Prevalence and Associations of Preeclampsia and Dyslipidemia Among Pregnant Women in Northern Ghana

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Abstract

Preeclampsia (PE) and dyslipidemia are major factors in maternal morbidity, especially in resource-constrained environments. This study examined the prevalence and correlations of preeclampsia and dyslipidemia in pregnant women in rural Ghana to guide interventions for enhanced maternal health outcomes. A cross-sectional study was conducted at the War Memorial Hospital in Navrongo, Ghana, enrolling 70 pregnant women in their third trimester. Preeclampsia was characterized by hypertension and proteinuria, whereas dyslipidemia was determined through lipid profile analysis. Data were gathered via clinical assessments and laboratory investigations, and associations were analyzed using chi-square tests, with a p-value < 0.05 being statistically significant. The incidence of preeclampsia was 8.57%, whereas 36% of patients were diagnosed with dyslipidemia, predominantly hypertriglyceridemia and hypercholesterolemia. Significantly, 50% of women with preeclampsia also exhibited dyslipidemia. Notable correlations were identified between preeclampsia and maternal age ($p < 0.05$) as well as physical activity level ($p < 0.0001$). Dyslipidemia had a strong correlation with gestational weight increase ($p = 0.036$) and dietary patterns ($p = 0.012$). No substantial correlations were identified between preeclampsia or dyslipidemia with BMI, parity, or familial history. This study underscores the relationship between lipid metabolism and hypertension problems during pregnancy, stressing the necessity for early screening and customized therapies. Incorporating lipid profile assessment and nutritional guidance into prenatal care may substantially enhance maternal health outcomes, especially in resource-limited environments.

Keywords

Preeclampsia, Dyslipidemia, Neonatal, Body Mass Index

1. Introduction

Preeclampsia (PE) is a hypertensive disorder of pregnancy characterized by hypertension [1] and proteinuria after 20 weeks of gestation [2,3]. More than 90% of maternal deaths worldwide occur in developing countries [4]. Ghana and many African countries are developing countries. Many of these deaths are associated with complications that cannot be properly managed because health care access is inadequate. The maternal mortality ratio (MMR), which is calculated as deaths per 100,000 live births, is a good measure of the effectiveness of maternal health. Developed countries have very low MMRs, with those of Sweden being as low as four, whereas in Africa, the values are quite high; for example, Chad is as high as 1100. Maternal mortality is extremely high in Sub-Saharan Africa, representing more than 90% of maternal deaths worldwide [4].

In sub-Saharan Africa, the most prevalent causative factors for maternal mortality are preeclampsia/eclampsia, sepsis, hemorrhage and restricted labour [5]. In Ghana, the maternal mortality ratio has remained alarmingly high, and hypertensive disorders during pregnancy are responsible for approximately 9% of maternal deaths [6]. In 2008, there were 953 institutional maternal deaths in Ghana, 168 of which were due to eclampsia, accounting for approximately 18% of the incidence [7]. In 2014, according to a previous study, the incidence rate in Ghana was approximately 7% [8]. It remains a leading cause of maternal and neonatal morbidity globally [4], with heightened prevalence in resource-constrained regions such as Sub-Saharan Africa [5].

1.1 Pathophysiology of Preeclampsia

The pathophysiology of preeclampsia remains difficult to understand despite several studies that have investigated it. Two main pathways have been elucidated: trophoblast invasion and oxygen dysregulation.

During a normal pregnancy, cytotrophoblasts penetrate the uterine myometrium and spiral arteries, creating a complex network of vascular anastomoses that eventually feed blood to the placenta and foetus [9]. This process is called interstitial invasion. Interstitial invasion occurs when extravillous cytotrophoblast (ECTB) cells are transported into the

endometrium and myometrium in the normal placenta. When ECTB cells permeate the maternal arteries they come in place of endothelial cells and are thus called endovascular ECTB cells.

In preeclampsia, cytotrophoblasts do not develop the invasive phenotype required to form these robust anastomoses, resulting in reduced and shallow endovascular invasion of the spiral arteries [10]. During placentation, many ECTB cells remain in the anchoring villi (AVs), which results in poor interstitial invasion. The resulting effect is that there is almost no endovascular invasion, and the spiral arterioles are usually stiffened [11,12]. This stiffening implies that these aberrant blood vessels have a narrow caliber, which causes placental ischaemia. However, poor trophoblast invasion resulting from intrauterine growth restrictions cannot be identified as preeclampsia without accompanying hypertension [13,14].

This abnormal placentation and ischaemia results in the release of antiangiogenic proteins into the maternal circulation. The most important factor, soluble fms like tyrosine kinase-1 (sFlt-1), is secreted into the maternal bloodstream. It sequesters other factors like the vascular endothelial growth factor A (VEGF-A), placental growth factor (PlGF) and vascular endothelial growth factor B (VEGF-B) , to regulate angiogenesis. Studies have shown that an increase in the level of sFLT-1, leads to a consequent increase in the ratio of sFLT-1 to PlGF. This increases the risk of preeclampsia. It can be early onset or late onset [15]. The two most investigated and implicated biomarkers, notably in the development of preeclampsia, are soluble FMS-like tyrosine kinase-1 (sFlt-1) and placental growth factor (PlGF). The pathophysiology is summarized in Figure 1 below.

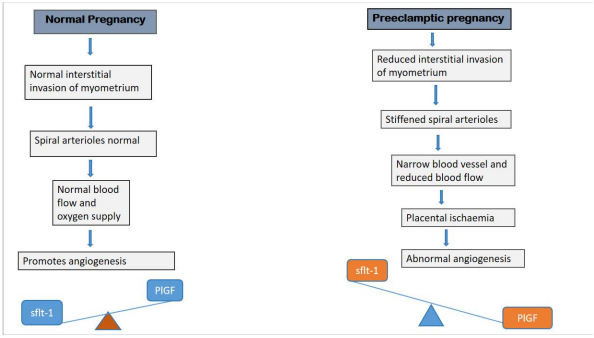

Figure 1. Pathophysiology of Preeclampsia: Step-by-Step Development and Comparison to Normal Pregnancy

Dyslipidemia, a metabolic derangement of lipids, has been associated with cardiovascular risk [16]. Dyslipidemia in adults is associated with cardiovascular diseases, hypertension, diabetes and atherosclerosis and is responsible for a high morbidity and mortality rates worldwide. It predisposes a person to atherosclerosis and other diseases. These factors caused over 17 million deaths worldwide in 2015, increasing by 12.5% [17]. The contribution of dyslipidemia to cardiovascular diseases is clearly visible on the basis of studies that have revealed a link between elevated levels of total cholesterol (TC), and low-density lipoprotein cholesterol (LDL-C), (triglycerides (TG) and decline of high density lipoprotein cholesterol (HDL-C) and cardiovascular disease (CVD) [16].

Even though the incidence of dyslipidemia is decreasing at a high rate in high economy countries, this trend does not occur in developing countries such as Ghana. The prevalence of dyslipidemia in Africa's sub-Saharan region is caused primarily by urbanization. However, in rural communities it has also recently become common because of the use of certain pesticides by their agricultural enterprises, which can cause dyslipidemia [18].

According to a study that analyzed ethnic differences in the levels of some lipids during pregnancy, Ghanaian women presented lower TC levels. Furthermore, these patients also had lower TG levels. Both high and low levels of maternal TG [19] and TC may have negative repercussions for pre-and postnatal growth .

Dyslipidemia may also play a role in the pathophysiology of preeclampsia through endothelial dysfunction [20]. Increased levels of lipids in circulation, as observed in dyslipidemia, cause clustering in endothelial cells. This causes a decline in the removal of prostacyclin, and the effect is endothelial dysfunction, as shown in Figure 2 below [20], an important part of the pathophysiology of preeclampsia [21].

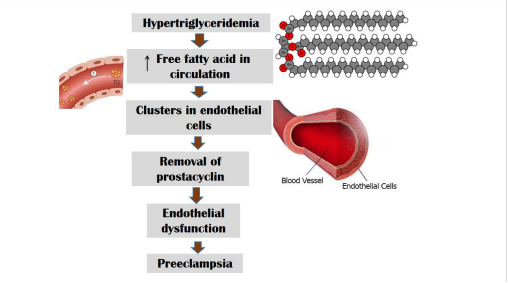

Figure 2. The Role of Dyslipidemia in the Development of Preeclampsia

Establishing the link between abnormal lipid profiles and the pathogenesis of preeclampsia.

Studies on the link between PE and dyslipidemia are sparse, especially in rural settings such as Navrongo, where healthcare access is limited. This study sought to bridge this gap by investigating the prevalence and correlations of PE and dyslipidemia among pregnant women and their associations, thereby contributing to improved maternal care strategies in northern Ghana.

2. Materials and Methods

2.1 Study Design and Setting

This cross-sectional study was conducted at the War Memorial Hospital, Navrongo, Ghana, between May and July 2019. The hospital serves as a secondary healthcare facility in the Kassena Nankana East Municipality. The municipality features a tropical wet and dry climate with Guinea savannah vegetation. The area experiences one rainy season that starts in April and ends in October with a mean annual rainfall of 950 mm. Mean daily maximum and minimum temperatures in the study setting range from a peak 42°C and 18.9 °C, respectively [22].

2.2 Study Participants and Data Collection

A total of 70 pregnant women aged 15–40 years, who were receiving prenatal care in their third trimester were recruited. The inclusion criteria included natural conception and clear gestational age, while those with severe infections or assisted pregnancies were excluded. Blood pressure measurements were taken using an OMRON sphygmomanometer, and proteinuria was assessed via dipsticks. Fasting venous blood samples were collected to analyze lipid profiles (total cholesterol, triglycerides, HDL-C, LDL-C) via enzymatic colorimetric assays using the Biobase Auto Chemistry analyzer BK-200. Dietary patterns and activity levels were self-reported via structured questionnaires.

2.3 Statistical Analysis

The data were analyzed using IBM SPSS (version 20). Descriptive statistics were used to summarize participant characteristics, whereas chi-square tests were used to evaluate associations between PE and dyslipidemia. A p-value <0.05 was considered to indicate statistical significance.

2.4 Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of the Navrongo Health Research Center (Ref: NHRCIRB350), and written informed consent was secured from all participants.

3. Results

3.1 Participant Characteristics

The mean age of the participants was 27.07 ± 5.92 years, with a mean BMI of 30.84 ± 8.30 kg/m². The mean gestational age was 30.50 ± 5.11 weeks. The results are summarized in Table 1.

Table 1. Demographic and clinical characteristics of participants

	Age	BMI	Maternal Age	Diastolic BP	Systolic BP
Mean	27.07	30.84	30.50	114.62	74.14
S. D.	5.92	8.30	5.11	12.90	10.09
Minimum	16.0	15.82	20.00	90.00	48.00
Maximum	40.0	59.16	39.00	145.5	94.00

3.2 Prevalence of Preeclampsia and Dyslipidemia

Among the 70 participants, 8.57% (n=6) were diagnosed with preeclampsia. The prevalence of dyslipidemia was 36% (n=18), with 62% of dyslipidemic participants having both hypertriglyceridemia and hypercholesterolemia. Notably, 50% of the preeclamptic participants were also dyslipidemic.

3.3 Preeclampsia Associations

The data showed that preeclampsia was more common in women 30 years or older (14.28%) than in women younger than 30 (6.12%) as shown in Table 2. A lot of the women who took part (67.14%) gained less than 11 kg during pregnancy, and all 6 cases of preeclampsia were found in this group. One more thing that was important was the type of food. 8.62% of the people who ate a lot of carbohydrates were preeclamptic, but no one who ate a lot of protein got preeclampsia. Twenty percent (20%) of the people who ate a lot of fat were preeclamptic.

In terms of physical movement, none of the people who took part did structured exercise. 37% of the people who were doing housework were preeclamptic, while only 17% of the people who were not doing anything got preeclampsia. Of the people who participated, 28.57% had a family history of preeclampsia. Of those with a family history, 15% actually got preeclampsia, while only 6% of those without a family history did. There were also trends in parity and BMI. For example, the risk of preeclampsia was lower in women who had more than one child (4.55%) than in women who had only one child (13.63%). Women whose BMI was less than or equal to 25 kg/m² were more likely to have it (25% vs. 7.57%). These links were not statistically significant, though ($p > 0.05$).

3.4 Dyslipidemia Associations

It was found that 37.25% of women aged 30 and up and 38.24% of women aged 30 and younger had dyslipidemia, as shown in Table 2. The amount of weight gain during pregnancy had a big effect on dyslipidemia (p = 0.036). Only 28.95% of women who gained less than 11.0 kg were dyslipidemic, but 58.33% of those who gained more were (Table 2). Type of food was also strongly linked to dyslipidemia (p = 0.012); 34.15% of people who ate carbohydrate-rich diets and 50% of people who ate protein-rich diets had dyslipidemia (Table 2). None of the particpants who have lots of fat in their diet reported having cholesterol.

Levels of physical exercise did not have a significant link with dyslipidemia (p = 0.138). 36.59% of people who were active in-home tasks (82% of the participants) had dyslipidemia, compared to 33.3% of people who were sedentary. A study of BMI trends showed that 33.3% of subjects with a BMI of less than 40 kg/m² had dyslipidemia. Those with a BMI of 40 kg/m² or more had a higher prevalence (42.86%), but this difference wasn't statistically significant (p = 0.30).

Table 2. Associations of preeclampsia and dyslipidemia with certain variables

Variable	Chi Square	P-value	Association	Condition
Age	36.64	0.04	Yes	Preeclampsia
Gestational weight gain	15.84	0.94	No	
Diet	5.41	0.07	No	
Activity level	14.56	0.00	Yes	
Miscarriages and comp.	1.33	0.25	No	
BMI	100.00	0.45	No	
Parity	2.83	0.24	No	
Family history of PE	1.27	0.26	No	
Marital status	0.01	0.76	No	
Maternal age	15.29	0.58	No	
Age	548.33	0.08	No	Dyslipidemia
Gestational weight gain	558.18	0.04	Yes	
Diet	75.35	0.01	Yes	
Activity level	32.72	0.14	No	
BMI	1250	0.30	No	

The results indicated that the majority of the participants were younger than 30 years (51.42%). Preeclampsia was more common in women aged 30 years and above, (4, 14.28%) than in women aged less than 30 years. The majority of the women's gestational weight gain was 11.0 kg or less, 47 (67.147%) of which all preeclampsia cases were reported (12.76%). Eighty-three (82.86) percent were reported to have mostly carbohydrates in their diet out of which five (5) were preeclamptic (8.62%), seven (10%) also had mostly protein-rich diets, and none were preeclamptic. Of the five (7.14%) who had fatty diets, one (1) was preeclamptic (20%). None of the participants were engaged in structured exercise, fifty-four (54%) were engaged in household exercise, two (2)were preeclamptic (3.70%), 16 (17%) were not engaged in any exercise at all and four (4, 25%) of them were preeclamptic .

Fifty-four (77.14%) participants had not experienced any miscarriage or complications, four (4) of whom were preeclamptic (7.41%), whereas seventeen (17) had experienced miscarriages and complications in previous pregnancies, and two (2) were preeclamptic(11.76%).Women who had a BMI of 25kg/m^2 or less were four (5.71%) and one(1) was preeclamptic (25%), sixty-six (85%) with a BMI higher than 25kg/m^2 and five (5) with a BMI of 7.57% with a preeclamptic BMI and 22 (31.43%) each; however one (1) of the multiparous women were preeclamptic (4.55%) and three (3) out of the primiparous women were preeclamptic (13.63%) twenty-six were nulliparous, and two (2) were preeclamptic (7.69%). In all, 20 (28.57%) of the participants had a family history of preeclampsia, three (3) out of them had preeclampsia (15%) but 50 (71.42%) had no family history of preeclampsia, and three 3, (36%) had preeclampsia Table 2 shows that a significant association existed between the prevalence of preeclampsia and age (p >0.05) or activity level (p>0.000). There was no significant association between the prevalence of preeclampsia and BMI (p=0.453), parity (p=0.243), family history of preeclampsia (p=0.260), miscarriages and complications in previous pregnancies (p=0.248), type of diet (p=0.067) or gestational weight gain (p=0.94).

The results from Table 2 indicate that thirty-four (68%) of the women were below thirty (30) years of age and thirteen (13) had dyslipidemia of some sort (38.24%) whiles sixteen (16) representing 32% were above 30 years and five (5) were found to be dyslipidemic(31.25%).

The majority of the women, 38 being 76% had gained a gestational weight of less than 11 kg; of these, 11, accounting for 28.95% were dyslipidemic, and 12, accounting for 24% were found to have seven (7) dyslipidemic participants (58.33%). Forty-one (41) participants, representing 59% of the participants, were said to have more carbohydrate-rich diets; 14 out of these participants (34.15%) were dyslipidemic; eight (8) of them had protein-rich diets; four (4) were dyslipidemic (50%); and only one had a fat-rich diet and that participant was not dyslipidemic. Many of the women (41) (approx. 82%) were engaged in household exercise, 15 were found to have dyslipidemia (36.59%), nine (9) (18%) were living sedentary lifestyles, and 3 (33.3%) were dyslipidemic. Women who had a BMI of <40 kg/m^2 were 36 (72%) and 12 of them were dyslipidemic (33.3%) and those who had a BMI >40 kg/m^2 were 14 (28%) and six (6) were dyslipidemic (42.86%).

The p values of 0.036 and 0.012 for gestational weight gain and type of diet, respectively, indicate a significant association between dyslipidemia and these two variables. P-values of 0.077, 0.138, and 0.30 indicate that there is no significant association between dyslipidemia and age, activity level or BMI, respectively.

Figure 3 below illustrates the prevalence of normal cases, preeclampsia, and dyslipidemia among the study participants. This highlights the significant percentage of dyslipidemia cases (36%) and the smaller proportion of preeclampsia cases (8.57%) relative to the total sample size.

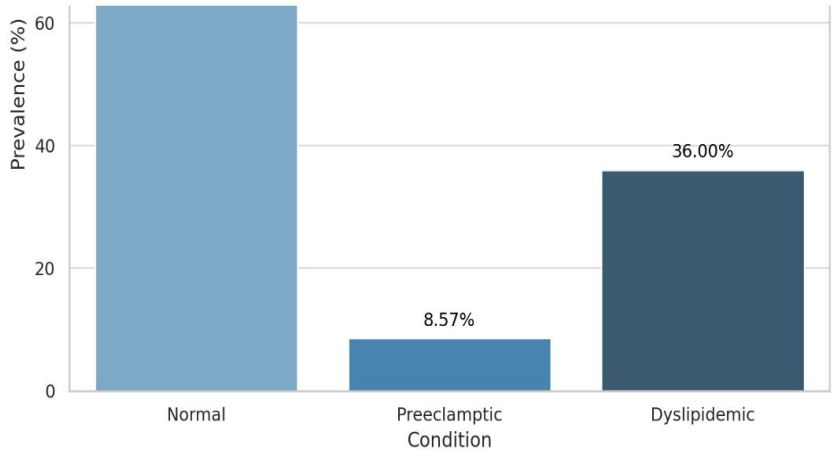

Figure 3. Association of preeclampsia and dyslipidemia

The chart below (Figure 4) depicts the distribution of dyslipidemia subtypes among the affected individuals. A significant result is that 62% of individuals exhibit both hypertriglyceridemia and hypercholesterolemia. Isolated hypercholesterolemia was noted in 32% of patients, whereas 30% displayed just hypertriglyceridemia. Furthermore, 14% of subjects exhibited increased LDL levels, underscoring the varied presentations of dyslipidemia in the research population.

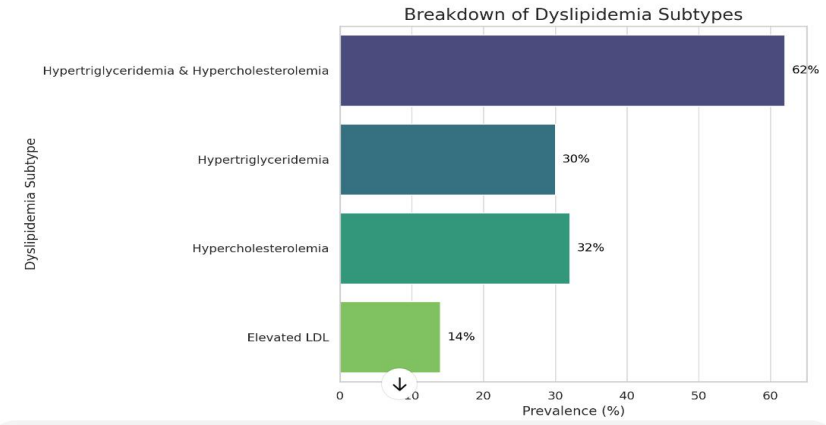

Figure 4. Breakdown of Dyslipidemia Subtypes Among Affected Participants

4. Discussion

4.1 Key Findings

This study revealed a relatively high prevalence of dyslipidemia (36%) and its overlap with preeclampsia (50%) in pregnant women in Navrongo. These results align with global trends linking dyslipidemia to endothelial dysfunction and hypertension during pregnancy. Associations with age and hypertension have been reported in most studies [23,24] by different authors. This study also demonstrated that the prevalence of preeclampsia increased with age. This is in tandem with the global cause or rise in blood pressure. Blood pressure usually increases in young people until middle age [25]. Ageing which in itself is not a disease has become a challenge. Gerber *et al.* [26] listed a diet rich in carbohydrates and transfats as risk factors for dyslipidemia. National Cholesterol Education Program [27] has added that diet modification is necessary for managing dyslipidemia. Notably, a significant association was observed between the type of diet and dyslipidemia ($p < 0.05$).

A significant association was found between activity level and preeclampsia, with $p < 0.05$. The American College of Obstetrics and Gynecology [28] reported that restricting of physical activity in addition to bed rest during pregnancy has no effect on preeclampsia prevention. According to Spracklen *et al*. [29], women who developed preeclampsia engaged in significantly less leisure-time physical activity than normotensive controls did. This finding indicates that as a

person's activity level increases, the risk of developing preeclampsia decreases. However, pregnant women should not engage in very strenuous exercise.

A significant association was observed with respect to gestational weight gain and BMI. A relationship has subsequently been established between BMI and dyslipidemia. Women with a higher BMI had relatively lower gestational weight gain. This study revealed that an association exists between gestational weight gain and dyslipidemia ($p< 0.05$). The relationship is such that a greater gestational weight is associated with a lower risk of dyslipidemia. It can thus be deduced that this parameter is inversely associated with dyslipidemia.

4.2 Comparison with the Literature

The prevalence of preeclampsia in this study (8.57%) is consistent with Ghana's national estimates [30]. The significant proportion of dyslipidemic women among preeclamptics underscores dyslipidemia's potential role as a risk factor, as documented in previous studies [31]. The notable correlation between age and preeclampsia corresponds with other studies indicating that maternal age is a risk factor for hypertensive diseases [29]. Advancing age induces vascular alterations that may render pregnant women susceptible to endothelial dysfunction, thereby elevating the risk of preeclampsia. This study's findings on the correlation between physical activity and preeclampsia further support evidence that sedentary lifestyles increase the incidence of hypertensive problems in pregnancy. Our findings underscore the necessity for moderated exercise levels, as excessive physical exertion may jeopardize both maternal and fetal health.

Dietary patterns revealed as a significant factor influencing dyslipidemia, with carbohydrate-rich and protein-deficient diets contributing to lipid abnormalities. These findings correspond with global data that subpar dietary quality aggravates metabolic diseases [27]. Our investigation revealed an inverse correlation between gestational weight growth and dyslipidemia, contradicting conventional knowledge that associates excessive weight gain with lipid abnormalities. This anomaly may indicate distinct population-specific factors, such baseline nutritional status or genetic predispositions, and requires more examination.

4.3 Implications and Limitations

This study's findings have substantial implications for maternity healthcare in rural Ghana and comparable resource-constrained environments. The study emphasizes the need for regular lipid screening within antenatal care, especially for women at elevated risk of preeclampsia. Considering the substantial impact of diet on lipid profiles, incorporating nutritional education into prenatal care programs may mitigate dietary risk factors. Furthermore, encouraging modest physical exercise may diminish the incidence of preeclampsia and enhance overall mother health. It is worth mentioning that the small sample size and restriction to third-trimester participants in this study is a delimiting factor; especially as this may not capture the full spectrum of dyslipidemia and preeclampsia onset.

5. Recommendations

Future research should explore larger, diverse cohorts and focus on cost-effective diagnostic tools for rural healthcare settings. The two biomarkers for preeclampsia should be considered for routine screening of all pregnant women during their first trimester, especially at-risk individuals.

6. Conclusion

This study highlights the interplay between preeclampsia and dyslipidemia among pregnant women in rural Ghana, revealing significant prevalence rates and associations. The results underscore the necessity for early diagnostic tools, lifestyle interventions and nutritional guidance to enhance maternal health outcomes. Resolving these difficulties could markedly alleviate the burden of pregnancy-related complications and improve the quality of maternal care in resource-limited settings.

Consent to Publish

All authors agreed that the content be published

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Conflicts of Interest

The authors declare no conflict of interest.

Author Contributions

Ahenkan Yeboah contributed to the data collection, analysis and manuscript preparation. Gideon Adu-Bonsu contributed to the figures, tables and proofreading of the manuscript.

Data Availability

The datasets generated during the current study are available from the corresponding author on reasonable request.

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