Prevalence and Risk Factors Associated With Preeclampsia, Low Birth Weight and Postpartum Hemorrhage in Northern Ghana

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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

48 complications. Younger women should be educated on the dangers of early marriages with its
49 attendant foeto-maternal complications.

50

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

52

53

54 **Introduction**

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

67 Postpartum hemorrhage (PPH) is blood loss of ≥ 1000 ml in the immediate post-partum period [10].
68 Although there have been several advances aimed at its prevention and management in recent years,
69 PPH remains a leading cause of maternal mortality and morbidity globally, affecting approximately
70 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.

93 **Methods**

94 **Study Design and population**

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

99 **Obstetric characteristics and perinatal outcomes**

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

103

104 **Laboratory methods**

105 Five milliliters of venous blood was drawn from antecubital vein of each study participant for
106 ABO/Rh blood group test, sickling test, haemoglobin genotype, haemoglobin concentration
107 estimation at 1st visit and G6PD quantitative test. ABO and Rh blood grouping was done using
108 commercially prepared monoclonal anti-A, anti-B, and anti-D [20]. Haemoglobin concentration was
109 determined using the Sysmex KX-21 N Automated three-part differential Hematology Analyzer.
110 Haemoglobin genotypes (AA, AS, SS & SC) were determined by alkaline electrophoresis at pH of
111 8.5 (Beijing Liuyi Instrument Factory, China).

112 G6PD status was determined quantitatively (RANDOX, UK). Respondents were classified as:
113 G6PD Normal if G6PD enzyme activity was ≥ 4000 mU/gHb (≥ 4.00 U/gHb), G6PD Partial Defect
114 if G6PD enzyme activity was 1000 to 3999 mU/gHb (1.00-3.99 U/gHb) and G6PD full defect if

115 G6PD enzyme activity was <1000 mU/gHb (<1.00 U/gHb) according to protocol developed by
116 Owusu et al. [21].

117

118 **Outcomes**

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

124

125 **Data analysis**

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

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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
Maternal age (years)	29.1 ± 5.8	14 – 41
Gestational age at first visit (weeks)	27.2 ± 12.6	5 – 42
	n	%
Residency		
Rural	108	40.3
Urban	160	59.7
Marital status		
Married	218	81.3
Single	50	18.7
Occupation		
Employed	184	68.7
Unemployed	84	31.3
Gestational age at 1st visit		
1st Trimester	50	18.7
2nd Trimester	64	23.9
3rd Trimester	154	57.5
Baby sex		
Female	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		
<11g/dl	135	50.4
>11g/dl	133	49.6
G6PD status		
full defect	14	5.2
partial defect	28	10.5
non defect	226	84.3

143 Hb: haemoglobin; G6PD: glucose-6-phosphate dehydrogenase.

144

Figure 1: Prevalence of PE, LBW and PPH.

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

161 confounders in multivariate logistic regression, delayed 1st ANC visit (AOR=16.82, 95% CI (3.61-
 162 78.5), p=0.000), younger maternal age (AOR= 15.19, 95% CI (1.85-124.56), p=0.011) and vaginal
 163 delivery (AOR=0.32, 95% CI (0.15-0.71), p=0.015) remained independently associated with PE
 164 (Table 2).

165

166 **Table 2: Crude and adjusted odds ratio for factors potentially associated with PE**

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 1st 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(80.82)	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	

AS	40(95.24)	2(4.76)	0.11(0.03-0.48)	0.003	1	
S	10(100)	0	-		-	
Sickling						
Negative	150(69.44)	66(30.56)	1			
Positive	50(96.15)	2(3.85)	0.09(0.02-0.38)	0.001	0.41(0.08-2.05)	0.276
1st Trimester Hb						
<11g/dl	71(73.20)	26(26.80)	1			
>11g/dl	129(75.44)	42(24.56)	0.89(0.50-1.57)	0.685		
G6PD status						
Non defect	160(70.80)	66(29.20)	1			
Full defect	12(85.71)	2(14.29)	0.40(0.09-1.86)	0.244		
Partial defect	28(100)	0	-	-		

167 Hb: haemoglobin; G6PD: glucose-6-phosphate dehydrogenase; PE: preeclampsia.

168

169 Crude and adjusted odds ratio of factors associated with LBW

170 Living in an urban area (COR=0.35, 95% CI (0.18-0.69), p=0.002) and vaginal delivery (COR=

171 0.36, 95% CI (0.18-0.71), p=0.004) were associated with lower odds of LBW. Delayed 1st ANC visit

172 was associated with higher odds of LBW (COR=3.26, 95% CI (1.10-9.69), p=0.034). However, upon

173 controlling for confounders in the multivariate model, delayed 1st ANC visit (AOR=3.26, 95% CI

174 (1.05-10.10), p=0.041) and vaginal delivery (AOR=0.36, 95% CI (0.17-0.74), p=0.006) were

175 independently associated with LBW (Table 3).

176

177 **Table 3: Crude and adjusted odds ratio of factors associated with LBW**

Variable	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		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)	1			
Single	46(92.0)	4(8.0)	0.41(0.14-1.21)	0.107		
Occupation						
Employed	158(85.87)	26(14.13)	1			
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)	1		1	
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)	1			
Male	126(87.50)	18(12.50)	0.6(0.31-1.56)	0.126		
Parity						
Nulliparity	68(79.07)	18(20.93)	1			
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)	1		1	
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)	1			
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)	1			
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)	1			
>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)	1			
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.

183 **Crude odds ratio of factors associated with PPH**

184 Advanced maternal age (COR=3.87, 95% CI (1.21-12.33), p=0.022) and male gender (COR=6.57,
 185 95% CI (1.46-29.5), p=0.014) were associated with higher odds of PPH whereas delayed 1st ANC
 186 visit (COR=0.14, 95% CI (0.04-0.49), p=0.002) was associated with a reduced odds of PPH. Women
 187 who were in their 3rd trimester during their 1st ANC visit (AOR=0.12, 95% CI (0.03-0.47), p=0.002),
 188 the aged women (AOR=3.96, 95% CI (1.17-13.35), p=0.027) and neonates of male gender
 189 (AOR=7.75, 95% CI (1.60-37.51), p=0.011) were independently associated with PPH (**Table 4**).

190

191 **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

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

193

194 Discussion

195 The prevalence of PE in our study is 25.4%. In 2006, a study in Accra, Ghana, by Obed and Patience
196 found a PE prevalence of 7.03% [16]. In 2013, Adu-Bonsaffoh et al. also found a 7.9% prevalence
197 of PE in Accra [23]. The higher prevalence in this study compared to previous studies in Southern
198 Ghana could be due to the small sample size and differences in socioeconomic and socio-
199 demographic factors such as employment, level of education, younger maternal age etc. Formal
200 education and employment status have been demonstrated to reduce the risk of many conditions
201 including PE [24] . However, most of the women from the Northern part of Ghana have inadequate
202 formal education and are either unemployed or engage in small scale jobs such as basket weaving,
203 petty trading and subsistence farming. Indeed, the Ghana Poverty Mapping Report by the Ghana

204 Statistical Service identifies the Northern regions of Ghana as the most deprived regions [25].
205 Additionally, young women are given out for marriage at a tender age in most parts of Northern
206 Ghana. These factors could account for the higher prevalence of PE in this study.

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

219 Younger-aged pregnant women were independently associated with increased odds of PE. This
220 finding concurs with the finding of Endeshaw et al. in Ethiopia [27]. PE is a multisystem disorder
221 of an unknown cause hence younger pregnant women who do not have the requisite physiological
222 make up and resources for pregnancy and parturition suffer adverse consequences. Additionally,
223 multiparity conferred protection against PE in our cohort as it reduced the odds of PE by 51%. This
224 protection may be due to immunological intolerance among primiparous women until the first
225 successful pregnancy induces adaptive changes leading to immunological tolerance in successive
226 pregnancies.

227 The AS haemoglobin genotype was also found to be associated with reduced odds of PE. This
228 finding is similar to the findings of Stamilio et al. [28] in the United States. The findings in this
229 study, however, differs from those of Larrabee & Monga [29], who found AS genotype to be
230 significantly associated with an increased odds of PE. The varying association between AS genotype
231 and PE may be due to differences in sample size used and sensitivity of the screening tests
232 performed.

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

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

248 LBW has been associated with several factors including nutritional factors, younger and advanced
249 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.

295 **List of abbreviations**

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

300

301 **Declarations**

302 **Funding**

303 This research did not receive any specific grant from funding agencies in the public, commercial, or
304 not-for-profit sectors.

305 **Consent for publication**

306 Not applicable

307 **Availability of data and materials**

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

310

311 **Conflict of Interest**

312 The authors declare that they have no competing interests.

313

314 **Ethics approval and consent to participate**

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

321

322 **Author contributions**

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

326

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330

331

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462

Figures

Figure 1

Prevalence of PE, LBW and PPH. The prevalence of PE, LBW and PPH were 25.4% (68/268), 15.7% (42/268) and 6.0% (16/268), respectively (Figure 1).

Supplementary Files

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- [QuestionnaireJournalPregnancyChildHealth.docx](#)