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Research Article

Prevalence and Associated Risk Factors of Preterm and Post-term Births in Northern Ghana: A Retrospective Study in Savelugu Municipality

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Abstract

Introduction: Preterm and post-term births are prominent leading causes of neonatal mortalities and significant contributors to long-term adverse health outcomes. Although preterm and post-term births are disproportionately rampant in most parts of Ghana, the magnitude and underlying predictors are not well comprehended which necessitates more evidence for appropriate interventions. This study assessed the prevalence and identified vital risk factors of preterm and post-term births in Northern Ghana.

Methods: This study is a retrospective cross-sectional design conducted on 356 postnatal mothers from February to March 2022 in Savelugu Municipality of Northern Region, Ghana. Anthropometric, clinical, obstetric, and sociodemographic data were collected from antenatal records using structured questionnaires. Multinomial logistic regression was used to identify independent factors of preterm and post-term births at 95% confidence interval.

Results: Prevalence of preterm and post-term births were 19.4% and 6.5% respectively. Anaemia in the first trimester of pregnancy (AOR: 2.205; 95%CI: 1.011−4.809), non-use of insecticide-treated bed nets (ITNs) during pregnancy (AOR: 1.979; 95%CI: 0.999−3.920), maternal age less than 20 years (AOR: 12.95; 95%CI: 2.977−56.34), and mothers with junior high school education (AOR: 0.225; 95%CI: 0.065−0.797) were independently associated with preterm births. Predictors for post-term births were macrosomia deliveries (AOR: 8.128; 95%CI: 1.777−37.18) and mothers with senior high school education (AOR: 0.001; 95%CI: 0.0001−0.125).

Conclusion: Preterm births are very prevalent, while post-term births are becoming crucial in the municipality. These predictors (gestational anaemia, ITNs use, teenagers, maternal education, and macrosomic births) of preterm and post-term births are modifiable and preventable. Therefore, interventions should be targeted at intensified community education on nutrition and lifestyle modifications, in addition to vigorous promotion of girls' child education through parental empowerment.

Keywords: Northern Ghana; Preterm births; Prevalence; Post-term births; Risk factors; Savelugu municipal

List of Abbreviations: ANC: Antenatal Care; GWG: Gestational Weight Gain; ITNs: Insecticide-Treated Bed Nets; MCHRBs: Maternal and Child Health Record Books; ODK: Open Data Kit; PNC: Postnatal Care; SDGs: Sustainable Development Goals; SES: Socioeconomic Status; SP: Sulphadoxine Pyrimethamine; STATA: Statistics and Data

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Introduction

Preterm and post-term births are regarded as the two forms of abnormal gestational age at birth responsible for chronic morbidities and neonatal mortalities worldwide [1,2]. Preterm births have predominantly been established as the principal cause of mortalities among children under five years of age, thereby accounting for 35.0% of neonatal deaths and about 16.0% of all worldwide deaths [3,4]. Similarly, post-term births have been evidenced to be associated with long-term child maladies and mortalities [5,6]. The World Health Organization denotes preterm births (also known as prematurity) as deliveries or births that occur before 37 weeks of gestation whilst post-term births (also called post-maturity/post-date) are defined as deliveries that happen at a gestational age equal to or above 42 weeks [4].

The multi-factorial determinants of abnormal gestational age at birth are largely related to biological, psychological, obstetric, demographic, and social contributions [1,6]. Therefore, there is a need to investigate clinical, nutritional, economic, geographic, and other related predictors of these preterm and post-term births globally, especially in developing countries. Some significant elements associated with preterm births encompass antepartum haemorrhage, pre-eclampsia, multiple pregnancy [7-11], gestational anaemia, rural residence, and short birth spacing [1,12-15]. Some retrospective studies in Africa also identified multiparity, adolescent mothers, low socioeconomic status (SES) [11,16], married mothers, low parity, and inadequate antenatal visits [16,17] as vital determinants of preterm babies. Alternatively, other studies revealed large babies [18], maternal overweight, low gestational weight gain [19,20], high SES, unmarried mothers [5], and pregnancy-related psycho-emotional problems [21] to be the predictors of post-term infants.

The global action for preterm births which is particularly centered on policies including the Sustainable Development Goals (SDGs) and Global Strategy for Women's, Children's and Adolescents' Health is still on course to improve newborn and child survival. However, post-term births have not been accorded similar needed attention. Notwithstanding, the prevalence rates of preterm and post-term births are still on the rise as preterm births have significantly upsurged spanning over 20 years [22]. Globally, an estimated 13.4 million (9.9%) babies were born too soon in 2020 with the highest burden in Southern Asia (13.2%) and sub-Saharan Africa (10.1%) [4]. The prevalence of preterm deliveries in Brazil [16], Ethiopia [9,12], Nigeria [11], Kenya [10], and Southern Ghana [17] were 11.5%, 13.3%, 16.0%, 18.3%, and 18.9% respectively. Additionally, in the Kassena-Nankana district in the Upper East Region of Ghana, the prevalence of preterm births was 32.0% [23]. On the other hand, despite data paucity on post-matured births in Ghana, the incidence was found to be 4.5%, 6.0%, 6.5%, and 11.4% among the American [20], Ethiopian [5], British [24], and South African [25] mothers correspondingly in some prospective and retrospective reports.

The entire globe has unacceptable gaps in perinatal health outcomes by virtue of low SES (poor), ethnic or racial differences, and most marginalized groups in society. Nonetheless, preterm and post-date births have higher survival rates in developed nations after delivery while low-resource settings like Ghana are still recording huge perinatal and neonatal deaths [1,4]. Therefore, identifying and comprehending the risk factors for preterm and post-term births have the potential to help tackle this problem and also aid in achieving SDG 3 through the reduction of neonatal mortalities and morbidities in developing countries like Ghana. Globally, most maternal and child health information on risk factors for abnormal gestational age at birth are always focused on preterm births without paying much attention to post-term ones. Nevertheless, this study considers both. Although preterm and post-term births are disproportionately rampant in most parts and peri-urban belts of Northern Ghana, the magnitude and underlying predictors are also not well comprehended which necessitates more evidence for apt interventions. Currently, there is a scarcity of published data on the prevalence of abnormal gestational age at birth and its possible determining factors in the Savelugu municipality and Northern Ghana. This study therefore assessed the prevalence of preterm and post-term births and their associated risk factors among mothers attending postnatal care services in the Savelugu municipality of Northern Ghana.

Materials and Methods

Study design

The study employed a retrospective and cross-sectional design to determine the magnitude of preterm and post-term births among mothers attending postnatal care (PNC) services and also identify the predictors of these adverse pregnancy outcomes in the study area.

Study area

Savelugu municipality is situated in the northern hemisphere of Northern Region of Ghana. The major source of income in the municipal is farming while the inhabitants are predominantly from the Dagomba ethnic group. Five major public health facilities with 21 operational CHPS zones provide health services to a populace of 125,469 in this municipality. The total number of reproductive-aged women is more than 40,000 which places the municipal at a higher risk of frequent pregnancies with routine increased rate of PNC and antenatal care (ANC) attendance. The municipal has a skilled delivery rate of 93% whereas monthly skilled delivery is estimated between 300 and 400. Moreover, maternal and child health record books (MCHRBs) have been consistently used by mothers when seeking antenatal, postnatal, and child

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welfare services since the inception of a Japanese project on MCHRBs [26].

Study population

This study recruited postnatal mothers living in the municipality and having a baby of less than 29 days (neonatal period). Mothers who owned MCHRBs and also attended first-day PNC services at the municipal public health facilities were sampled while mothers with heart diseases, twin deliveries, and home deliveries were not included in the study.

Sample size and sampling methods

The sample size (n) was attained by the formula; n = $\frac{Z^2 \text{ X } p(1-p)}{e^2}$. Due to the scarcity of Ghanaian data on post-term births, the study employed prevalence (p) of preterm births in Southern Ghana which was reported as 33% [8]. By applying margin of error (e) of 5%, and standard normal variate (z) at 95% confidence level of 1.96, the sample size was initially estimated at 339. After adding 5% non-response rate [7], the final sample size was rounded off to 356.

During sampling, all the five major public health facilities namely Savelugu municipal hospital, Diare, Moglaa, Pong-Tamale, and Savelugu RCH health centres in the municipality were selected. Probability proportional to size technique was used to estimate the sample sizes for the five major public health facilities in the study area (Table 1). A coin was tossed to randomly select all the 356 postnatal mothers, using the daily PNC attendance book from the respective public health facilities.

Study variables

All the study variables and/or data were collected from MCHRBs and/or ANC records except some sociodemographic information which was collected through structured interviews from February to March 2022. Data collection was done using structured questionnaires designed onto Open Data Kit (ODK) version 2021.2.4 (Get ODK Inc., San Diego, USA), and pre-installed onto handheld tablets.

The outcome variable for this study is gestational age at birth which is multinomial recorded as preterm (< 37 weeks of gestation) = 1, normal term (≥ 37–41 weeks of gestation) = 2, and post-term (≥ 42 weeks of gestation) = 3. The "normal term" was used as the base outcome (reference point) during analyses.

From the collected data, 39 exposure variables were selected and categorized based on biological plausibility, existing literature, and the potential to influence gestational age at birth [18,27-29] (Tables 2-4). Some of these exposure variables included marital status, educational level, ethnic group, religion, sex of neonate, household size, job status, birthweight, birth length, parity, gravidity, frequency of ANC visits, tetanus-diphtheria immunization, iron-folic acid intake, anthelminthic drugs intake, and sulphadoxine-pyrimethamine (SP) doses intake, gestational weight gain (measured within one week prior to delivery and the one recorded at the first trimester ANC visit), and pre-gestational body mass index (mother's body weight at first trimester of pregnancy during antenatal visit was used as a proxy for pre-pregnancy weight since foetal weight is low). Other variables were diagnosis of hypertension, diabetes, hepatitis B, and malaria during pregnancy, rhesus type, Glucose-6-phosphate dehydrogenase deficiency (G6PD) status, haemoglobin levels at first, second, and third trimesters of pregnancy (classified as anaemia [< 11g/dL], normal [≥ 11–13.1g/dL], and high [≥ 13.2g/dL]), and wealth index [18,27,28].

Wealth index was assessed based on possession of household assets, housing quality, and availability of household utilities among others which were used as proxy indicators for SES of mothers. By using principal component analysis, the SES of mothers was then categorized into five groups (thus, wealth quintiles: poorest, poorer, poor, less poor, least poor) [29].

Statistical analysis

The data attained was first transferred from ODK platform onto Microsoft excel version 17.0 before moving them onto STATA version 17.0 (Stata Corporation, Texas, USA). All analyses were conducted in STATA and the results were presented in the form of Tables, Figure, summary statistics in odds ratios (OR), and p-values at 95 % confidence intervals (CI). Associations between each exposure (background)

Table 1: Approximated facility sample sizes in the study area.

Public health facilities	U: Total first PNC visits at targeted health facilities in 2020	V: Facility coverage [=(U)/8042]	X: Number of mothers to be drawn for each facility [= (V) × 356]
Diare health centre	2220	0.276	98
Moglaa health centre	346	0.043	15
Pong-Tamale health centre	852	0.106	38
Savelugu health centre	1198	0.149	53
Savelugu municipal hospital	3426	0.426	152
Total	8042	1	356

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variable and outcome variable (gestational age at birth) were explored at the bivariate level by using Chi-square or Fisher's exact test (Tables 2-4). Variance inflation factor (VIF) was used to address potential multicollinearity between all exposure variables significant at $p < 0.05$ before employing them in logistic analyses. During the testing, the variables with a VIF of less than 10 were selected for the logistic analyses. After addressing multicollinearity, the significant exposure variables were simultaneously entered into a multinomial logistic regression model to identify the associated risk factors of preterm and post-term births (Table 5).

Results

Background characteristics among study participants

The average age of the mothers was 27 years with a standard deviation of ±5. Larger proportion of the mothers had marriage partners (90%) and 88% were Muslims. Approximately, one-third of the mothers had no formal education (34%) (Table 2). Slightly above one-half of the respondents were informally employed (51%), attended ANC less than eight times (54%), took more than three doses of sulphadoxine-pyrimethamine (SP) drugs (55%), and used insecticide-treated bed nets (ITNs) (61%) during gestation (Table 3). The incidence of gestational anaemia in the first, second, and third trimesters were 45%, 56%, and 44% respectively. Less than one-quarter of the mothers were diagnosed with gestational diabetes (6%), gestational hypertension (12%), and hepatitis B (11%) infections during pregnancy. Most mothers experienced two or more childbirths (73%) and had become pregnant for more than one time (75%). A greater proportion of the neonates were born with small weights (22%) as compared to macrosomic births (9%) (Table 4).

Prevalence of preterm and post-term births

Out of the total study participants, the prevalence of preterm and post-term births was 19.4% (95%CI: 15.4%–23.8%) and 6.5% (95%CI: 4.1%–9.5%) respectively (Figure 1).

Association of preterm and post-term births with background characteristics

As presented in Tables 2-4, maternal age (p=0.001), educational level (p=0.009), gestational weight gain (p=0.012), neonatal birth length (p=0.041), neonatal birth weight (p<0.001), frequency of ANC visits (p<0.001), use of ITNs (p=0.037), frequency of SP intake (p=0.009), number of pregnancies (p=0.002), number of deliveries (p=0.001), haemoglobin levels in each trimester of pregnancy (p<0.001), gestational diabetes (p=0.014), and G6PD status (p=0.034) showed bivariate relationship with abnormal gestational age at birth (preterm and post-term births).

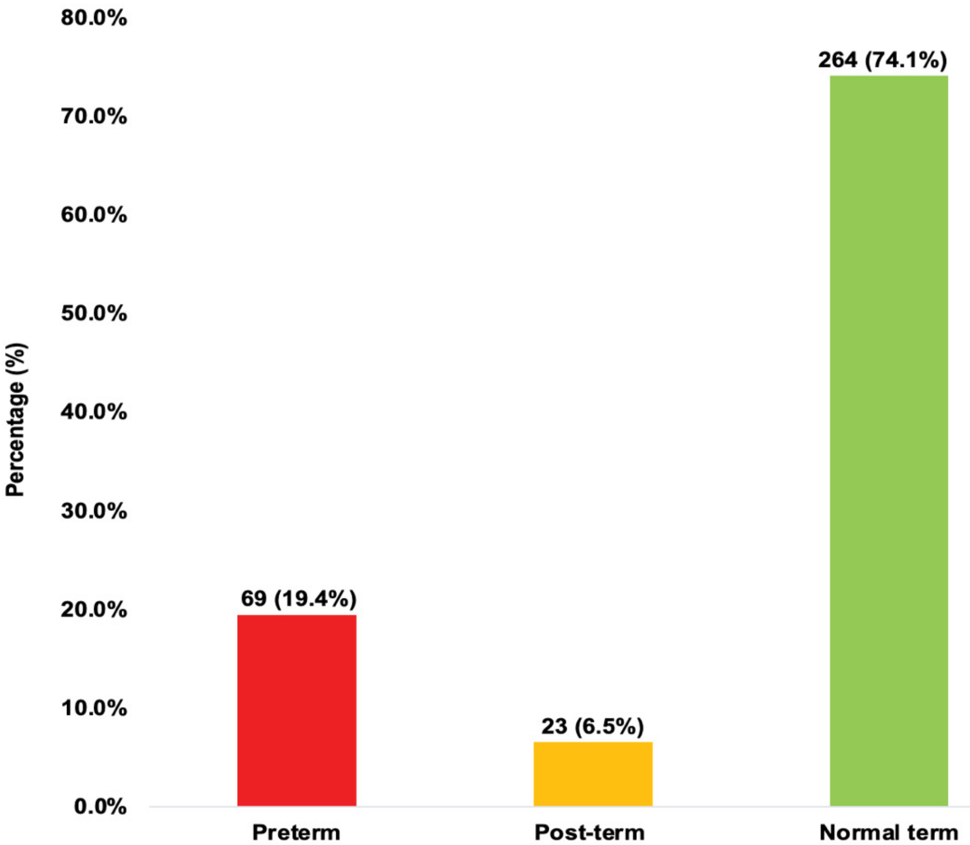

Figure 1: Prevalence of preterm and post-term births.

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Table 2: Association of preterm and post-term births with sociodemographic characteristics among study participants.

Background variables	Total (%) n = 356	Bivariate analysis Preterm (%) n = 69	Post-term (%) n = 23	Normal term (%) n = 264	p–value *
Maternal age category					
16 to 19 years	18 (5.1)	10 (14.5)	0 (0.0)	8 (3.0)	
20 to 35 years	308 (86.5)	54 (78.2)	23 (100.0)	231 (87.5)	0.001†
Above 35 years	30 (8.4)	5 (7.3)	0 (0.0)	25 (9.5)	
Mean (SD) = 27 (5)					
Marital status					
Married	319 (89.6)	59 (85.5)	21 (91.3)	239 (90.5)	0.492
Unmarried	37 (10.4)	10 (14.5)	2 (8.7)	25 (9.5)	
Highest level of education					
None	121 (34.0)	24 (34.8)	13 (56.5)	84 (31.8)	
Primary	46 (12.9)	14 (20.3)	3 (13.0)	29 (11.0)	
Junior high	46 (12.9)	7 (10.1)	3 (13.0)	36 (13.6)	0.009†
Senior high	105 (29.5)	14 (20.3)	1 (4.5)	90 (34.1)	
Tertiary	38 (10.7)	10 (14.5)	3 (13.0)	25 (9.5)	
Ethnic group					
Dagomba	273 (76.7)	52 (75.4)	15 (65.2)	206 (78.0)	
Frafra	60 (16.8)	14 (20.3)	6 (26.1)	40 (15.2)	0.432
Others[a]	23 (6.5)	3 (4.4)	2 (8.7)	18 (6.8)	
Religious affiliation					
Christian	44 (12.4)	4 (5.8)	3 (13.0)	37 (14.0)	0.181
Muslim	312 (87.6)	65 (94.2)	20 (87.0)	227 (86.0)	
Occupation status					
Unemployed	142 (39.9)	24 (34.8)	7 (30.4)	111 (42.1)	
Informal	181 (50.8)	40 (57.9)	15 (65.2)	126 (47.7)	0.334
Formal	33 (9.3)	5 (7.3)	1 (4.4)	27 (10.2)	
Fuel type					
Firewood	148 (41.6)	32 (46.4)	7 (30.4)	109 (41.3)	
Charcoal	162 (45.5)	31 (44.9)	14 (60.9)	117 (44.3)	0.397
Gas	46 (12.9)	6 (8.7)	2 (8.7)	38 (14.4)	
Wealth index					
Poorest	72 (20.2)	13 (18.8)	3 (13.0)	56 (21.2)	
Poorer	75 (21.0)	19 (27.5)	5 (21.7)	51 (19.3)	
Poor	70 (19.7)	15 (21.7)	4 (17.4)	51 (19.3)	0.63
Less Poor	70 (19.7)	13 (19.0)	7 (30.4)	50 (19.0)	
Least Poor	69 (19.4)	9 (13.0)	4 (17.4)	56 (21.2)	
Family size					
Less than 10 occupants	283 (79.5)	58 (84.1)	19 (82.6)	206 (78.0)	0.505
10 occupants or more	73 (20.5)	11 (15.9)	4 (17.4)	58 (22.0)	
Neonatal age category					
Less than 1 week	106 (29.8)	20 (29.0)	6 (26.1)	80 (30.3)	0.902
2 weeks or more	250 (70.2)	49 (71.0)	17 (73.9)	184 (69.7)	
Gender of neonates					
Male	200 (56.2)	38 (55.1)	10 (43.5)	152 (57.6)	0.417
Female	156 (43.8)	31 (44.9)	13 (56.5)	112 (42.4)	

*SD: standard deviation; † p-value < 0.05; *Chi-square/Fisher's exact test; [a]Bulsa, Dagaati, Ewe*

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Table 3: Association of preterm and post-term births with antenatal and anthropometric characteristics among study participants.

Background variables	Total (%) n = 356	Bivariate analysis Preterm (%) n = 69	Post-term (%) n = 23	Normal term (%) n = 264	p–value *
Maternal body mass index					
Underweight (< 18.5 kg/m²)	25 (7.0)	4 (5.8)	0 (0.0)	21 (8.0)	
Normal (≥ 18.5 to 24.9 kg/m²)	229 (64.3)	47 (68.1)	18 (78.3)	164 (62.1)	0.54
Overweight (≥ 25.0 kg/m²)	102 (28.7)	18 (26.1)	5 (21.7)	79 (29.9)	
First-trimester gestational weight					
Less than 50 kg	42 (11.8)	9 (13.0)	0 (0.0)	33 (12.5)	0.192
50 kg or more	314 (88.2)	60 (87.0)	23 (100.0)	231 (87.5)	
Maternal height					
Less than 150 cm	13 (3.7)	2 (2.9)	0 (0.0)	11 (4.2)	1
150 cm or more	343 (96.7)	67 (97.1)	23 (100.0)	253 (95.8)	
Gestational weight gain					
Less than 6 kg	94 (26.4)	19 (27.5)	0 (0.0)	75 (21.2)	0.012†
6 kg or more	262 (73.6)	50 (72.5)	23 (100.0)	189 (71.6)	
Neonatal birth length					
48 cm or more	72 (20.2)	16 (23.2)	0 (0.0)	56 (21.2)	0.041†
Less than 48 cm	284 (79.8)	53 (76.8)	23 (100.0)	208 (78.8)	
Neonatal birth weight (BW)					
Low birth weight (< 2.5 kg)	79 (22.2)	29 (42.0)	2 (8.7)	48 (18.2)	
Normal BW (≥ 2.5 kg – 3.9 kg)	246 (69.1)	37 (53.6)	11 (47.8)	198 (75.0)	< 0.001†
Macrosomia (≥ 4.0 kg)	31 (8.7)	3 (4.4)	10 (43.5)	18 (6.8)	
Frequency of ANC visits					
Less than 8 visits	191 (53.7)	48 (69.6)	4 (17.4)	139 (52.6)	< 0.001†
8 visits or more	165 (46.3)	21 (30.4)	19 (82.6)	125 (47.4)	
Facility type for ANC visits					
District hospital	175 (49.2)	32 (46.4)	10 (43.5)	133 (50.4)	0.716
Health centre	181 (50.8)	37 (53.6)	13 (56.5)	131 (49.6)	
Family planning use before last pregnancy					
No	232 (65.2)	45 (65.2)	12 (52.2)	175 (66.3)	0.395
Yes	124 (34.8)	24 (34.8)	11 (47.8)	89 (33.7)	
Insecticide-treated nets (ITNs) use					
No	138 (38.8)	36 (52.2)	9 (39.1)	93 (35.2)	0.037†
Yes	218 (61.2)	33 (47.8)	14. (60.9)	171 (64.8)	
Frequency of sulphadoxine-pyrimethamine (SP) intake					
None	18 (5.1)	6 (8.7)	2 (8.7)	10 (3.8)	
1 to 3 times	141 (39.6)	34 (49.3)	3 (13.0)	104 (39.4)	0.009†
More than 3 times	197 (55.3)	29 (42.0)	18 (78.3)	150 (56.8)	
Anthelminthics intake					
No	218 (61.2)	44 (63.8)	15 (65.2)	159 (60.2)	0.797
Yes	138 (38.8)	25 (36.2)	8 (34.8)	105 (39.8)	
Iron/folic acid intake					
No	13 (3.7)	1 (1.5)	0 (0.0)	12 (4.6)	0.298
Yes	343 (96.3)	68 (98.5)	23 (100.0)	252 (95.4)	
Tetanus-diphtheria vaccination					
No	26 (7.3)	4 (5.8)	2 (8.7)	20 (7.6)	0.85
Yes	330 (92.7)	65 (94.2)	21 (91.3)	244 (92.4)	
Nutrition education received					
No	47 (13.2)	5 (7.3)	6 (26.1)	36 (13.6)	0.064
Yes	309 (86.8)	64 (92.7)	17 (73.9)	228 (86.4)	

*†p-value < 0.05; *Chi-square test/Fisher's exact test*

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Table 4: Association of preterm and post-term births with clinical and obstetric characteristics among study participants.

Background variables	Total (%) n = 356	Bivariate analysis Preterm (%) n = 69	Post-term (%) n = 23	Normal term (%) n = 264	p-value*
Number of pregnancies					
0 – 1 pregnancy	88 (24.7)	25 (36.2)	0 (0.0)	63 (23.9)	0.002†
≥ 2 pregnancies	268 (75.3)	44 (63.8)	23 (100.0)	201 (76.1)	
Number of deliveries					
0 – 1 delivery	97 (27.3)	27 (39.1)	0 (0.0)	70 (26.5)	0.001†
≥ 2 deliveries	259 (72.7)	42 (60.9)	23 (100.0)	194 (73.5)	
Haemoglobin (Hb) levels at first trimester					
Low Hb/Anaemia (< 11g/dL)	160 (44.9)	49 (71.0)	4 (17.4)	107 (40.5)	< 0.001†
Normal Hb (≥ 11 – 13.1g/dL)	177 (49.7)	20 (29.0)	12 (52.2)	145 (54.9)	
High Hb (≥ 13.2g/dL)	19 (5.4)	0 (0.00)	7 (30.4)	12 (4.6)	
Hb levels at second trimester					
Low Hb/Anaemia	200 (56.2)	56 (81.2)	5 (21.7)	139 (52.6)	< 0.001†
Normal Hb	152 (42.7)	13 (18.8)	16 (69.6)	123 (46.6)	
High Hb	4 (1.1)	0 (0.00)	2 (8.7)	2 (0.8)	
Hb levels at third trimester					
Low Hb/Anaemia	158 (44.4)	46 (66.6)	3 (13.0)	109 (41.3)	< 0.001†
Normal Hb	192 (53.9)	22 (31.9)	19 (82.6)	151 (57.2)	
High Hb	6 (1.7)	1 (1.5)	1 (4.4)	4 (1.5)	
Malaria infection during pregnancy					
No	254 (71.3)	44 (63.8)	20 (87.0)	190 (72.0)	0.094
Yes	102 (28.7)	25 (36.2)	3 (13.0)	74 (28.0)	
HIV infection					
No	350 (98.3)	67 (97.1)	22 (95.6)	261 (98.9)	0.354
Yes	6 (1.7)	2 (2.9)	1 (4.4)	3 (1.1)	
Hepatitis B infection					
No	318 (89.3)	58 (84.1)	21 (91.3)	239 (90.5)	0.286
Yes	38 (10.7)	11 (15.9)	2 (8.7)	25 (9.5)	
Gestational diabetes status					
Not diagnosed	335 (94.1)	69 (100.0)	20 (87.0)	246 (93.2)	0.014†
Diagnosed	21 (5.9)	0 (0.00)	3 (13.0)	18 (6.8)	
Gestational hypertension status					
Not diagnosed	312 (87.6)	58 (86.1)	20 (87.0)	234 (88.6)	0.586
Diagnosed	44 (12.4)	11 (15.9)	3 (13.0)	30 (11.4)	
Sickle cell status					
Negative	301 (84.5)	54 (78.3)	18 (78.3)	229 (86.7)	0.153
Positive	55 (15.5)	15 (21.7)	5 (21.7)	35 (13.3)	
G6PD status					
Normal	333 (93.5)	61 (88.4)	20 (87.0)	252 (95.4)	0.034†
Complete/partial	23 (6.5)	8 (11.6)	3 (13.0)	12 (4.6)	

*†p-value < 0.05; *Chi-square test/Fisher's exact test*

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Associated risk factors of preterm and post-term births

Fifteen exposure variables exhibited significant bivariate association (p<0.05) with preterm and post-term births as shown in Tables 2-4. However, one variable (thus, number of pregnancies) was excluded from the significant exposure variables due to multicollinearity before all the other variables were entered into the final logistic model. In the final model, maternal age < 20 years, educational level (junior high school), non-use of ITNs, and anaemia in the first trimester of pregnancy remained significant for preterm births while senior high school level of education and macrosomia (large birth weight) showed significant relationship with post-term births (Table 5).

Mothers aged less than 20 years (thus teenage mothers) were 12.95 times more likely to give birth to preterm babies (AOR: 12.95; 95%CI: 2.977−56.34). Mothers who completed junior high school were less likely to give birth to preterm babies, showing 77.5% [=(1−0.225)−100] reduction in delivering preterm babies (AOR: 0.225; 95%CI: 0.065−0.797). Mothers who didn't use ITNs during pregnancy were 97.9% more likely to have preterm births (AOR: 1.979; 95%CI: 0.999−3.920). The odds of a mother with anaemia in the first trimester of pregnancy having a preterm birth was 2.205 times (AOR: 2.205; 95%CI: 1.011−4.809).

Furthermore, mothers who completed senior high school were 99.9% less likely to give birth to post-term babies (AOR: 0.001; 95%CI: 0.0001−0.125). Mothers who delivered at an advanced age (post-term) were also more likely to give birth to macrosomic (large weight) babies (AOR: 8.128; 95%CI: 1.777−37.18).

Table 5: Multivariate analysis of risk factors for preterm and post-term births.

Variables	Multinomial logistic regression (Normal term = base outcome)							
	Preterm births				Post-term births			
	COR	p–value (95%CI)	AOR	p–value (95%CI)	COR	p–value (95%CI)	AOR	p–value (95%CI)
Maternal age category								
16 to 19 years	5.344	0.001 (2.014 – 14.18)†	**12.95**	**0.001 (2.977 – 56.34)†**	—	0.994 (—)	—	0.997 (—)
20 to 35 years				1.000				
Above 35 years	0.856	0.761 (0.313 – 2.337)	0.651	0.482 (0.197 – 2.154)	—	0.989 (—)	—	0.993 (—)
Highest level of education								
None				1.000				1.000
Primary school	1.69	0.189 (0.772 – 3.696)	1.077	0.878 (0.418 – 2.770)	0.668	0.551 (0.178 – 2.513)	0.176	0.079 (0.252 – 1.227)
Junior high school	0.681	0.016 (0.269 – 1.722)†	**0.225**	**0.017 (0.065 – 0.797)†**	0.538	0.356 (0.145 – 2.005)	0.237	0.152 (0.033 – 1.704)
Senior high school	0.544	0.099 (0.264 – 1.122)	0.382	0.057 (0.154 – 0.944)	0.072	0.012 (0.009 – 0.561)†	**0.001**	**0.004 (0.0001 – 0.125)†**
Tertiary	1.4	0.444 (0.591 – 3.316)	1.282	0.647 (0.442 – 3.717)	0.775	0.708 (0.205 – 2.939)	0.111	0.068 (0.010 – 1.179)
Gestational weight gain								
Less than 6 kg				1.000				1.000
6kg or more	1.044	0.006 (0.578 – 1.888)†	1.754	0.123 (0.860 – 3.578)	—	0.991 (—)	—	0.991 (—)
Neonatal birth length								
48 cm or more				1.000		1.000		1.000
Less than 48 cm	0.891	0.022 (0.474 – 1.678)†	2.039	0.079 (0.919 – 4.521)	—	0.974 (—)	—	0.992 (—)
Frequency of ANC visits								
Less than 8 visits				1.000				1.000
8 visits or more	0.487	0.013 (0.276 – 0.858)†	0.862	0.688 (0.417 – 1.780)	5.282	0.003 (1.750 – 15.95)†	4.652	0.111 (0.702 – 30.82)
ITNs use								
Yes				1.000				1.000
No	2.006	0.011 (1.174 – 3.427)†	**1.979**	**0.005 (0.999 – 3.920)†**	1.182	0.708 (0.493 – 2.835)	1.244	0.772 (0.284 – 5.442)
Frequency of SP intake								
None	1.835	0.272 (0.621 – 5.424)	0.529	0.596 (0.050 – 5.594)	6.933	0.046 (1.034 – 46.51)†	5.434	0.112 (0.393 – 7.520)
1 to 3 times				1.000				1.000
More than 3 times	0.591	0.064 (0.339 – 1.030)	0.894	0.746 (0.452 – 1.767)	4.16	0.025 (1.195 – 14.48)†	4.641	0.088 (0.794 – 27.13)
Number of pregnancies								

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0 – 1 pregnancy		[Reference]	Excluded due to multicollinearity			[Reference]	Excluded due to multicollinearity	
≥ 2 pregnancies	1.812	0.040 (1.028 – 3.193)†			——	0.986 (——)		
Number of deliveries								
0 – 1 delivery				1.000				1.000
≥ 2 deliveries	1.781	0.042 (1.022 – 3.104)†	1.005	0.989 (0.451 – 2.242)	——	0.987 (——)	——	0.991 (——)
Neonatal birth weight								
Low birth weight	3.233	< 0.001 (1.811 – 5.771)†	1.514	0.337 (0.649 – 3.535)	0.75	0.714 (0.161 – 3.496)	1.27	0.864 (0.083 – 19.39)
Normal BW				1.000				1.000
Macrosomia	0.892	0.860 (0.250 – 3.181)	2.845	0.172 (0.634 – 12.77)	10	< 0.001 (3.742 – 26.72)†	**8.128**	**0.007 (1.777 – 37.18)†**
Hb levels at first trimester								
Low Hb/Anaemia	3.32	< 0.001 (1.865 – 5.911)†	**2.205**	**0.047 (1.011 – 4.809)†**	0.452	0.179 (0.142 – 1.439)	1.27	0.864 (0.083 – 19.39)
Normal Hb				1.000				1.000
High Hb	——	0.991 (——)	——	0.998 (——)	7.051	0.001 (2.341 – 21.23)†	4.716	0.162 (0.538 – 41.35)
Hb levels at second trimester								
Low Hb/Anaemia	3.812	< 0.001(1.989 – 7.304)†	2.422	0.050 (0.998 – 5.876)	0.277	0.015 (0.098 – 0.777)†	0.747	0.726 (0.147 – 3.798)
Normal Hb				1.000				1.000
High Hb	——	0.987 (——)	——	0.999 (——)	7.944	0.049 (1.010 – 58.34)†	0.136	0.236 (0.005 – 3.658)
Hb levels at third trimester								
Low Hb/Anaemia	2.897	< 0.001 (1.647 – 5.094)†	1.009	0.983 (0.449 – 2.268)	0.219	0.016 (0.063 – 0.757)†	0.427	0.440 (0.049 – 3.699)
Normal Hb				1.000				1.000
High Hb	1.715	0.636 (0.183 – 16.06)	14.46	0.097 (0.614 – 34.07)	1.987	0.549 (0.211 – 18.71)	0.288	0.458 (0.011 – 7.743)
Gestational diabetes status								
Not diagnosed				1.000				1.000
Diagnosed	——	0.982 (——)	——	0.998 (——)	2.051	0.028 (0.557 – 7.558)†	3.814	0.221 (0.448 – 32.47)
G6PD status								
Normal				1.000				1.000
Complete/partial	2.754	0.034 (1.078 – 7.031)†	2.673	0.337 (0.360 – 19.87)	3.15	0.094 (0.821 – 12.08)	6.242	0.285 (0.218 – 17.89)
Regression model								
R^2	0.432							
p-value	< 0.001							

†p-value < 0.05; AOR: adjusted odds ratio; COR: crude odds ratio

Discussion

Abnormal gestational age at birth and its associated complications are one of the setbacks in reducing children under-five mortality in most developing countries like Ghana [1]. The study found the prevalence of preterm births to be 19.4%. The prevalence of preterm births is greater than the worldwide incidence of 10.6% [30]. Additionally, greater preterm prevalence was found in this study than the prevalence from developing countries including Brazil (11.5%) [16], Ethiopia (13.3%) [9,12], Iran (12.7%) [31], Kenya (18.3%) [10], and Southern Nigeria (16.0%) [11]. This places the municipality at higher risk of neonatal deaths since preterm births are responsible for 35.0% of all neonatal mortalities and about 16.0% of all global deaths [3]. These aforementioned countries (Brazil, Ethiopia, Iran, Kenya, and Nigeria) might be effectively implementing the recommended interventions on premature births and may have comprehensive healthcare system for pregnant women leading to their relatively low preterm prevalence. Moreover, despite the diverse healthcare systems across those countries, the study designs, and larger sample sizes employed in those earlier studies [9-12,16,31] could be accountable for these variations. The present study finding was also lower than some retrospective studies in Northern India and a teaching hospital in Southern Ghana with prevalence of 35.0% [32] and 37.3% [7] respectively. The increased rate of multiple gestations in India and Southern Ghana could be responsible [7,32], as this may cause an overly stretched uterus which might precipitate preterm deliveries [12] as multiple gestations are established predictors of preterm births [30].

The prevalence of post-term births in this study was estimated at 6.5%. Our study's post-term prevalence

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was lesser as compared to some findings in the Northern Ethiopia [5], and South Africa [25] at corresponding rates of 8.0%, and 11.4%. The differences could be explained in terms of demographic and geographical features of the study populations, as well as the timing of these studies. Furthermore, the lesser post-term births in our study may be linked to the cultural beliefs of the Savelugu citizenry. Culturally, the people of Savelugu municipal regard post-term births as a curse. Due to this cultural belief, pregnant women usually ingest some local oxytocin (kalgu-tim) to increase uterine contractions whenever they reach term gestational age [26], leading to early delivery of their babies and causing a possible reduction of post-term births.

In the study, 5.1% (95%CI: 3.0% - 7.9%) of the mothers were teenagers (adolescents). Teenage mothers (thus, mothers aged less than 20 years) were 13 times more likely to deliver prematurely. An analogous pattern was found among Brazilian [16] and Nigerian [11] mothers aged less than 20 years old with an increased risk of preterm births. However, our study was incongruent with some retrospective studies in Southern Ghana [7,17], Kenya [10], and Ethiopia [12]. Teenagers (young mothers) are still in the active phase of physiological, psychological, emotional, biological, and physical maturity and development. These young women (teenagers) may not cope with the changing demands of pregnancy and also identify the significance of feto-maternal nutrition, childbearing, and self-care activities among others during pregnancy [33] which may lead to adverse pregnancy outcomes like preterm births.

The current study demonstrated that mothers who completed junior high school had a reduced risk for preterm births. This is different from the findings of Wagura and colleagues [10] but similar to that of Spanish and Japanese cohort studies [34,35] which indicated that maternal lower educational level (junior high school) was associated with premature births. Approximately 13.0% (95%CI: 9.6% – 16.9%) of the mothers completed junior high school while 34.0% (95%CI: 29.1% – 39.2%) had no formal education in the Savelugu municipality. Junior high school education has been linked to lower the incidence of pregnancy complications in women including delivery of preterm babies [36,37]. This is in agreement with our study findings. It is found in most developing countries that unsatisfactory antenatal visits which predict preterm births are higher in settings where junior high school enrollment rate is low [35,36]. Hence, this gives an explanation of why mothers who completed junior high school tend to be protective against preterm births.

Gestational anaemia is a global challenge as well as the most prodigious haematological manifestation of pregnancy and a heralded cause of gestational complications and adverse reproductive outcomes [6]. Mothers with anaemia in the first trimester of pregnancy were twice more likely to give birth to preterm babies in this study. This finding is consistent with some meta-analyses [38,39] which concluded that first-trimester anaemia increases the risk of premature births. Many prospective and retrospective studies were also consistent with our study findings [13-15] while others were incongruent [40,41]. Despite the complex and multifactorial aetiological mechanisms such as nutritional deficiencies (iron, folic acid, vitamin A, or vitamin B12), infections (malaria, worm infestations, and HIV), and haemoglobinopathies (sickle cell) underlying the relationship between low gestational haemoglobin levels and prematurity, iron deficiency (which is a major contributor to gestational anaemia) tend to be the most reported trigger of preterm births [39,42]. Thus, anaemia in the first and/or early trimester of gestation may designate pre-existing, early onset, and/or persistent iron deficiency which precipitates preterm births. Additionally, the current study revealed significant crude association between first-trimester gestational anaemia and non-intake of antihelminthics (OR: 1.55, p = 0.038). This evidence supports the mechanism of infections like worm infestations on gestational anaemia leading to the delivery of preterm babies [42]. Anaemia including iron deficiency could induce maternal infection, hypoxia, and oxidative stress that may trigger the spontaneous onset of preterm labour [32]. This highlights the need for early prevention and treatment of anaemia during pregnancy due to the relatively high preterm prevalence in the Savelugu municipality.

About 40% (95%CI: 33.7% – 44.0%) of mothers didn’t use ITNs during pregnancy in our study which is comparable to a Nigerian cross-sectional study [43]. Non-use of ITNs during gestation was significantly associated with an increased risk of preterm births in our study. This is confirmatory to some studies in the Sahelian Africa [44,45]. Strengthening community and antenatal education on the use of ITNs during pregnancy is crucial for preventing malaria infection [43,44] which predisposes pregnant women to premature deliveries. Likewise, health facilities must constantly supply these ITNs to pregnant mothers and adequately monitor ITNs use to prevent malaria infections from leading to preterm births in the municipality.

On the other hand, post-term births have not been accorded similar recognition as preterm births. Hence, there are very rare studies on post-term births globally. From our study, senior high school leavers were protective factor for post-term births. Thus, mothers who completed senior high school were less likely to deliver post-mature babies. The proportion of mothers with senior high school education were 29.5% (95%CI: 24.8% – 34.5%) in our present study. The present finding is unparallel to a prospective study in Ethiopia where no association was found between post-term births and maternal educational level [5]. By virtue of relatively higher education among mothers who completed senior high school, we conjecture that mothers with senior secondary

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education are relatively knowledgeable and aware of their reproductive health and pregnancy outcomes and always adhere to antenatal care education and counseling which lead to a reduction in the birth of post-term babies.

With an approximate macrosomia incidence of 9.0% (95% CI: 5.0% – 12.0%) found in our study, it was revealed that macrosomia was significantly associated with post-maturity. This finding is in contrast to that of meta-analysis [19] and longitudinal studies in the United States of America [20] but mirrored a cross-sectional study by Adjei-Gyamfi and his colleagues [18]. Maternal, child, and neonatal mortalities are associated with advanced gestational age (post-term) in most developing countries [46]. Physiologically, large-weight (macrosomic) foetus tends to experience weekly intra-uterine weight gain estimated between 0.12 to 0.24 kilograms as the foetus continuously stays in the uterus after 37 weeks of gestation [47]. As the uterus promotes growth processes, the foetus enjoys a substantial increase in weight as it stays longer in the uterus leading to late gestation. In our study, out of the 31 mothers who delivered macrosomic babies, larger proportion were diagnosed with gestational diabetes (26; 83.9%) as few mothers were not diagnosed with gestational diabetes during pregnancy ($p=0.011$ in $\chi 2$/Fisher's exact test). Concurrently, of the same 31 mothers, those who had gestational weight gain (GWG) of at least 6kg (28; 90.3%) were greater than those who had GWG less than 6kg ($p=0.027$ in $\chi 2$/Fisher's exact test). As supported by previous studies [5,18-20], gestational diabetes, and increased GWG surge the risk of macrosomia births [5,19,20], which could subsequently lead to higher post-term deliveries in the municipality.

Limitations of the Study

This study identified some limitations. Selection bias could happen. The study did not recruit mothers without antenatal record books, delivered at home, and were absent from first-trimester antenatal services. Furthermore, information bias could occur due to the use of previous obstetric and anthropometric data from antenatal records including gestational age, birthweight, birth length, ANC visits, and mother's weight among others. This is because mismeasurement and mis-recording could occur rendering some of the data incorrect. Finally, since the study design is a cross-sectional type, it may require regional or national studies to attain generalizable findings and conclusions.

Conclusion

Preterm births are very prevalent while post-term births are increasingly becoming more important in the Savelugu municipality. Preterm births were independently associated with anaemia in the first trimester of pregnancy, non-use of ITNs during pregnancy, teenage mothers, and mothers with junior high school education. Alternatively, while macrosomic deliveries increased the risk of post-term births, mothers with senior high school levels of education appeared to be a protective factor. These risk factors are modifiable and preventable. Ghanaian Ministry of Health through the Ghana Health Service should give greater attention to first-trimester anaemia during pregnancy (due to its effect on preterm births) through the consistent creation of community and health workers' awareness. Also, promoting and encouraging girl child education through parental empowerment in Ghana (especially in Savelugu municipality) in addition to regular community education on nutrition together with lifestyle modification are commended.

Declarations

Ethical Standards Disclosure

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Ethical Committee of Graduate School of Tropical Medicine and Global Health, Nagasaki University, Japan (approval no.: NU_TMGH_2021_194_1) and Ghana Health Service Ethics Review Committee, Ghana (approval no.: GHS-ERC 026/12/21). Written informed consent/assent was obtained from all study participants and/or legal representatives.

Consent for publication

Not required

Availability of data and materials

The datasets generated, and analyzed during the present study will be made available by the corresponding author, without undue reservation. Kindly email: adjeigyamfis@yahoo.com

Conflict of Interest

None

Authorship

SAG, HA, and AA formulated the research questions, designed, and conceptualized the study. SAG and AA carried out the data collection, data analysis, and interpretations. All authors contributed to drafting the manuscript, reviewing, and approving the final manuscript.

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