPH12, should be the aim to reduce the amount of blood loss and prevent the development of composite adverse outcomes.

The determination of risk factors for composite adverse outcomes of PPH is critical as it could help in reducing the risks of maternal mortality that women with PPH face.

Limitations
Its major limitation is that it was a retrospective, single-centre study that used secondary data. This could limit the generalizability of its findings to other centres of low-resourced settings who may not be using the same management standards or have fewer healthcare personnel.

Conclusions
The independent predictors for composite adverse outcomes of PPH were rural dwelling, a prior Caesarean section, antenatal haemoglobin level, and current delivery by Caesarean section. Blood loss was also an independent predictor for composite adverse outcomes of PPH. All these risk factors are easily identifiable and should be clearly noted by attending clinicians. Crucially, this new information should help in increasing clinical vigilance and preventing maternal deaths especially in low- and middle income countries were PPH

| Variable                        | P-value       |
|---------------------------------|---------------|
| Age                             | <0.0001       |
| Gravidity                       | 0.01          |
| Parity                          | 0.004         |
| Gestational age                 | 0.03          |
| HIV status                      | 0.01          |
| Antiretroviral therapy          | 0.05          |
| Booked                          | 0.01          |
| Referred                        | 0.31          |
| Unbooked                        | 0.025         |
| Place of dwelling               | <0.0001       |
| Past history of PPH             | 0.31          |
| Past history of APH             | 0.38          |
| Previous LSCS                   | 0.001         |
| Preeclampsia                    | 0.24          |
| APH                             | <0.0001       |
| Presence of fibroids            | 0.48          |
| Large for gestational age       | 0.40          |
| IUD                             | <0.0001       |
| IOL                             | 0.90          |
| Prolonged labour                | 0.35          |
| Oxytocin augmentation           | 0.48          |
| Antenatal haemoglobin           | 0.04          |
| Blood loss                      | <0.0001       |
| Post PPH haemoglobin            | <0.0001       |
| Perineal trauma                 | 0.09          |
| Uterine atony                   | 0.10          |
| Bleeding disorder               | 0.72          |
| Ruptured uterus                 | 0.02          |
| Oxytocin drip                   | 0.04          |
| Rectal misoprostol              | 0.32          |
| Vaginal packing                 | 0.26          |
| Perineal repairs                | 0.09          |
| Manual removal of placenta      | 0.75          |

Table 6. Bivariate correlations between independent variables and composite adverse outcome.
Table 7. Univariate and multivariate analysis between demographics and composite adverse outcome in PPH.

| Variable                  | Univariate Odds ratio | 95% Confidence Interval | P-value | Multivariate Odds ratio | 95% Confidence Interval | P-value |
|---------------------------|-----------------------|--------------------------|---------|-------------------------|--------------------------|---------|
|                           |                       | Lower                    | Upper   |                         | Lower                    | Upper   |         |
| Age (years)               |                       |                          |         |                         |                          |         |         |
| 14–20                     | Reference             |                          |         |                         |                          |         |         |
| 21–24                     | 1.87                  | 0.33                     | 10.61   | 0.48                    | 1.31                     | 0.16    | 10.88   | 0.80    |
| 25–29                     | 3.38                  | 0.72                     | 15.79   | 0.12                    | 1.65                     | 0.19    | 14.04   | 0.65    |
| 30–34                     | 3.42                  | 0.70                     | 16.74   | 0.13                    | 1.92                     | 0.21    | 18.01   | 0.57    |
| 35 and above              | 9.48                  | 2.10                     | 42.75   | 0.003                   | 3.33                     | 0.35    | 31.55   | 0.29    |
| Gravidity                 |                       |                          |         |                         |                          |         |         |
| 1–2                       | Reference             |                          |         |                         |                          |         |         |
| 3–4                       | 3.23                  | 0.87                     | 11.98   | 0.08                    | 2.05                     | 0.35    | 12.10   | 0.43    |
| 4 and above               | 4.61                  | 1.36                     | 15.57   | 0.01                    | 2.18                     | 0.20    | 23.39   | 0.52    |
| Parity                    |                       |                          |         |                         |                          |         |         |
| 0–1                       | Reference             |                          |         |                         |                          |         |         |
| 2–3                       | 1.41                  | 0.61                     | 3.27    | 0.42                    | 0.80                     | 0.14    | 4.61    | 0.80    |
| 4 and above               | 2.91                  | 1.40                     | 6.08    | 0.004                   | 1.30                     | 0.21    | 8.00    | 0.78    |
| Gestational age (weeks)   |                       |                          |         |                         |                          |         |         |
| 24–30                     | Reference             |                          |         |                         |                          |         |         |
| 31–34                     | 0.83                  | 0.20                     | 3.43    | 0.80                    | 2.55                     | 0.36    | 17.88   | 0.35    |
| 35–36                     | 0.54                  | 0.16                     | 1.87    | 0.33                    | 3.46                     | 0.61    | 19.61   | 0.16    |
| 37–40                     | 0.18                  | 0.06                     | 0.54    | 0.002                   | 0.97                     | 0.22    | 4.15    | 0.96    |
| 41 and above              | 0.18                  | 0.05                     | 0.66    | 0.01                    | 0.84                     | 0.16    | 4.38    | 0.83    |
| Marital status            |                       |                          |         |                         |                          |         |         |
| Single                    | Reference             |                          |         |                         |                          |         |         |
| Married/Divorced          | 2.20                  | 0.94                     | 5.15    | 0.07                    | 2.05                     | 0.79    | 5.36    | 0.14    |
| No. foetuses              |                       |                          |         |                         |                          |         |         |
| Single                    | Reference             |                          |         |                         |                          |         |         |
| Multiple                  | 0.27                  | 0.04                     | 2.02    | 0.20                    | 0.16                     | 0.02    | 1.33    | 0.10    |
| HIV status                |                       |                          |         |                         |                          |         |         |
| Negative                  | Reference             |                          |         |                         |                          |         |         |
| Positive                  | 2.21                  | 1.09                     | 4.47    | 0.03                    | 1.79                     | 0.40    | 7.96    | 0.44    |
| Antiretroviral therapy    |                       |                          |         |                         |                          |         |         |
| No                        | Reference             |                          |         |                         |                          |         |         |
| Yes                       | 1.99                  | 1.00                     | 3.97    | 0.05                    | 1.46                     | 0.71    | 3.01    | 0.31    |
| Unbooked                  |                       |                          |         |                         |                          |         |         |
| No                        | Reference             |                          |         |                         |                          |         |         |
| Yes                       | 2.49                  | 1.10                     | 5.63    | 0.03                    | 0.20                     | 0.01    | 1.16    | 0.06    |
| Place of dwelling         |                       |                          |         |                         |                          |         |         |
| Urban                     | Reference             |                          |         |                         |                          |         |         |
| Rural                     | 4.71                  | 2.30                     | 9.67    | <0.0001                 | 4.57                     | 1.87    | 11.12   | 0.001   |
Table 8. Univariate and multivariate analysis between risk factors, blood tests and interventions and composite adverse outcome in PPH.

| Variable                  | Univariate Odds ratio | 95% Confidence Interval | P-value | Multivariate Odds ratio | 95% Confidence Interval | P-value |
|---------------------------|-----------------------|-------------------------|---------|-------------------------|-------------------------|---------|
|                           |                       | Lower | Upper |                           | Lower | Upper |                           |         |
| Previous LSCS             |                       |       |       |                           |       |       |                           |         |
| No                        | Reference 3.11        | 1.50  | 6.42  | 0.002                    | 2.57  | 1.10  | 6.00                     | 0.03     |
| Yes                       | Reference 1.51        | 0.76  | 3.00  | 0.24                     | 1.50  | 0.69  | 3.28                     | 0.31     |
| Preeclampsia              |                       |       |       |                           |       |       |                           |         |
| No                        | Reference 7.08        | 3.45  | 14.55 | <0.0001                  | 5.45  | 2.23  | 13.27                    | <0.0001  |
| Yes                       | Reference 5.76        | 2.66  | 12.46 | <0.0001                  | 2.12  | 0.79  | 5.70                     | 0.14     |
| APH                       |                       |       |       |                           |       |       |                           |         |
| No                        | Reference 24.89       | 2.63  | 235.46| 0.01                     | 19.64 | 1.44  | 268.50                   | 0.03     |
| Yes                       | Reference 1.12        | 0.52  | 2.43  | 0.77                     | 1.53  | 0.61  | 3.80                     | 0.36     |
| IUD                       |                       |       |       |                           |       |       |                           |         |
| No                        | Reference 0.61        | 0.19  | 1.92  | 0.004                    | 0.84  | 0.06  | 1.44                     | 0.29     |
| Yes                       | Reference 0.21        | 0.08  | 0.61  | 0.004                    | 0.84  | 0.06  | 1.44                     | 0.29     |
| ANC Hb (g/dL)             |                       |       |       |                           |       |       |                           |         |
| 0–5.99                    | Reference 24.89       | 2.63  | 235.46| 0.01                     | 19.64 | 1.44  | 268.50                   | 0.03     |
| 6–10.99                   | Reference 1.12        | 0.52  | 2.43  | 0.77                     | 1.53  | 0.61  | 3.80                     | 0.36     |
| 11 and above              |                       |       |       |                           |       |       |                           |         |
| Mode of delivery          |                       |       |       |                           |       |       |                           |         |
| NVD                       | Reference 12.92       | 5.77  | 28.93 | <0.0001                  | 10.21 | 4.39  | 23.74                    | <0.0001  |
| LSCS                      | Reference 3.11        | 1.50  | 6.42  | 0.002                    | 2.57  | 1.10  | 6.00                     | 0.03     |
| Vacuum, forceps*          | Reference 0.61        | 0.19  | 1.92  | 0.004                    | 0.84  | 0.06  | 1.44                     | 0.29     |
| Birth weight (g)          |                       |       |       |                           |       |       |                           |         |
| 0–1500                    | Reference 0.61        | 0.19  | 1.92  | 0.004                    | 0.84  | 0.06  | 1.44                     | 0.29     |
| 1501–2500                 | Reference 0.21        | 0.08  | 0.61  | 0.004                    | 0.84  | 0.06  | 1.44                     | 0.29     |
| 2501–4000                 |                       |       |       |                           |       |       |                           |         |
| 4001 and above            |                       |       |       |                           |       |       |                           |         |
| Blood loss (ml)           |                       |       |       |                           |       |       |                           |         |
| 500–1000                  | Reference 9.95        | 4.02  | 24.67 | <0.0001                  | 9.94  | 3.68  | 26.88                    | <0.0001  |
| 1001–1500                 | Reference 31.36       | 10.36 | 94.97 | <0.0001                  | 41.27 | 11.32 | 150.54                   | <0.0001  |
| 1501–2000                 | Reference 86.25       | 22.23 | 334.69| <0.0001                  | 164.77| 31.06 | 874.25                   | <0.0001  |
| 2001 and above            |                       |       |       |                           |       |       |                           |         |
| Post-delivery Hb (g/dL)   |                       |       |       |                           |       |       |                           |         |
| 0–5.99                    | Reference 9.03        | 2.70  | 30.21 | <0.0001                  | 4.73  | 0.95  | 23.58                    | 0.06     |
| 6–10.99                   | Reference 2.19        | 0.86  | 5.55  | 0.10                     | 1.33  | 0.42  | 4.22                     | 0.63     |
| 11 and above              |                       |       |       |                           |       |       |                           |         |
| Perineal trauma           |                       |       |       |                           |       |       |                           |         |
| No                        | Reference 0.31        | 0.07  | 1.31  | 0.11                     | 1.16  | 0.11  | 12.23                    | 0.90     |
| Yes                       | Reference 2.20        | 0.84  | 5.78  | 0.11                     | 1.91  | 0.42  | 8.73                     | 0.40     |
| Uterine atony             |                       |       |       |                           |       |       |                           |         |
| No                        | Reference 3.81        | 1.12  | 12.94 | 0.03                     | 1.34  | 0.18  | 10.13                    | 0.78     |
| Yes                       | Reference 0.39        | 0.16  | 0.96  | 0.04                     | 0.30  | 0.05  | 2.01                     | 0.22     |
| Ruptured uterus           |                       |       |       |                           |       |       |                           |         |
| No                        | Reference 0.45        | 0.14  | 1.41  | 0.17                     | 0.90  | 0.14  | 6.03                     | 0.91     |
| Yes                       | Reference 2.10        | 0.03  | 1.57  | 0.13                     | 0.43  | 0.02  | 8.10                     | 0.58     |
| Intravenous fluids        |                       |       |       |                           |       |       |                           |         |
| No                        | Reference 0.39        | 0.16  | 0.96  | 0.04                     | 0.30  | 0.05  | 2.01                     | 0.22     |
| Yes                       | Reference 0.45        | 0.14  | 1.41  | 0.17                     | 0.90  | 0.14  | 6.03                     | 0.91     |
mortality is of high prevalence. Regular on-site training of staff can focus on drilling on this important issues and can improve outcomes\(^3\).

**Data availability**

**Underlying data**

Mendeley Data: Composite adverse outcomes in primary PPH. [https://doi.org/10.17632/wjtn8rmgcc.3\(^2\)].

This project contains the following underlying data:

- PPH-Data-Share (XLSX). The raw de-identified data gathered from each patient examined in this study.

De-identified individual-level data for all patients.

**Extended data**

Mendeley Data: Composite adverse outcomes in primary PPH. [https://doi.org/10.17632/wjtn8rmgcc.3\(^2\)].

This project contains the following extended data:

- Data Collection Sheet-PPH (DOCX).

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

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Version 2

Reviewer Report 14 December 2020

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Jaffu O. Chilongola
Kilimanjaro Christian Medical Centre, Kilimanjaro Clinical Research Institute, Moshi, Tanzania

The author seems not to accept/adopt most of the changes. This brings the question of whether any other review and comments to the author will be of any use.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Infectious diseases, Immunology, Molecular Biology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 29 October 2020

https://doi.org/10.5256/f1000research.30195.r73166

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Eba Abdisa
Department of Psychiatry, School of Nursing and Midwifery, Institute of Health Sciences, Wollega University, Nekemte, Ethiopia

I am happy because the author addressed all of my previous comments. I want to appreciate him. Now the paper is in a position to be indexed.

Competing Interests: No competing interests were disclosed.
I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 18 September 2020

https://doi.org/10.5256/f1000research.25139.r69904

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Eba Abdisa
Department of Psychiatry, School of Nursing and Midwifery, Institute of Health Sciences, Wollega University, Nekemte, Ethiopia

Title: Risk factors for composite adverse outcomes of postpartum hemorrhage in a low-resource setting: a single-center cross-sectional study in Mpilo Central Hospital, Bulawayo, Zimbabwe

- The title seems interesting, particularly it tried to address the problem of the low-income countries, but it should be arranged as "Risk factors for Composite adverse outcome of postpartum hemorrhage in Mpilo central hospital, Bulawayo, Zimbabwe: Cross sectional study" - this is because this country is known to be in low resource by default; no need to say "in a low resource setting".

Abstract:

Background: "Primary postpartum hemorrhage continues to cause considerable global maternal morbidity and mortality."

- Rewrite the above statement as "Globally, primary postpartum hemorrhage continues to cause considerable maternal morbidity and mortality".

Conclusion: how is such information useful for preventing death? What are possible methods? Who will use this information? You must state some of them in the background section. From all independent factors, which one is difficult to prevent? Be specific when you conclude your findings.

Introduction:

- Your citation in paragraph one: you didn't take the information from the primary results, rather you cited the secondary result(paper). Please try to address the first research finding and cite it correctly

- Instead of ‘say et al, ford et al, Tort et al’, use ‘researcher(s), report(s), finding(s)…

- Are the 810 women's death related to PPH? You must be specific.
○ What makes the increment of PPH from 6.1%-8.3% in Australia? Please present some evidence findings for the reason that the researchers stated.

○ In paragraph 5, you said, ‘Tort et al used multivariable mixed mode’, please state only what the study assessed and what it got, and avoid the methodology the researchers used.

○ Poor composite adverse outcome (para. 5): you must clearly define it.

○ **Significance of the study:** the last paragraph stated the importance of this study. But do you think that your findings might help only clinicians? What about your study population? What about the policy makers?

○ Your introduction section seems shallow.

○ APH: write the full version.

**Methods:**

○ Why did you only use a single study setting? Please justify.

○ What if the women delivered outside by developed PPH? Why did you exclude such a risk group? Giving birth out of healthcare setting will even be expected to the complication. Please say something.

○ Detailed description is expected regarding your study area: number of deliveries per year/month, number of skilled birth attendants (midwifery, physicians & others).

○ **Data collection:** this seems shallow. It was not clear how you selected your study group (sample size). How did you collect data of 385? Did you start from a specific year? Example random vs nonrandom?

○ **Data analysis:** software package that you used to enter data(excel). In this case, it seems difficult to manage missed data and mistakes. Why don't you use Epidata, epi-info...?

○ Why did the committee waive the requirement for patient consent?

**Discussion:** It seems well organized.

○ But consider to compare your findings with others' past international/national findings and put your opinion when you get the difference.

**Is the work clearly and accurately presented and does it cite the current literature?**

Yes

**Is the study design appropriate and is the work technically sound?**

Partly

**Are sufficient details of methods and analysis provided to allow replication by others?**
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Partly

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: women health, mental health, clinical condition, child health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 26 August 2020
https://doi.org/10.5256/f1000research.25139.r64325

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Michael Johnson Mahande
Department of Epidemiology & Biostatistics, Institute of Public Health, Kilimanjaro Christian Medical University College, Moshi, Tanzania

Risk factors for composite adverse postpartum haemorrhage in a low resources setting: a single-centre cross sectional study in Mpilo Central Hospital Bulawayo, Zimbabwe.

Section
Comment, question, suggestion.

Abstract

1. The abstract background should consist a few statements that explain the meaning and aim of the study not the model used. The model used (multivariable logistic regression) can be explained in the methods section.

Introduction

Background

1. No comment.

Methodology

1. Why did authors calculate sample size while the study utilized data that were retrospective
collected? I expected the study could use all available data and power could be calculated instead of the sample size.

Results
1. It could be more important if the tables for social demographic characteristics and clinical characteristics were included in the manuscript.

2. In presenting numbers in the table is better to have the standard decimal points to be presented especially when presenting p-values.

3. Consider combining single and divorced in marital status as divorced have few participants for regression analysis.

Discussion
1. NONE.

Strengths and limitations
1. Despite being a study involving a single center, what is the strength of this study?

Conclusion
1. No comment.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
Partly

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Reproductive Health, Maternal Newborn & Sexual Adolescent Health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.
It is surprising that this manuscript has only one author. This means the lone author did everything from conceiving the ideas, data collection, analysis, writing the manuscript. It has to be confirmed that NO one else has participated in this work.

2. Age ranges in table 1 variables are too narrow to provide useful information on the outcome variable.

3. The analyses are weak perhaps because the design was also weak. When A low post delivery Hb level is considered as a risk for PPH it brings the confusion what would otherwise be expected. Similarly, when Ruptured uterus is tested for its association with PPH. Many of the predictors are obviously inherently related to the outcome variable. It is unclear what information this manuscript attempting to bring forth.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
No

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Infectious diseases, Immunology, Molecular Biology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.
Author Response 11 Oct 2020

Solwayo Ngwenya, Mpilo Central Hospital, Bulawayo, Zimbabwe

Reviewer 1

1. It is surprising that this manuscript has only one author. This means the lone author did everything from conceiving the ideas, data collection, analysis, writing the manuscript. It has to be confirmed that NO one else has participated in this work. I can confirm that I am the sole author. Response: I have done many studies of this magnitude before as a sole author.

2. Age ranges in table 1 variables are too narrow to provide useful information on the outcome variable. Response: I have decided to leave them as they are as this didn't not affect the logistic regression.

3. The analyses are weak perhaps because the design was also weak. When A low post delivery Hb level is considered as a risk for PPH it brings the confusion what would otherwise be expected. Similary, when Ruptured uterus is tested for its association with PPH. Many of the predictors are obviously inherently related to the outcome variable. It is unclear what information this manuscript attempting to bring forth. Response: Comments noted.

Competing Interests: None