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Preterm birth, low birth weight, and their co-occurrence among women with preexisting chronic diseases prior to conception: a cross-sectional analysis of postpartum women in a low-resource setting in Ghana

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Abstract

Background The incidence of chronic diseases, which are significant contributors to maternal deaths and adverse new-born outcomes, is increasing among women of reproductive age in northern Ghana. This emerging health issue raises serious concerns about the potential exacerbation of adverse birth outcomes in this setting, given that it is one of the regions in the country with a high incidence of such outcomes. We investigated the risks of preterm birth (PTB), low birth weight (LBW), and concurrent PTB and LBW among women with preexisting chronic conditions prior to conception in the Tamale Metropolis of northern Ghana.

Methods A facility-based cross-sectional study was conducted among 420 postpartum women randomly selected from five public health facilities. Information was collected electronically on participants' self-reported experience of chronic conditions, namely, hypertension, diabetes, asthma, heart disease, and sickle cell disease, prior to their most recent pregnancy. Information on gestational age at delivery and birth weight was also collected. Regression modeling was used to quantify the risk of adverse newborn outcomes among women who reported preexisting chronic conditions prior to pregnancy.

Results Chronic diseases affected 31.2% of our sample. Of these, 28.6% had a single chronic condition, while 2.6% had comorbid chronic conditions. The prevalence of PTB was 24.0% (95% CI: 20.2, 28.4), 27.6% (95% CI: 23.5, 32.1) of the newborns were born LBW, and 17.4% (95% CI: 14.0, 21.3) of the pregnancies resulted in both PTB and LBW. Compared with those without chronic conditions, women with chronic conditions prior to conception had a greater risk of PTB (aOR = 6.78, 95% CI: 3.36, 13.68), LBW (aOR = 5.75, 95% CI: 2.96, 11.18), and the co-occurrence of PTB and LBW (aOR = 7.55, 95% CI: 3.32, 17.18).

Conclusions We observed significant rates of PTB, LBW, and the co-occurrence of PTB and LBW among women who were already aware that they had preexisting chronic conditions prior to conception. Our findings highlight

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a potential gap in the quality of prenatal care provided to these women before delivery. Preconception care may offer an opportunity to address preexisting chronic conditions in women before pregnancy and potentially improve maternal and newborn health outcomes.

Keywords Noncommunicable diseases, Adverse pregnancy outcomes, Pregnant women, Ghana

Background

Preterm birth (PTB) and low birth weight (LBW) represent significant public health challenges, that exert substantial impacts on the health and well-being of newborns worldwide. Recent estimates indicate that nearly 10% (13.4 million) of infants are born preterm, and approximately 15% (21.0 million) experience low birth weight annually on a global scale [1, 2]. Notably, the sub-Saharan African (SSA) region, which ranks second only to Asia, bears a substantial burden of PTB and LBW. The literature reports that a variety of factors, either directly or indirectly, influence birth outcomes, including maternal age, level of education, marital status, obstetrical factors like gravidity and parity, medical conditions like hypertensive disorders of pregnancy, healthcare, and behavioural factors like smoking and antenatal care use [3–6]. Scholars have also identified that PTB and LBW are related, with data showing that newborns born prematurely are more likely to have a low birth weight [7–9].

Noncommunicable diseases (NCDs), also referred to as chronic diseases, impact individuals across diverse backgrounds and geographical regions globally. This category of health conditions continues to be the primary contributor to the highest disease burden, accounting for 74% of global deaths in 2019 [10]. The prevalence of chronic diseases poses a significant concern, particularly in SSA, where existing health systems in many countries face challenges such as fragility, fragmentation, inadequate resources, and limited infrastructure and capacity to address the rising burden of these conditions and have historically prioritised the management of infectious diseases and maternal, neonatal, and child health [11–13]. The increasing recognition of the challenges presented by chronic diseases is apparent in global initiatives such as the UN Sustainable Development Goals. Among these goals is a target to reduce premature deaths attributed to major NCDs by 30% by the year 2030, alongside a focus on promoting mental health and overall well-being [14].

Despite global improvements in healthcare, chronic diseases such as hypertension, diabetes, cardiovascular conditions, and chronic respiratory issues significantly impact maternal health and can detrimentally influence pregnancy outcomes. The scientific literature suggests that the burden of adverse birth outcomes, such as premature delivery and low birth weight, is notably higher among women with preexisting chronic diseases, especially in resource-constrained settings [15, 16]. Perinatal mortality has also been observed among these women in severe situations [17]. Systematic reviews and meta-analytic studies have shown that babies who are born early or with a low birth weight have a greater chance of developing long-term conditions such as metabolic syndrome and cardiometabolic disorders as adults [18–20]. This interconnected relationship between chronic conditions and adverse birth outcomes creates a potentially vicious cycle.

The relationship between chronic diseases and adverse birth outcomes involves intricate interactions among biological, economic, social, and healthcare factors. Nevertheless, maternal health management of chronic diseases, particularly in low- and middle-income countries (LMICs), is often neglected: a systematic review of studies revealed a significant gap in LMICs, as most guidelines focus on high-income countries [21]. Furthermore, the existing guidelines in high-income countries neglect the multimorbidity of chronic diseases in pregnant women by focussing on single conditions. In Ghana, NCDs contribute 43% of all-cause mortality, including major diseases such as heart disease, stroke, diabetes, cancer, and respiratory disease [22]. However, the capacity to address chronic conditions at the primary healthcare level is limited due to issues such as poor policy awareness, coordination, funding, and intersectoral engagement [23, 24].

Chronic diseases are on the rise among women of reproductive age in northern Ghana, a region characterised by socioeconomic disparities and inadequate healthcare infrastructure [25]. This emerging health issue raises serious concerns about the potential exacerbation of adverse birth outcomes in this population, given that it is one of the regions in the country with a high burden of such outcomes, as indicated by existing studies [26–28]. Moreover, earlier research on adverse birth outcomes in the region has overlooked this important aspect [26, 28–30]. For example, Hussein et al., in their prospective cohort study, investigated prenatal malaria exposure and its association with adverse birth outcomes [28]. Similarly, Boah and colleagues assessed the risk of adverse birth outcomes among women who experienced physical and psychological intimate partner violence during pregnancy [30]. Thus, there is a pressing need to deepen our understanding of how preexisting chronic conditions

might impact the risk of adverse birth outcomes in this setting.

This study aimed to assess the prevalence of preexisting chronic conditions among women prior to conception and to investigate any potential associations between these conditions and the risk of PTB and LBW, as well as the co-occurrence of PTB and LBW within the Tamale Metropolitan Area of the northern region of Ghana.

Methods

Study setting and design

This facility-based cross-sectional study was conducted in the Tamale Metropolitan Area of the northern region of Ghana. The Tamale Metropolitan Area is among the 261 Metropolitan, Municipal, and District Assemblies in Ghana and one of the 16 MMDAs located in the Northern Region. It was upgraded to the status of a metropolis in 2004, with Tamale serving as the capital. The area has a population of 374,744 according to the most recent 2021 population and housing census [31]. Three public hospitals, eight health centres, more than ten private hospitals, a hospital run by the Christian Health Association of Ghana (CHAG), and more than 20 private clinics all provide care for the local population. Health centres provide primary healthcare services such as antenatal care (ANC), immunisation, family planning, and basic treatments for common illnesses.

Sample size and sampling strategy

Our study employed a multiple sampling approach to select both health facilities and study participants. We purposefully chose health facilities because they offered advantages in terms of convenience and access to the target population. Five health centres were randomly selected from the available eight in the metropolis using the lottery technique. The sample size for the study was then determined using the Taro Yamane formula for estimating proportions in finite populations, expressed as follows:

$$n = \frac{N}{1 + Ne^2} \quad (1)$$

where n denotes the desired sample size, e represents the desired precision, and N represents the estimated cumulative number of deliveries from the five selected health facilities for the year 2022. Assuming 5% desired precision and an estimated 8489 deliveries, the minimum sample size required for the study was 382 women. To account for possible nonresponse, we adjusted the sample size to 420 and allocated it to each of the facilities based on their proportion of deliveries.

For participant selection, a systematic random selection method was utilised. The postnatal register at each health facility served as a sampling frame and provided a list of women who had given birth within the past twelve months. The sampling interval was determined by dividing the total number of eligible women by the minimum sample size required from the facility. Starting with a random selection from the first ten names in the sampling frame, respondents were then chosen using the sampling interval until the desired sample size was achieved.

Data collection tool and procedures

The study utilised a semistructured questionnaire to collect data electronically via Google Forms on Apple phones running iOS software. A pilot test was conducted with 42 women from healthcare facilities outside the study area to ensure the reliability of the questionnaires in gathering the needed information. Modifications were made where applicable to unclear questions to enhance clarity.

Information was collected from respondents covering various aspects, including their background characteristics, obstetrical history, ANC utilisation during their most recent pregnancy, and the self-reported presence of preexisting chronic conditions prior to their most recent pregnancy. Information on their birth outcomes, such as birth weight and gestational age at delivery, was also gathered. Maternal and child record books were used to retrieve information on ANC, birth outcomes, and certain obstetrical information. Five trained research assistants conducted the data collection, ensuring adherence to the research protocol and ethical guidelines. The interviews were conducted with the women when they visited the facility to receive postnatal care or child welfare services. The data were collected throughout August and September 2023.

Measures

Dependent variables

Three outcome variables were considered in the present study, namely PTB, LBW, and concurrent PTB and LBW. These outcomes were defined according to international classifications [32]. Preterm birth is when a baby is born too early, before 37 weeks of pregnancy have been completed. On the other hand, LBW occurs when a baby is born with a weight less than 2500 g, regardless of gestational age. Concurrent or co-occurrence of PTB and LBW was defined as a baby being born prematurely and having a low birth weight at the same time. The gestational age at delivery was established using the last menstrual period and ultrasound.

Main independent variable

The main independent variable in this study was the self-reported presence of preexisting conditions. In this

study, the following conditions were considered: hypertension, asthma, diabetes, sickle cell disease, and heart disease. These conditions are commonly diagnosed at health facilities in Ghana [22]. Furthermore, these conditions are frequently included in studies involving chronic diseases among pregnant women globally [33]. Information regarding the presence of these conditions or otherwise before their most recent pregnancy was obtained from respondents using two questions. These questions are as follows: 1) "Have you ever been told by a doctor or other health worker that you have [name of condition]?" 2)"Before your recent pregnancy, were you taking any drugs (medication) for [name of condition]?" The response options for both questions were "yes" or "no." These questions have been employed in standard WHO STEPS surveys to gather information on NCDs and their risk factors [34]. Respondents who answered "yes" to any of the conditions were classified as having a preexisting chronic condition.

Covariates

While the main interest is in understanding the relationship between preexisting chronic conditions and the selected outcomes, studies conducted in low-resource settings have indicated that various sociodemographic, obstetric, and healthcare-related factors and interventions may influence these birth outcomes [3–5]. Therefore, factors such as the age and education of the woman, the number of pregnancies (gravidity) and births (parity) she has had, and healthcare-related factors, including healthcare facility, antenatal care utilisation, and interventions such as iron and folic acid supplementation, drugs against helminth parasites, and malaria prophylaxis, were considered potential confounding factors during the analysis. This was done to ensure that the results were accurately interpreted and that potential confounding factors were isolated. Gravidity was used in its continuous form for analysis.

Statistical analysis

All analyses were performed in Stata 15/IC for Windows (StataCorp LLC, Texas, USA). We used both descriptive and inferential statistics. The descriptive statistics explored the distribution of study respondents by their background characteristics, the percentage distribution of chronic conditions existing among respondents prior to pregnancy, and the prevalence of the study outcomes, PTB, LBW, and concurrent PTB and LBW. We used crude logistic regression models to investigate the relationship between each chronic condition and the outcomes. We used adjusted binary logistic regression models to quantify the associations between the main exposure variable, as an aggregate exposure, and the outcomes. However, only the results of the adjusted analyses are presented as adjusted odds ratios (aORs) with their corresponding 95% confidence intervals. Statistical significance was set to a probability value less than 0.05 in two-tailed tests. We used the Hosmer–Lemeshow goodness-of-fit test to evaluate the fitness of our models; all models indicated a good fit ($p > 0.05$).

Ethical considerations

The current investigation was conducted in accordance with the ethical guidelines specified in the Declaration of Helsinki regarding research with human beings [35]. Specifically, this study received approval from the Ghana Health Service Ethics Review Committee (GHS-ERC 101/07/2023). Moreover, prior to participation, the respondents provided both verbal and written informed consent after being briefed on the study's objectives, procedures, potential benefits and risks, their right to withdraw at any stage, and the guarantee of confidentiality and anonymity throughout the research process.

Results

Background characteristics of the respondents included in the present study

Table 1 presents information on the background characteristics of the respondents, including their demographic and obstetrical characteristics, health-seeking behaviour, and ANC interventions received during their most recent pregnancy. The results showed that a higher percentage of the respondents were in the 25 – 34- year-old age group (52.6%), had received basic education (33.6%), were in a relationship (89.8%), and were employed (69.3%). Furthermore, less than half (42.9%) of the respondents made at least eight ANC visits before delivery and booked their first visit in the first trimester. Moreover, a greater percentage reported receiving iron and folic acid supplements (77.6%) and IPTp (88.6%) during pregnancy.

Prevalence of preexisting chronic diseases among women of reproductive age prior to conception

The percentage distribution of preexisting chronic diseases among women prior to pregnancy is summarised in Table 2. According to the findings, hypertension was the most prevalent chronic condition reported by women, accounting for 12.4% of cases. Diabetes affected 7.6% of the respondents, while sickle cell disease affected 4.8%. Conversely, heart disease was the least frequently reported condition among the surveyed population, affecting 1.9%. In total, chronic diseases affected 31.2% of our sample. More specifically, 28.6% of respondents had a single chronic condition, while 2.6% had comorbid chronic conditions (see Fig. 1).

Table 1 Background characteristics of the respondents included in the present study (*N* = 420)

Characteristic	Frequency	Percent
Age in groups		
15–24	98	23.3
25–34	221	52.6
35–49	101	24.1
Educational level		
No formal education	93	22.1
Basic education	141	33.6
Secondary	102	24.3
Tertiary	84	20.0
Marital status		
Single	43	10.2
Partnered	377	89.8
Religion		
Christianity	61	14.5
Islamic	343	81.7
African traditional	16	3.8
Ethnicity		
Dagomba	283	67.4
Gonja	58	13.8
Gruni	23	5.5
Others	56	13.3
Employment		
Unemployed	129	30.7
Employed	291	69.3
Number of ANC visits before delivery		
1—7	240	57.1
8 +	180	42.9
Gestation (in months) at ANC booking		
1—3	180	42.9
4—6	215	51.2
7—9	25	5.9
Gravidity (mean ± SD)	420	2.8 ± 1.5
Dewormer given during pregnancy		
No	274	65.2
Yes	146	34.8
Given iron and folic acid supplementation during pregnancy		
No	94	22.4
Yes	326	77.6
IPTp given		
No	48	11.4
Yes	372	88.6
Health facility		
Bilpela	55	13.1
Moshie Zongo	70	16.7
Nyohini	84	20.0
Tamale Reproductive and Child Health	148	35.2
Vittin health centre	63	15.0

ANC Antenatal care, *IPTp* Intermittent preventive treatment of malaria during pregnancy

Table 2 Percentage distribution of preexisting chronic conditions among women prior to pregnancy (*N* = 420)

Type of chronic condition	Frequency	Percent
Hypertension		
No	368	87.6
Yes	52	12.4
Diabetes		
No	388	92.4
Yes	32	7.6
Heart disease (s)		
No	412	98.1
Yes	8	1.9
Asthma		
No	390	92.9
Yes	30	7.1
Sickle cell disease		
No	400	95.2
Yes	20	4.8

Burden of preterm birth, low birthweight, and the co-occurrence of preterm birth and low birth weight in women with preexisting chronic diseases prior to conception

The rates of PTB, LBW, and the co-occurrence of PTB and LBW are illustrated in Fig. 2. According to the information presented in Fig. 2a, the prevalence of PTB was 24.0% (95% CI: 20.2, 28.4). Similarly, 27.6% (95% CI: 23.5, 32.1) of the newborns were born with a low birth weight (Fig. 2b). Furthermore, 17.4% (95% CI: 14.0, 21.3) of pregnancies resulted in both PTB and LBW, as shown in Fig. 2c.

Risk of preterm birth, low birth weight, and the co-occurrence of preterm birth and low birth weight in pregnant women with preexisting chronic diseases

We analysed the relationship between each chronic condition and PTB, LBW, and the co-occurrence of PTB and LBW. Table 3 presents the results of this crude analysis. Each of the three outcomes had a statistically significant relationship with hypertension, heart disease, and sickle cell disease. Only preterm birth was significantly associated with asthma, while diabetes was not associated with any of the outcomes. Overall, among variables that were associated with the outcomes, women who self-reported the existence of chronic conditions had increased odds of the outcomes. We analysed the crude association between the preexisting chronic conditions and the birth outcomes. For this analysis, we aggregated the exposures by combining the chronic conditions that showed

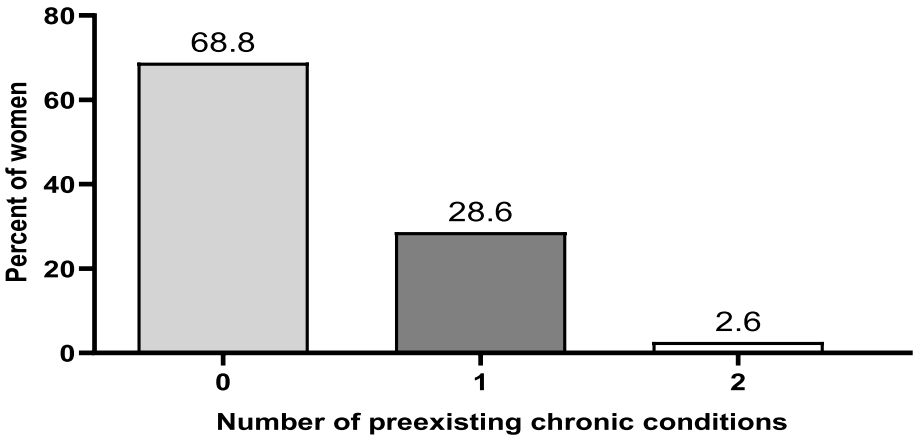

Fig. 1 Prevalence of preexisting chronic conditions among women of reproductive age prior to conception

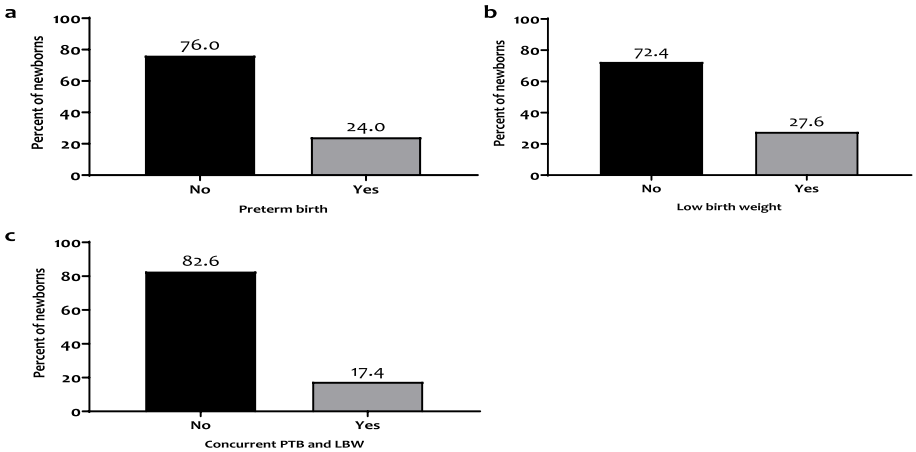

Fig. 2 Rates of preterm birth, low birth weight, and concurrent preterm birth and low birth weight among women with preexisting chronic diseases prior to conception

significant associations with birth outcomes, excluding diabetes mellitus. The results showed that women with preexisting conditions had increased odds of delivering prematurely (cOR = 7.80, 95% CI: 4.72, 12.88), having a low-birth-weight baby (cOR = 6.16, 95% CI: 3.80, 9.99), and experiencing both PTB and LBW (cOR = 6.58, 95% CI: 3.83, 11.31).

Table 4 presents the results of the regression analysis on the risk of PTB, LBW, and concurrent PTB and LBW among pregnant women with any preexisting chronic conditions, after accounting for potential confounding factors, including demographic and economic variables, obstetric factors, health-seeking behaviour, and ANC interventions. For this analysis, we used only the aggregated exposure variable. The findings revealed a strong association between preexisting chronic conditions in women before pregnancy and the risk of PTB, LBW, and concurrent PTB and LBW. Specifically, women with preexisting chronic conditions had significantly greater odds of delivering prematurely (aOR = 6.78, 95% CI: 3.36, 13.68), having a low-birth-weight baby (aOR = 5.75, 95% CI: 2.96, 11.18), and experiencing both PTB and LBW (aOR = 7.55, 95% CI: 3.32, 17.18).

Several potentially confounding variables, including maternal age, the number of ANC visits prior to birth, iron and folic acid supplementation, and intermittent preventive treatment of malaria during pregnancy (IPTp), exhibited significant associations with the outcomes. Compared to women aged 15–24 years, those aged 25–34 years and 35–49 years had lower incidences of PTB, LBW, and concurrent PTB and LBW. Similarly, women who had at least eight ANC visits prior to childbirth had a reduced risk of PTB, LBW, and concurrent PTB and LBW. Additionally, women who received IPTp were less likely to experience PTB, LBW, and concurrent PTB and LBW than were those who did not receive IPTp.

Table 3 The association between each chronic condition and preterm birth, low birth weight, and concurrent preterm birth and low birth weight

Condition	Preterm birth (PTB) cOR [95% CI]	Low birth weight (LBW) cOR [95% CI]	Concurrent PTB and LBW cOR [95% CI]
Hypertension			
No	1.00	1.00	1.00
Yes	5.70***[3.10, 10.47]	6.58***[3.53, 12.26)	6.17***[3.31, 11.50]
Diabetes			
No	1.00	1.00	1.00
Yes	0.87[0.36, 2.09]	0.46[0.17, 1.23]	0.29[0.07, 1.27]
Heart disease			
No	1.00	1.00	1.00
Yes	5.48**[1.28, 23.37]	8.23**[1.63, 41.41]	8.43***[1.96, 36.11]
Asthma			
No	1.00	1.00	1.00
Yes	3.53***[1.66, 7.51]	1.83[0.85, 3.93]	1.49[0.61, 3.62]
Sickle cell disease			
No	1.00	1.00	1.00
Yes	5.24***[2.07, 13.22]	5.35***[2.08, 13.78]	5.34***[2.13, 13.38]
Chronic condition (s) present			
No	1.00	1.00	1.00
Yes	7.80***[4.72, 12.88]	6.16***[3.80, 9.99]	6.58***[3.83, 11.31]

cOR Crude odds ratio

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Individuals who received deworming treatment, on the other hand, were less likely to experience PTB or have a child with concurrent PTB and LBW. The analysis also showed that women who booked their first ANC visit in their third trimester had increased odds of having LBW babies compared to those who booked in their first trimester of pregnancy (aOR = 5.85, 95% CI: 1.40, 23.97). An increase in the number of pregnancies increased the odds of experiencing concurrent PTB and LBW (aOR = 1.39, 95% CI: 1.03, 1.85). We have presented the marginal analysis (delta-method) of the predicted probability of the outcomes based on the covariates as supplemental material (see Additional file 1).

Discussion

The aim of the present study was to assess the prevalence of preexisting chronic conditions among pregnant women and investigate any potential associations between these conditions and the risk of PTB and LBW, as well as concurrent PTB and LBW, in a setting characterised by socioeconomic disparities, inadequate healthcare infrastructure, and a high burden of adverse newborn outcomes. According to our study, more than three out of ten women in the sample (31.2%) had at least one chronic disease, with more than a quarter (28.6%) having a single chronic condition and approximately 3% presenting with comorbid chronic conditions. Hypertension was the most prevalent condition among the examined conditions, followed by diabetes and asthma. Sickle cell disease was less common, with heart disease being the least reported condition.

Our analysis, utilising chronic conditions as an aggregate exposure, limits direct comparisons with studies that did not use this approach. Nevertheless, consistent with our findings, a study identified hypertension as the most common chronic condition among more than 1000 conditions found in pregnant women [36]. Despite the difference in approach, the overarching message remains consistent: chronic conditions pose a substantial challenge for pregnant women, impacting their health and potentially influencing pregnancy outcomes [37, 38]. For example, a study in Haiti reported that 7.1% of pregnant women had diabetes only, 12.6% had hypertensive disorders of pregnancy, and 4.2% had both diabetes and hypertensive disorders of pregnancy [17]. Similarly, a study from a low-resource setting found that about 1% of pregnant women had cardiovascular disease [15].

Table 4 Risk of preterm birth, low birth weight, and concurrent preterm birth and low birth weight in pregnant women with preexisting chronic diseases prior to conception

Variable	PTB aOR [95% CI]	LBW aOR [95% CI]	Concurrent PTB and LBW aOR [95% CI]
Chronic condition (s) present			
No	1.00	1.00	1.00
Yes	6.78***[3.36, 13.68]	5.75***[2.96, 11.18]	7.55***[3.32, 17.18]
Age group			
15–24	1.00	1.00	1.00
25–34	0.18***[0.08, 0.46]	0.24***[0.11, 0.54]	0.09***[0.03, 0.28]
35–49	0.24*[0.08, 0.75]	0.30*[0.11, 0.85]	0.12**[0.03, 0.46]
Education level			
No formal education	1.00	1.00	1.00
Basic education	0.79[0.38, 1.68]	0.87[0.42, 1.78]	0.66[0.29, 1.51]
Secondary	1.21[0.52, 2.85]	0.92[0.40, 2.12]	1.12[0.43, 2.94]
Tertiary	0.40[0.08, 2.13]	0.88[0.27, 2.86]	0.85[0.15, 4.90]
Marital status			
Single	1.00	1.00	1.00
Partnered	0.41[0.17, 1.01]	1.11[0.44, 2.83]	0.47[0.18, 1.29]
Religious affiliation			
African traditional	1.00	1.00	1.00
Christianity	0.51[0.09, 3.11]	3.21[0.60, 17.28]	1.29[0.16, 10.49]
Islam	0.55[0.12, 2.47]	1.93[0.45, 8.25]	1.80[0.32, 10.10]
Employment status			
Unemployed	1.00	1.00	1.00
Employed	1.03[0.52, 2.04]	0.60[0.32, 1.12]	0.87[0.41, 1.85]
Number of ANC visits			
Less than 7	1.00	1.00	1.00
8 or more	0.22**[0.08, 0.65]	0.38*[0.15, 0.94]	0.14**[0.03, 0.62]
Gestation at ANC booking			
First	1.00	1.00	1.00
Second	0.65[0.25, 1.68]	1.55[0.65, 3.71]	0.52[0.17, 1.67]
Third	1.13[0.27, 4.77]	7.94**[1.81, 34.87]	1.39[0.30, 6.57]
Gravidity	1.22[0.95, 1.57]	1.11[0.89, 1.41]	1.34*[1.01, 1.80]
Given dewormer			
No	1.00	1.00	1.00
Yes	0.33*[0.12, 0.92]	0.58[0.26, 1.34]	0.35[0.10, 1.25]
Given iron and folic acid supplementation			
No	1.00	1.00	1.00
Yes	0.37**[0.18, 0.76]	0.58[0.29, 1.18]	0.34**[0.16, 0.77]
IPTp given			
No	1.00	1.00	1.00
Yes	0.62[0.26, 1.47]	0.32*[0.14, 0.80]	0.46[0.19, 1.14]
Healthcare facility			
Bilpela	1.00	1.00	1.00
Moshie Zongo	0.50[0.17, 1.48]	0.84[0.30,2.32]	0.58[0.16, 2.08]
Nyohini	0.91[0.34, 2.49]	0.67[0.25, 1.83]	1.23[0.39, 3.94]
Tamale Reproductive and Child Health	0.65[0.25, 1.67]	0.83[0.34, 2.05]	0.86[0.29, 2.57]
Vittin health centre	0.88[0.30, 2.59]	0.83[0.29, 2.35]	1.27[0.37, 4.38]

ANC Antenatal care, *aOR* Adjusted odds ratio, *LBW* Low birth weight, *IPTp* Intermittent preventive treatment of malaria during pregnancy, *PTB* Preterm birth

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

According to our study, nearly a quarter (24.0%) of the babies were born prematurely, and more than a quarter (27.6%) had a low birth weight. Furthermore, nearly one in every seven (17.4%) newborns was both premature and had a low birth weight. The rates of PTB and LBW in the present study are higher than those reported in both the SSA region (10% and 13.7%, respectively) and the world on an annual basis (10% and ≈15%, respectively) [1, 2]. Furthermore, analyses of pregnant women and their babies in rural communities across six LMICs found a combined preterm birth and LBW rate of 5.5% [3]. The most recent Ghana demographic and health survey revealed that 11% of newborns in Ghana are born with a low birth weight [39]. We attribute the higher rates of adverse newborn outcomes reported in the current study compared to the existing studies to the fact that adverse newborn outcomes are relatively more prevalent among women with chronic conditions than among healthy women [16, 36, 40].

Our analysis provides evidence of a significant association between preexisting chronic conditions, such as hypertension, asthma, sickle cell disease, and heart disease, and a greater risk of PTB, and LBW and the co-occurrence of PTB and LBW in the northern region of Ghana, which is consistent with previous studies [15, 17, 40, 41]. However, our study also contributes to the literature by examining the co-occurrence of PTB and LBW in this population, providing valuable insights into the complexity of pregnancy complications in women with chronic diseases.

Chronic conditions such as hypertension, asthma, sickle cell disease, and heart disease can potentially contribute to adverse newborn outcomes such as PTB, LBW, or both through various mechanisms. Moreover, it is also worth noting that each of these conditions may have different mechanisms and levels of association with adverse newborn outcomes. We postulate that one of these mechanisms involves genetic predispositions associated with certain chronic conditions, which may also play a role in increasing the risk of preterm birth and low birthweight in infants [42–45].

In addition to genetics, placental insufficiency also represents a potential central link between chronic conditions and adverse newborn outcomes. This insufficiency manifests through various mechanisms, including vascular complications and impaired oxygen transport. Chronic conditions such as hypertension, asthma, and sickle cell disease can affect pregnancy outcomes by reducing blood flow to the placenta, leading to inadequate oxygen and nutrient supply to the fetus [46, 47]. Indeed, it has been established that the efficacy of the placental glucocorticoid barrier, which protects the fetus from excess intrauterine glucocorticoid exposure, is compromised in pregnancies complicated by maternal asthma, reducing oxygen and nutrient supply to the fetus [48, 49]. This disruption can result in decreased oxygen and nutrient supplies to the fetus, resulting in PTB and LBW as the fetus fails to receive enough nourishment and oxygen for proper development.

Additionally, managing chronic conditions during pregnancy can be stressful for the mother and increase cortisol levels [50]. High cortisol levels, in turn, can reduce lymphocyte sensitivity to glucocorticoids by binding to glucocorticoid receptors [51]. This diminished sensitivity may impair the body's ability to regulate inflammation and immune responses, potentially impacting both maternal and fetal health during pregnancy. Moreover, chronic conditions, when not controlled, can increase the risk of maternal complications during pregnancy, such as preeclampsia in the case of hypertension or gestational diabetes, further increasing the risk of PTB and LBW [52–54].

Our study also identified additional significant factors influencing adverse birth outcomes alongside chronic conditions, which was our primary focus. We observed that an increased frequency of ANC visits and the receipt of essential ANC interventions, namely iron and folic acid supplements, dewormers, and IPTp, were associated with a reduced chance of adverse birth outcomes. These findings align with population-based studies that have emphasised the potential significance of ANC in improving birth outcomes and reducing child mortality and malnutrition in the longer term [3, 55]. Conversely, late booking for ANC was associated with an increased likelihood of LBW. We propose discussing these factors together rather than independently, as they all fall within the ANC framework.

Regular ANC attendance allows for the timely identification and management of maternal health conditions and pregnancy complications that have the potential to increase the risk of adverse birth outcomes. Consistent visits enable healthcare providers to monitor fetal growth, assess maternal health status, and provide necessary interventions or referrals as needed [56]. Iron and folic acid supplementation during ANC contributes to optimal maternal nutrition, which is essential for fetal development and growth, thus reducing the risk of LBW [57, 58]. Similarly, dewormer administration and IPTp during pregnancy can prevent parasitic infections and their associated consequences, including anaemia, which are known to increase the risk of adverse birth outcomes, consequently reducing the incidence of PTB and LBW [28, 59, 60]. Additionally, early initiation of ANC allows for timely initiation of interventions and monitoring, while late booking may limit the effectiveness of interventions and increase the likelihood of adverse outcomes.

Implications of the study's findings for policy and practice

Maternal mortality is commonly attributed to direct obstetric causes, but a significant proportion of deaths, approximately 15%, are due to preexisting medical conditions. Our study highlights the burden of chronic conditions, particularly noncommunicable diseases such as hypertension and diabetes, which are increasing in prevalence, among women prior to conception [11]. Managing these conditions during pregnancy will pose further challenges to our already constrained healthcare system [23]. Addressing the needs of pregnant women with preexisting medical conditions requires targeted interventions, including strengthening health systems, integrating chronic disease management into maternal health services, and improving access to medications and support [61, 62].

The high burden of PTB and LBW and the co-occurrence of PTB and LBW in the study setting suggest that a substantial number of new-borns are likely to face challenges not only in early childhood but also throughout adulthood. These challenges may include developmental delays, cognitive impairments, chronic health conditions, and socioeconomic disadvantages [18, 20, 63, 64]. Moreover, there is a potential for a complex, vicious cycle in which females born preterm or with low birth weight tend to develop chronic conditions later in life and subsequently deliver children with adverse birth outcomes, thus perpetuating the intergenerational transmission of adverse birth outcomes and chronic conditions. Addressing the underlying factors contributing to PTB and LBW, such as those identified in our study, is crucial for improving the long-term health and well-being of these vulnerable newborns.

The high rates of adverse birth outcomes among the women with preexisting chronic diseases in our sample who received antenatal care may be attributed to various factors. These factors include the severity of the chronic condition, individual variability, and complications during pregnancy. However, it also raises questions about the comprehensiveness, timeliness, and effectiveness of the care provided to these women during pregnancy. This highlights potential gaps in the healthcare system's ability to adequately support high-risk pregnancies, given that these women were already aware of their condition prior to becoming pregnant. Studies suggest that preconception care, including counselling, has reduced adverse birth outcomes in women with preexisting chronic conditions [65, 66]. By focussing on this crucial period before conception, healthcare providers can empower women with chronic conditions to enhance their health, thereby reducing the likelihood of complications during pregnancy and improving outcomes for both mothers and children. Preconception care programmes may include preconception health screening to identify and address any existing chronic conditions or risk factors that may affect pregnancy outcomes, as well as comprehensive counselling and support services.

Strengths and limitations

Our study is cross-sectional in design, limiting our ability to establish causality. Although we identified an association between preexisting chronic conditions and adverse birth outcomes, we cannot definitively conclude that these conditions directly caused these outcomes.

Furthermore, it is important to note that participants in facility-based studies may not fully represent the entire population, as they are typically those who seek healthcare services. This could result in an over-representation of women with access to healthcare or those with more severe health conditions. Moreover, we acknowledge that we relied on participants' self-reports of their preexisting condition prior to becoming pregnant. We cannot rule out the possibility for some participants to unintentionally forget certain conditions, thereby resulting in underreporting of such conditions. However, existing evidence indicates high validity for self-reported maternal chronic conditions during the periconception period, including diabetes and hypertensive disorders [67].

There are confounding variables that were not accounted for in our analysis, such as women's autonomy, birth intervals, malaria infection status, gestational anaemia status, and water and sanitation [6, 68–70]. As a result, our findings should be interpreted with caution. Despite these limitations, the findings of your study have direct clinical relevance. Since we collected information on the presence of chronic conditions before pregnancy, we can reasonably infer that these conditions preceded the birth outcomes, establishing a direct association between the two factors. This insight can inform healthcare providers about the potential risks associated with preexisting chronic conditions during pregnancy, leading to improved patient care and management strategies.

Conclusions

Our study has highlighted a significant problem regarding preexisting chronic conditions and their impact on adverse newborn outcomes in terms of PTB, LBW, and the co-occurrence of both PTB and LBW. The findings indicate a high prevalence of chronic conditions among women prior to pregnancy and a significant burden of adverse pregnancy outcomes among these women in the study setting. Considering that these women were already aware of their condition(s) before conception, our findings highlight a potential gap in the quality of prenatal care provided to them before delivery. Preconception care may offer an opportunity to address preexisting chronic conditions in women before pregnancy and potentially improve maternal and newborn health outcomes.

Abbreviations

aORs	Adjusted odds ratios
ANC	Antenatal care
CHAG	Christian health association of Ghana
IPTp	Intermittent preventive treatment of malaria during pregnancy
LMICs	Low- and middle-income countries
LBW	Low birth weight
NCDs	Noncommunicable diseases
PTB	Preterm birth
SSA	Sub-Saharan Africa

Supplementary Information

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Supplementary Material 1

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Not applicable

Authors' contributions
EAA, MNA, and MB conceptualised and designed the study. EAA and MB conducted the data analysis. RNM, GAA, LOO, NS, NMC, and ABM interpreted the findings, contributed to the intellectual content, and drafted the manuscript. EAA, MNA, and MB reviewed the draft manuscript. All authors critically reviewed and approved the final manuscript for submission.

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Availability of data and materials
The minimal dataset that would be necessary to interpret, replicate and build upon the findings reported in the article are contained within the publication.

Declarations

Ethics approval and consent to participate
The current investigation was conducted in accordance with the ethical guidelines specified in the Declaration of Helsinki regarding research with human beings. The study received approval from the Ghana Health Service Ethic Review Committee (GHS-ERC 101/07/2023). Moreover, prior to participation, the respondents provided both verbal and written informed consent after being briefed on the study's objectives, procedures, potential benefits and risks, their right to withdraw at any stage, and the guarantee of confidentiality and anonymity throughout the research process.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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