Prevalence and risk factors associated with preeclampsia, low birth weight and postpartum hemorrhage in Northern Ghana.

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Abstract

Background: The study evaluated the risks for developing low birth weight (LBW), preeclampsia (PE) and postpartum hemorrhage (PPH) in relation to maternal socio-demographic, obstetric characteristics and clinical laboratory information obtained at 1st antenatal care (ANC) visit.

Methods: The study included 268 pregnant women attending 1st ANC visit at the Bolgatanga Regional Hospital. Structured questionnaires were used to obtain socio-demographic and obstetric data from respondents. The main variables were LBW, PPH, PE, mode of delivery, residency, gestational age at 1st ANC visit, maternal age, sickling positivity, Hb at 1st ANC visit, Hb genotype and G6PD status. Odds ratio [OR, 95% confidence interval (CI)] for the association between socio-demographic, obstetric characteristics and clinical variables in relation to PE, LBW and PPH were assessed using logistic regression model.

Results: The prevalence of PE, LBW and PPH were 25.4% (68/268), 15.7% (42/268) and 6.0% (16/268), respectively. For PE, delayed 1st ANC visit (AOR=16.82, 95% CI (3.61-78.5), p=0.000) and younger maternal age (AOR= 15.19, 95% CI (1.85-124.56), p=0.011) were independently associated with higher odds whereas vaginal delivery (AOR=0.32, 95% CI (0.15-0.71), p=0.015) was independently associated with reduced odds. Delayed 1st ANC visit (AOR=0.12, 95% CI (0.03-0.47)), p=0.002) independently reduced the risk of PPH whereas the male gender (AOR=7.75, 95% CI (1.60-37.51), p=0.011) independently increased the risk of PPH. Lastly, delayed 1st ANC visit (AOR=3.26, 95% CI (1.05-10.10), p=0.041) was independently associated with increased odds of LBW whereas vaginal delivery (AOR=0.36, 95% CI (0.17-0.74), p=0.006) was an independent risk factor for LBW in the multivariate model.

Conclusion: The study identified delayed ANC visit as an independent risk factor for PE, LBW and PPH in Northern Ghana. Vaginal delivery and younger maternal age were also independent risk factors for PE. Additionally, the male gender was independently associated with PPH whereas vaginal delivery was independently associated with LBW. We recommend that public health education for pregnant women that highlights the importance of early ANC visit be enhanced. This will facilitate early identification and intervention for women with risk of foeto-maternal
complications. Younger women should be educated on the dangers of early marriages with its attendant foeto-maternal complications.

*Keywords:* PPH; PE; LBW; Hb-genotype; Sickling; Blood group; G6PD; ANC; Residency

**Introduction**

According to the World Health Organization (WHO), low birth weight (LBW) refers to the weight at birth that is less than 2500g [1]. Birth weight is an essential predictor of infant growth and survival. Infants born with low birth weight (LBW) begin life immediately disadvantaged and face extremely poor survival rates [2, 3]. LBW infants suffer severe cognitive and neurological impairment, increased risk of high blood pressure, obstructive lung disease, cholesterol, renal damage, acute diarrhea, impaired immune function and poor cognitive development [4, 5]. Globally, about 16% of live births, or 20 million infants per year, are born with LBW, with 90% of these born in developing countries [6]. The prevalence of LBW varies between and within geographical regions. In Northern Ghana, the prevalence of LBW was 13.8% based on data collected between 2009 and 2011 [7]. Current data on LBW is thus needed. The factors associated with LBW is multifactorial, including nutritional factors, younger and advanced maternal age, parity, limited birth spacing, low pre-pregnancy BMI and parasitic infections [8, 9].

Postpartum hemorrhage (PPH) is blood loss of ≥1000 ml in the immediate post-partum period [10]. Although there have been several advances aimed at its prevention and management in recent years, PPH remains a leading cause of maternal mortality and morbidity globally, affecting approximately 2% of all women who give birth [11]. In Ghana, the prevalence of PPH was 4.4% in 2018 [12]. Like
LBW, the cause of PPH is multifactorial and has been related with late antenatal care (ANC) registration [13], preexisting maternal anaemia [11], prolonged labor and younger maternal age [12].

Preeclampsia (PE) is the leading cause of maternal morbidity and mortality globally [14]. The prevalence of PE is 2-8% worldwide and up to 10% in developing countries [15]. In Ghana, the prevalence of PE ranged between 6.55 and 7.03% from 2006-2009 [16]. Data from 2014 revealed an increased prevalence of PE (48.8%) and eclampsia (13.5%) among women with hypertensive disorders of pregnancy [17]. Current data on PE, particularly in Northern Ghana is wanting. The progression of PE to eclampsia is very alarming. Eclampsia is associated with several adverse fetal outcomes including preterm birth, small-for-gestational-age babies, placental abruption, and perinatal death. Although PE is a pregnancy-associated disorder with no definite cause, factors that have been identified to be associated with PE include maternal age (below 18 years or advanced age), first pregnancy, personal and family history of PE, obesity and preexisting medical conditions, gestational diabetes and hypertension [18].

Taken together, LBW, PPH and PE remain public health threats and contribute to pregnancy-associated morbidity and mortality, particularly in developing countries. This notwithstanding, only few studies have been conducted to highlight potential risk factors of these conditions to facilitate prevention and management in Ghana, especially in the Northern parts of the country where healthcare facilities are very limited. This study aimed at evaluating the risk factors of LBW, PPH and PE in the Northern part of Ghana.
Methods

Study Design and population

The study was conducted at the Bolgatanga Regional Hospital, a tertiary care center in the Upper East Region of Ghana from March 2018 to March, 2019. A total of 268 consecutive consenting pregnant women were included in the study. Participants included did not have eclampsia, deliveries with birth defects, had singleton gestation and delivered full term babies.

Obstetric characteristics and perinatal outcomes

Using a well-structured closed ended questionnaire according to WHO guidelines [19], socio-demographic and obstetric data including maternal age, gestational age at 1st visit, parity, marital status, occupation and residency were obtained from each participant.

Laboratory methods

Five milliliters of venous blood was drawn from antecubital vein of each study participant for ABO/Rh blood group test, sickling test, haemoglobin genotype, haemoglobin concentration estimation at 1st visit and G6PD quantitative test. ABO and Rh blood grouping was done using commercially prepared monoclonal anti-A, anti-B, and anti-D [20]. Haemoglobin concentration was determined using the Sysmex KX-21 N Automated three-part differential Hematology Analyzer. Haemoglobin genotypes (AA, AS, SS & SC) were determined by alkaline electrophoresis at pH of 8.5 (Beijing Liuyi Instrument Factory, China).

G6PD status was determined quantitatively (RANDOX, UK). Respondents were classified as: G6PD Normal if G6PD enzyme activity was ≥ 4000 mU/gHb (≥4.00 U/gHb), G6PD Partial Defect if G6PD enzyme activity was 1000 to 3999 mU/gHb (1.00-3.99 U/gHb) and G6PD full defect if
G6PD enzyme activity was <1000 mU/gHb (<1.00 U/gHb) according to protocol developed by Owusu et al. [21].

**Outcomes**

Birth weight in grams (g) was measured within 24 hours after birth and LBW was diagnosed if a neonate has a weight <2500 g [1]. PE was diagnosed based on a systolic blood pressure ≥140 mmHg and/or diastolic blood pressure (≥90mmHg) on two separate occasions with proteinuria (≥300 mg/24 h or ++ on a dipstick) after 20 weeks of gestation [22]. PPH was diagnosed based on a postpartum blood loss of 1000 ml or more in the immediate postpartum period [10].

**Data analysis**

Categorical variables were presented as frequencies and percentages and significance of association was assessed using Chi-square or Fisher’s exact test where applicable. Multivariate logistic regression analysis was used to evaluate the risk factors of PPH, LBW and PE. Statistical analysis was performed using Stata version 14.2 and a p-value < 0.05 was considered statistically significant.
Results

A total of 268 pregnant women with mean age of 29.1 (SD: 5.8) years old and gestational age at 1st visit 27.2 (12.7) weeks were included. Majority of the women resided in urban communities (59.7%), were married (81.3%), employed (68.7%), multiparous (39.6%) and began antenatal care in third trimester (57.5%). Most of the women were of the AA genotype (80.6%) and O positive blood group (67.9%) (Table 1).

Table 1: Baseline characteristics of study population

| Variable                          | Mean ± SD | Min-Max | Variable                          |
|----------------------------------|-----------|---------|----------------------------------|
| Maternal age (years)             | 29.1 ± 5.8| 14 – 41 | Residency                        |
| Gestational age at first visit (weeks) | 27.2 ± 12.6 | 5 – 42 | Rural                            |
|                                  |           |         | Urban                            |
| Marital status                   |           |         | Married                          |
| Employed                         | 184       | 68.7    | Single                           |
| Unemployed                       | 84        | 31.3    | Gestational age at 1st visit     |
| 1st Trimester                    | 50        | 18.7    | Female                           |
| 2nd Trimester                    | 64        | 23.9    |                                   |
| 3rd Trimester                    | 154       | 57.5    |                                   |
| Baby sex                         | 124       | 46.3    |                                   |
Male 144 53.7

**Parity at 1st visit**
- Nulliparity 86 32.1
- Uniparity 76 28.4
- Multiparity 106 39.6

**Mode of delivery**
- Caesarian section 122 45.5
- Vaginal delivery 146 54.5

**Blood group**
- A positive 26 9.7
- AB positive 12 4.5
- B negative 4 1.5
- B positive 36 13.4
- O negative 8 3
- O positive 182 67.9

**Sickling**
- Negative 216 80.6
- Positive 52 19.4

**Hb genotype**
- A 216 80.6
- AS 42 15.7
- S 10 3.7

**1st Trimester Hb**
- <11 g/dl 135 50.4
- >11 g/dl 133 49.6

**G6PD status**
- full defect 14 5.2
- partial defect 28 10.5
- non defect 226 84.3

Hb: haemoglobin; G6PD: glucose-6-phosphate dehydrogenase.
The prevalence of PE, LBW and PPH were 25.4% (68/268), 15.7% (42/268) and 6.0% (16/268), respectively (Figure 1).

Crude and adjusted odds ratio for factors potentially associated with PE

Younger aged pregnant women (COR=8.28, 95% CI (2.43-28.19), p=0.001) and women who were in their 3rd trimester at 1st ANC visit (COR= 18.0, 95% CI (2.32-139.92), p=0.000) presented with increased odds of PE whereas living in the urban areas (COR=0.26, 95% CI (0.14-0.46), p=0.000), sickling positivity (COR= 0.09, 95% CI (0.02-0.38), p=0.001), Hb genotype of AS (COR= 0.11, 95% CI (0.03-0.48), p=0.003), being unmarried (COR=0.34, 95% CI (0.14-0.85), p=0.020), having multiple children (COR=0.49, 95% CI (0.26-0.93), p=0.030) and vaginal delivery (COR=0.49, 95% CI (0.28-0.85), p=0.012) were associated with lower odds of PE. Upon controlling for potential
confounders in multivariate logistic regression, delayed 1\textsuperscript{st} ANC visit (AOR=16.82, 95% CI (3.61-78.5), p=0.000), younger maternal age (AOR= 15.19, 95% CI (1.85-124.56), p=0.011) and vaginal delivery (AOR=0.32, 95% CI (0.15-0.71), p=0.015) remained independently associated with PE (Table 2).

| Variable                          | PE absent=100 | PE present=34 | COR(95%CI)   | p-value | AOR(95%CI)    | p-value |
|-----------------------------------|---------------|--------------|--------------|---------|---------------|---------|
| Maternal age                      |               |              |              |         |               |         |
| 20-30                             | 120(76.81)    | 16(23.19)    | 1            |         | 1             |         |
| <20                               | 2(28.57)      | 5(71.43)     | 8.28(2.43-28.19) | 0.001   | 15.19(1.85-124.56) | 0.011   |
| >30                               | 45(77.59)     | 13(22.41)    | 0.96(0.53-1.72) | 0.884   | 0.98(0.46-2.05) | 0.947   |
| Residency                         |               |              |              |         |               |         |
| Rural                             | 64(59.26)     | 44(40.74)    | 1            |         |               |         |
| Urban                             | 136(85.0)     | 24(15.0)     | 0.26(0.14-0.46) | 0.000   | 0.57(0.27-1.17) | 0.123   |
| marital status                    |               |              |              |         |               |         |
| Married                           | 156(71.56)    | 62(28.44)    | 1            |         |               |         |
| Single                            | 44(88.0)      | 6(12.0)      | 0.34(0.14-0.85) | 0.020   | 0.24(0.05-1.22) | 0.085   |
| Occupation                        |               |              |              |         |               |         |
| Employed                          | 138(75.0)     | 46(25.0)     | 1            |         |               |         |
| Unemployed                        | 62(73.81)     | 22(26.19)    | 1.06(0.59-1.92) | 0.835   |               |         |
| Gestational age at 1\textsuperscript{st} visit |
| 1st Trimester                     | 48(96.0)      | 2(4)         | 1            |         | 1             |         |
| 2nd Trimester                     | 64(100.0)     | 0(0.0)       | -            |         |               |         |
| 3rd Trimester                     | 88(57.14)     | 66(42.86)    | 18(2.32-139.92) | 0.000   | 16.82(3.61-78.50) | 0.000   |
| Baby sex                          |               |              |              |         |               |         |
| Female                            | 94(75.81)     | 30(24.19)    | 1            |         |               |         |
| Male                              | 106(73.61)    | 38(26.39)    | 1.12(0.65-1.95) | 0.681   |               |         |
| Parity                            |               |              |              |         |               |         |
| Nulliparity                       | 56(65.12)     | 30(34.88)    | 1            |         | 1             |         |
| Uniparity                         | 30(78.95)     | 16(21.05)    | 0.50(0.25-1.01) | 0.053   | 0.51(0.19-1.31) | 0.160   |
| Multiparity                       | 84(79.25)     | 22(20.75)    | 0.49(0.26-0.93) | 0.030   | 0.41(0.17-1.00) | 0.051   |
| Mode of delivery                  |               |              |              |         |               |         |
| caesarian section                 | 82(67.21)     | 40(32.79)    | 1            |         |               |         |
| vaginal delivery                  | 118(80.82)    | 28(19.18)    | 0.49(0.28-0.85) | 0.012   | 0.32(0.15-0.71) | 0.005   |
| Hb genotype                       |               |              |              |         |               |         |
| A                                 | 150(69.44)    | 66(30.56)    | 1            |         | 1             |         |
|      | NBW=113 | LBW=21 | COR(95% CI) | P-value | AOR(95% CI) | P-value |
|------|---------|--------|-------------|---------|-------------|---------|
| **Maternal age** |          |        |             |         |             |         |
| 20-30| 120(86.96) | 18(13.04) | 1           |         |             |         |
| <20  | 10(71.43)  | 4(28.57)  | 2.67(0.76-9.41) | 0.127   |             |         |
| >30  | 96(82.76)  | 20(17.24) | 1.39(0.70-2.77) | 0.351   |             |         |
| **Residency** |         |        |             |         |             |         |
| Rural| 82(75.93)  | 26(24.07) | 1           |         |             |         |
| Urban| 144(90.0)  | 16(10.0)  | 0.35(0.18-0.69) | 0.002   | 0.53(0.26-1.09) | 0.083 |
| Marital status | Married | 180(82.57) | 38(17.43) |  |  
| Single | 46(92.0) | 4(8.0) | 0.41(0.14-1.21) | 0.107 |  
| Occupation | Employed | 158(85.87) | 26(14.13) |  |  
| Unemployed | 68(80.95) | 16(19.05) | 1.43(0.72-2.84) | 0.306 |  
| Gestational age at 1st Visit | 1st Trimester | 46(92.0) | 4(8.0) |  |  
| 2nd Trimester | 60(93.75) | 4(6.25) | 0.77(0.10-5.86) | 0.717 | 0.9(0.21-3.88) | 0.887 |  
| 3rd Trimester | 120(77.92) | 34(22.08) | 3.26(1.10-9.69) | 0.034 | 3.26(1.05-10.10) | 0.041 |  
| Baby sex | Female | 100(80.65) | 24(19.35) |  |  
| Male | 126(87.50) | 18(12.50) | 0.6(0.31-1.56) | 0.126 |  
| Parity | Nulliparity | 68(79.07) | 18(20.93) |  |  
| Uniparity | 68(89.47) | 8(10.53) | 0.44(0.18-1.09) | 0.077 |  
| Multiparity | 90(84.91) | 16(15.09) | 0.67(0.32-1.41) | 0.294 |  
| Mode of delivery | caesarian section | 94(77.05) | 28(22.95) |  |  
| vaginal delivery | 132(90.41) | 14(9.59) | 0.36(0.18-0.71) | 0.004 | 0.36(0.17-0.74) | 0.006 |  
| Hb-genotype | A | 178(82.41) | 38(17.59) |  |  
| AS | 40(95.24) | 2(4.76) | 0.23(0.05-1.01) | 0.052 |  
| S | 8(80.0) | 2(20.0) | 1.17(0.24-5.73) | 0.846 |  
| Sickling | Negative | 178(82.41) | 38(17.59) |  |  
| Positive | 48(92.31) | 4(7.69) | 0.39(0.13-1.45) | 0.087 |  
| 1st Trimester Hb | <11g/dl | 50(87.63) | 4(12.37) |  |  
| >11g/dl | 45(82.46) | 6(17.54) | 1.51(0.73-3.10) | 0.265 |  
| G6PD status | Non defect | 188(83.19) | 38(16.81) |  |  
| Full defect | 12(85.71) | 2(14.29) | 0.82(0.18-3.83) | 0.806 |  
| Partial defect | 52(92.86) | 4(7.14) | 0.38(0.09-1.67) | 0.201 |  

G6PD: glucose-6-phosphate dehydrogenase; Hb: haemoglobin; NBW: normal birth weight; LBW: low birth weight.
Crude odds ratio of factors associated with PPH

Advanced maternal age (COR=3.87, 95% CI (1.21-12.33), p=0.022) and male gender (COR=6.57, 95% CI (1.46-29.5), p=0.014) were associated with higher odds of PPH whereas delayed 1st ANC visit (COR=0.14, 95% CI (0.04-0.49), p=0.002) was associated with a reduced odds of PPH. Women who were in their 3rd trimester during their 1st ANC visit (AOR=0.12, 95% CI (0.03-0.47), p=0.002), the aged women (AOR=3.96, 95% CI (1.17-13.35), p=0.027) and neonates of male gender (AOR=7.75, 95% CI (1.60-37.51), p=0.011) were independently associated with PPH (Table 4).

### Table 4: Crude odds ratio of factors associated with PPH

| Variable             | PPH absent=126 | PPH present=8 | COR(95%CI)       | p-value | AOR(95%CI)       | p-value |
|----------------------|----------------|---------------|------------------|---------|------------------|---------|
| Maternal age         |                |               |                  |         |                  |         |
| 20-30                | 134(97.1)      | 4(2.9)        |                  | 1       |                  |         |
| <20                  | 14(100.0)      | 0 (0.0)       |                  | -       |                  |         |
| >30                  | 104(89.66)     | 12(10.34)     | 3.87(1.21-12.33) | 0.022   | 3.96(1.17-13.35) | 0.027   |
| Residency            |                |               |                  |         |                  |         |
| Rural                | 104(96.3)      | 4(3.7)        |                  | 1       |                  |         |
| Urban                | 148(92.5)      | 12(7.5)       | 2.11(0.66-6.72)  | 0.207   |                  |         |
| Marital status       |                |               |                  |         |                  |         |
| Married              | 204(93.58)     | 14(6.42)      |                  | 1       |                  |         |
| Single               | 48(96.0)       | 2(4.0)        | 0.61(0.13-2.76)  | 0.518   |                  |         |
| Occupation           |                |               |                  |         |                  |         |
| Employed             | 170(92.39)     | 14(7.61)      |                  | 1       |                  |         |
| Unemployed           | 82(97.62)      | 2(2.38)       | 0.30(0.07-1.33)  | 0.113   |                  |         |
| Gestational age at 1st Visit |          |               |                  |         |                  |         |
| 1st Trimester        | 42(84)         | 8(16)         | 1                | 1       |                  |         |
| 2nd Trimester        | 60(93.75)      | 4(6.25)       | 0.35(0.10-1.24)  | 0.103   | 0.28(0.07-1.07)  | 0.064   |
| 3rd Trimester        | 150(97.4)      | 4(2.6)        | 0.14(0.04-0.49)  | 0.002   | 0.12(0.03-0.47)  | 0.002   |
| Baby sex             |                |               |                  |         |                  |         |
| Female               | 122(98.39)     | 2(1.61)       | 1                | 1       |                  |         |
| Male                 | 130(90.28)     | 14(9.72)      | 6.57(1.46-29.50) | 0.014   | 7.75(1.60-37.51) | 0.011   |
| Parity               |                |               |                  |         |                  |         |
Nulliparity: 80(93.02) 6(6.98) 1
Uniparity: 70(92.11) 6(7.89) 1.14(0.35-3.71) 0.824
Multiparity: 102(96.23) 4(5.97) 0.52(0.14-1.92) 0.328

Mode of delivery:
Caesarian section: 116(95.08) 6(4.92) 1
Vaginal delivery: 136(93.15) 10(6.85) 1.42(0.50-4.03) 0.508

Hb genotype:
A: 202(93.52) 14(6.48) 1
AS: 42(100) 0 (0.0) - -
S: 8(80) 2(20) 3.61(0.70-18.62) 0.126

Sickling:
Negative: 202(93.52) 14(6.48) 1
Positive: 50(96.15) 2(3.85) 0.58(0.13-2.62) 0.477

1st Trimester Hb:
<11g/dl: 89(91.75) 8(8.25) 1
>11g/dl: 163(95.32) 8(4.68) 0.55(0.20-1.50) 0.242

G6PD status:
Non defect: 214(94.69) 12(5.31) 1
Full defect: 14(100) 0 - -
Partial defect: 24(85.71) 4(14.29) 2.97(0.89-9.94) 0.077

PPH: postpartum hemorrhage; Hb: haemoglobin; G6PD: glucose-6-phosphate dehydrogenase.

Discussion

The prevalence of PE in our study is 25.4%. In 2006, a study in Accra, Ghana, by Obed and Patience found a PE prevalence of 7.03% [16]. In 2013, Adu-Bonsaffoh et al. also found a 7.9% prevalence of PE in Accra [23]. The higher prevalence in this study compared to previous studies in Southern Ghana could be due to the small sample size and differences in socioeconomic and socio-demographic factors such as employment, level of education, younger maternal age etc. Formal education and employment status have been demonstrated to reduce the risk of many conditions including PE [24]. However, most of the women from the Northern part of Ghana have inadequate formal education and are either unemployed or engage in small scale jobs such as basket weaving, petty trading and subsistence farming. Indeed, the Ghana Poverty Mapping Report by the Ghana
Statistical Service identifies the Northern regions of Ghana as the most deprived regions [25]. Additionally, young women are given out for marriage at a tender age in most parts of Northern Ghana. These factors could account for the higher prevalence of PE in this study.

There was an 18-fold increased odds of PE among pregnant women who had their 1st antenatal booking in their 3rd trimester of pregnancy. The delayed first ANC booking was independently associated with increased risk of PE. Timely ANC booking facilitates early identification of signs related to various conditions during pregnancy. This allows for early intervention and improvement of health outcomes for both the mother and baby [24]. Indeed, You et al. in a study in the US, proposed that a substantial number of the serious complications of PE could be prevented through identification of symptoms through early reporting by patients [26]. It is therefore not surprising that delayed first ANC visit was associated with PE. On the other hand, urban settlement was associated with reduced odds of PE. Affirmatively, a study conducted in India by Sahu et al. [4] found rural residents to have increased risk of PE compared to urban residents. The reduced odds of PE among urban residents could be attributed to the availability and access to quality health care in the urban centers compared to the rural setting.

Younger-aged pregnant women were independently associated with increased odds of PE. This finding concurs with the finding of Endeshaw et al. in Ethiopia [27]. PE is a multisystem disorder of an unknown cause hence younger pregnant women who do not have the requisite physiological make up and resources for pregnancy and parturition suffer adverse consequences. Additionally, multiparity conferred protection against PE in our cohort as it reduced the odds of PE by 51%. This protection may be due to immunological intolerance among primiparous women until the first successful pregnancy induces adaptive changes leading to immunological tolerance in successive pregnancies.
The AS haemoglobin genotype was also found to be associated with reduced odds of PE. This finding is similar to the findings of Stamilio et al. [28] in the United States. The findings in this study, however, differs from those of Larrabee & Monga [29], who found AS genotype to be significantly associated with an increased odds of PE. The varying association between AS genotype and PE may be due to differences in sample size used and sensitivity of the screening tests performed.

Our study also reports a significant reduction in the risk of PE in single mothers compared to the married counterparts. Findings of studies done in Ghana by Addai-Mensah et al. 2018 and Roman et al. 2019 [30, 31] differs from ours. They found that married pregnant women were more likely to go for ANC visits than single women possibly due to support from their spouses in compelling them to follow the required guidelines for safe pregnancy and delivery. Additionally, husbands played an economic role in the frequency of a pregnant women’s ANC visits with some men taking up the responsibility of maintaining the wellbeing of their pregnant wives by ensuring that they attend ANC clinics.

We found a LBW prevalence of 15.7% in this study. This finding is higher compared to a study by Adam et al. in the Brong Ahafo region who reported a LBW prevalence of 11% [37]. Our finding is also higher than the LBW prevalence of 13.7% reported by Agorinya et al. based on data from 2009 to 2011 in the Northern part of Ghana [38]. The LBW prevalence recorded in this study is also slightly higher than the national prevalence of 10.7% [39]. Overall, although the prevalence of LBW in Northern Ghana is high in this study compared to previous studies in the region, the degree of increase is only marginal.

LBW has been associated with several factors including nutritional factors, younger and advanced maternal age, parity, limited birth spacing, low pre-pregnancy BMI and parasitic infections. In this
study, we found urban residence to be associated with a reduction in the odds of producing babies
with LBW. This finding agrees with a study by Mahumud et al. in Bangladesh who found rural
settlement to be associated with an increased odds of LBW [40]. Women from urban parts of the
Northern sector of Ghana have access to quality health care, potable water, majority are educated
and employed with requisite knowledge of nutrition and balanced diet. They also readily adhere to
antenatal regimen [26]. These advantages of the urban residents over the rural residents may account
for the reduced the likelihood of LBW among women from the urban parts of the study area. As
anticipated, vaginal delivery was also associated with lower odds of LBW. Majority of caesarian
section deliveries are as result of foeto-maternal complications hence it is not surprising that vaginal
delivery presented with reduced odds of producing babies with LBW. This finding agrees with that
of a study in China by Chen et al. who reported caesarian delivery to be associated with increased
odds of LBW [41]. We found delayed 1st ANC visit as an independent risk factor for LBW as
reported elsewhere [42, 43].

The prevalence of PPH in this study was 6% which is equal in magnitude to the global incidence of
6% [44]. The highest burden of PPH (10.5%) occurs in low income countries like Sub-Saharan
Africa and Asia [45]. Advanced maternal age was independently associated with an increased odds
of PPH similar to studies done elsewhere who also found several risk factors for PPH; past history
of PPH, multigravida, macrosomia, primigravida, grand multi-parity, advanced maternal age,
younger pregnant women, preterm births, labour induction, cesarean birth [46–48]. Surprisingly,
delayed 1st ANC visit independently reduced the risk of PPH in our study contrary to the findings of
Haftu et al. in Ethiopia who found it to be associated with high incidence of PPH [49]. The male
gender was independently associated with increased odds of PPH. This suggests that male neonates
may have certain physiological features which may trigger obstetric hemorrhage in the mother hence
further investigations should be done in this area.
Strength and limitation of the study

This study included singleton pregnancies, allowing for the control of the confounding effect of twin gestations. Recent studies on the prevalence and risk factors of PE, LBW and PPH in Northern Ghana is limited; thus, this study provides current data on these conditions. It further serves as a baseline data on foeto-maternal complications in Ghana upon which further studies could be referenced and conclusions drawn for proper management of the conditions.

This study is however limited by the cross-sectional study design and limited sample size. As a result, the findings of this study cannot be generalized to the general population. We recommend large longitudinal studies to better understand the changes in perinatal outcome indicators and factors contributing to PE, LBW and PPH in Ghana.

Conclusion

The study identified delayed ANC visit as an independent risk factor for PE, LBW and PPH in Northern Ghana. Vaginal delivery independently reduced the odds of PE whereas younger maternal age increased the odds of PE. Additionally, the male gender was independently associated with increased odds of PPH whereas vaginal delivery was independently associated with reduced odds of LBW. We recommend that public health education for pregnant women that highlights the importance of early ANC visit be enhanced. This will facilitate early identification and intervention for women with risk of foeto-maternal complications. Younger women should be educated on the dangers of early marriages with its attendant foeto-maternal complications of pregnancy such as PE, LBW, neonatal respiratory distress, maternal death, NICU admissions and neonatal death.
List of abbreviations

LBW: Low Birth Weight; PPH: Postpartum Hemorrhage; PE: Preeclampsia; ANC: Antenatal Care;
G6PD: Glucose-6-Phosphate Dehydrogenase; CI: Confidence Interval; Hb: Haemoglobin; WHO:
World Health Organisation; BMI: Body Mass Index; NBW: Normal Birth Weight; NICU: Neonatal
Intensive Care Unit; COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio; SD: Standard Deviation.

Declarations

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not-for-profit sectors.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding
author on reasonable request.

Conflict of Interest

The authors declare that they have no competing interests.
Ethics approval and consent to participate

Ethical approval for this study was obtained from the institutional review board of the Navrongo Health Research Centre of the Ghana Health Service. Written informed consent was obtained from all participants who opted to participate after the aims and objectives of the study had been explained to them. Participation was voluntary, and respondents were assured that the information obtained was strictly for research and academic purposes only and were guaranteed the liberty to opt out from the study at their own convenience.

Author contributions

BA, BG, RKOE and EWO conceived and designed the study. BA drafted the manuscript. BA, EWO and DA analyzed the data. BAM, EMD, SAS, GH, PAJ, SC and WO contributed with valuable references. All authors read and revised the manuscript and gave final approval of the manuscript.

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