Original Research Article

Risk and Protective factors associated with Gestational Hypertension in Ghana: The case of the Bolgatanga Regional Hospital of the Upper East Region

ABSTRACT

Aim: The goal of this study was to identify some risk and protective factors associated with gestational hypertension among pregnant women in the Bolgatanga Regional Hospital of Ghana's Upper East Region.
Study Design: This study is a one case-control study design.
Place and Duration of Study: The study was conducted in the Antenatal clinic and Maternity ward of the Upper East Regional hospital in Bolgatanga
Methodology: The study settled on normal pregnancy (normotensive) and coded it as "0," while pregnant women who showed signs of high blood pressure were coded as "1." Sixteen (16) risk factor variables were taken into consideration. Data for the study was gathered from the history of 50 pregnant women who were visiting the Bolgatanga Regional Hospital for antenatal care. The analysis was conducted using the logistic regression model of STATA 14.
Results: The study disclosed that white blood cells (WBC), low-density lipoprotein cholesterol (LDL), placenta weight (PW), gestational weight (GW), body mass index (BMI) were statistically significant. BMI was discovered to have a positive association with gestational hypertension (*OR= 2.208, P= .025*), whereas PW (OR=0.994, *P= .085*), GW (*OR=0.815, P=.079*), WBC (*OR=0.719, P=.01*), and LDL (*OR=0.645*, *P= .027*) were discovered to have negative associations with gestational hypertension (odds ratios less than one).
Conclusion: The results identified BMI as a risk factor while PW, GW, WBC, and LDL were protective factors. On the basis of the analysis it was recommended that health professionals should raise the awareness of women on the risks of gestational hypertension even before they become pregnant, especially maintaining healthy weight.

Keywords: *Blood Pressure, Gestational hypertension, Gravidity, Parity, Body Mass Index, Cholestrol, Odds Ratio*

1. INTRODUCTION

Hypertension is high blood pressure (HBP) that occurs because of force exerted by the blood pressure against the walls of the blood vessels with pressure reading of more than 140/90mmHg. Gestational hypertension (GH) is a condition which affects pregnant women globally. This normally sets in after 20 weeks of conception. Between 5 and 10% of all pregnancies in connection with haemorrhages and infections are attributed to pregnancy induced hypertension. This leads to maternal mortality and morbidity which are risk factors for both mother and child health wise. No therapeutic agents have been developed to prevent or cure hypertension in pregnancy for reasons that there is little or absence of a complete understanding of the pathogenesis of this disease. Nonetheless, several abnormalities or complications develop as the pregnancy develops and these have been observed clinically to aid in the causation and progress of Pregnancy induced hypertension, with the involvement of glucose, cholesterol and mother's gravida status.
Due to the substantial incidence of maternal and perinatal adversity associated with hypertensive disorders in pregnancy (HDP), there is still a significant therapeutic problem in modern obstetric practice, [1] and [2]. According to [3], one of the main causes of maternal and perinatal mortality is gestational hypertension and can also result to chronic hypertension, kidney failure, and neurological abnormalities. Gestational hypertension, sometimes referred to as pregnancy-induced hypertension (PIH), occurs when

a pregnant woman develops new hypertension after 20 weeks of pregnancy without the appearance of protein or other pre-eclampsia signs, [4].
According to a study published in [5], obstetric causes accounted for 73% of all maternal deaths that occurred between 2003 and 2009, while indirect causes contributed to 27.5% of all fatalities and hypertensive illnesses were responsible for 14% of deaths.
Pre-eclampsia has a number of known risk factors, including null parity, obesity, pre-existing hypertension, a history of the condition in the past or in the family, current autoimmune conditions, and extremes in maternal age, even if the exact etiology of the condition is unknown. Globally, the condition causes 500,000 child fatalities and 70,000 maternal deaths each year [6, 7], with more than half of all deaths, sub-Saharan Africa (SSA) is thought to be the region most severely affected, [8].
Despite improvements in perinatal care, hypertensive disorders of pregnancy, which affect 5–10% of all pregnancies, continue to be a major cause of maternal and fetal sicknesses. [9]. Studies conducted across the globe, according to [10], revealed that 10% of pre-eclampsia pregnancies are complicated by pregnancy-induced hypertension, and that about 9.1% of motherly deaths in Africa are brought on by pregnancy-related hypertensive diseases. The majority (99%) of maternal deaths occur in developing nations, with more than half occurring in sub-Saharan Africa, where 1 in 180 pregnant women die after childbirth, compared to 1 in 4,900 in affluent nations, raising serious concerns about maternal mortality.
Pre-eclampsia affects 2-8% of all pregnancies globally, accounting for nearly one-third of all maternal deaths as well as more than 6 million perinatal deaths and 8 million preterm births, according to studies by [11; 12; 13; 14]
Pre-eclampsia, one of several hypertension disorders of pregnancy, has been reported by the World Health Organization (WHO) to have a negative influence on mother and newborn health with no proven cure other than ending the pregnancy or expelling the fetus [15](WHO, 2011).
Despite the fact that pre-eclampsia has recently acquired attention, it wasn't until the late 1800s that a relationship between high blood pressure, edema, and proteinuria and eclampsia was established that it was discovered to be significant [9]. Although the pathophysiology was not entirely known, it was believed to be related to early pregnancy-related placental disruption, which was followed by inflammation and progressive damage, [15]. Pregnancy-related hypertension complications may have an impact on both the mother and the fetus. The fetus may experience preterm delivery, respiratory distress syndrome, and fetal growth restriction, while the mother may experience neurological sequelae, renal failure, or liver failure [16].

The most typical medical issue related to pregnancy is hypertension [17]. According to [18; 19] pregnancy induced hypertension is also the main cause of maternal and perinatal illness and mortality. In 3% to 10% of all pregnancies, this happens. One of the top five main causes of maternal and newborn fatalities in Ghana is the prevalence of hypertension during pregnancy [20]. Additionally, [21] discovered that hypertensive pregnancies were one of the four main risk factors linked to 40% of maternal mortality in Ghana. According to [22, pregnancy induced hypertension is responsible for 9% of maternal fatalities in Ghana.
Although there is no known cause for pregnancy-related hypertension, numerous risk factors have been linked to this problem, including nulliparity, a history of pre-eclampsia, diabetes mellitus, renal illness, obesity, severe anemia, malaria, and HIV [23]. According to [24], increasing maternal age has also been linked to an increased risk of hypertension during pregnancy. Both women age 35 or older and women between the ages of 13 and 16 were discovered to be at risk for pregnancy-related hypertension.
According to studies conducted by [25], in Ghana, Pregnancy-Induced-Hypertension is one of the commonest cause of pregnancy complications with 7.0% incidence rate of pre-eclampsia.
Prevention of hypertension during pregnancy in Ghana faces a number of challenges including the delay in seeking medical attention after recognizing its signs, as well as the lack of awareness of risk factors connected to it [26].
However in the Bolgatanga Hospital, where this study was conducted, there is no data available on Pregnancy-Induced-Hypertension, hence, the reason for conducting this study at the Bolgatanga Regional Hospital in view of the fact that it is a referral hospital. From the literature reviewed so far it is seen that little or no research has been done to identify risk and protective factors associated with pregnancy induced hypertension among pregnant women in the Bolgatanga hospital. It is against this background that this study sought to identify risk and protective factors associated with pregnancy induced hypertension among pregnant women in the region by means of the Logistic Regression Model.

2. Materials and Methods

2.1 Study Area

This study is a one case-control study which was conducted in the Upper East Regional hospital in Bolgatanga. Data for the study was gathered from 50 pregnant women who were visiting the Bolgatanga Regional Hospital for antenatal care. .

The Bolgatanga Regional Hospital's antenatal clinic typically sees patients every four weeks until 28 weeks, then every two weeks until 36 weeks, and finally once a week until delivery. In addition to other clinical evaluations, blood pressure, weight, and a urine sample are also taken at each appointment. The urine sample is then examined for protein and glucose.

A questionnaire was used at the antenatal clinic of the Regional Hospital to gather data on the participants' ages, the number of pregnancies they had, their obstetric history, and whether they had received chemoprophylaxis while pregnant. Additionally, data on the newborn was gathered and recorded, including the placenta's weight and the infant's birth weight. Based on the last menstrual cycle date and the newborn's evaluation at delivery, the gestational period was estimated**.**

2.2 Inclusion criteria

Preterm births, or births between 28 and 37 weeks, were regarded as premature. Low birth weight (LBW) babies were defined as singletons weighing less than 2,500 grams. Hundred (100) pregnant women in total were enrolled as study participants. Women were classified as primigravidae if they had just one pregnancy, paucigravidae if they had two or three, and multigravidae if they had more than three pregnancies. Out of the 100 women who were selected for the study, 50 of them had hypertensive related conditions, and so were taken as the study group. The other fifty (50) pregnant women did not have any pathological conditions like hypertension, pre-eclampsia, gestational diabetes, or any other condition during pregnancy and so were taken as the control group. Pregnant women with pre-eclampsia had sustained proteinuria of 300 mg/24 hours without a urinary tract infection and a sustained diastolic blood pressure of 90 mmHg or higher.

2.3 Exclusion criteria

Pre-existing hypertension, ischemic heart disease, chronic renal failure, diabetes mellitus, and patients receiving treatment with medications that can interfere with lipid profiles were all exclusion criteria. Gross proteinuria (assessed by a urine heat test) and pathological edema were used to diagnose pre-eclampsia in patients as well as persistent hypertension (more than 140/90mmHg).

2.4 Ethical clearance

The Navrongo Health Research Centre Institutional Review Board gave the study their seal of approval. All expecting mothers who were being admitted to the maternity ward of the Upper East Regional Hospital, Bolgatanga, provided written, fully informed consent.

2.5 Statistical analysis

Pre-eclampsia, severe pre-eclampsia, gestational hypertensives, full-term pregnancies, preterm births, BMIs below and above 30, and adverse birth outcomes were all categories used to categorize pregnant women. The analysis was performed using STATA 14 software.

2.6 Analytical Framework

A pregnant woman can have Pregnancy-Induced-Hypertension or not and so the response variable can take two values. Thus the probability of a pregnant woman to have Pregnancy-induced-Hypertension or not follows a binary or dichotomous response and so by [27] the Logit model can be applied for such analysis.

An event's log-odds are a linear combination of one or more independent variables in the logit model, a statistical model that depicts the likelihood that the event will occur.

The following is the cumulative logistic distribution function:

$$P_i = \frac{1}{1+e^{z_i}} = \frac{e^z}{1+e^z} \quad (1)$$

Where

$$Z_i = \beta_0 + \beta_i X_i \quad (2)$$

Z can be between $-\infty$ to $+\infty$, and p_i can be between *0* and *1*. The likelihood that a pregnant woman will not experience pregnancy-induced hypertension is given by $1- p_i$, If p_i is the probability of a pregnant woman suffering from Pregnancy-induced-Hypertension. In this instance

$$1- p_i = \frac{1}{1+e^{z_i}} \quad (3)$$

The odd-ratio in favour of Pregnancy-Induced-Hypertension is given by

$$\frac{p_i}{1-p_i} = \frac{1+e^{z_i}}{1+e^{-z_i}} = e^{Z_i} \quad (4)$$

If we take the natural log of equation (4) we get

$$ln\left(\frac{p_i}{1-p_i}\right) = Z_i = \beta_0 + \beta_i X_i + K \quad (5)$$

The relative effect of each independent variable on the likelihood that a pregnant woman suffers from Pregnancy-induced-Hypertension is given by the marginal effect

$$\frac{\partial(p_i)}{\partial(x_i)} = \beta_i[\overline{p}_i(1-\overline{p}_i)] \quad (6)$$

Where $\overline{P}_i$ is the mean of the dependent variable.
Odds ratios greater than 1 correspond to risk factors, those between 0 and 1 correspond to protective factors. Odds ratios of exactly 1 correspond to "no association." An odds ratio cannot be less than 0.

2.7 **Definitions of variables and their Measurements**
Table 1 is a summary of the measurements of the variables used in this study.

Table 1: Variables, their Measurements and symbols

Variable Name	Measurement	Symbol
Age	Age of respondent in years	Age
Parity	Number of births given by respondent	Parity
Gravidity	Number of pregnancies by each respondent	Gravidity
Gestational Weight	Weight of mothers as a result of the pregnancy (kg)	GW
Glucose	Miligram per deciliter	Glucose
Placenta Length	In centimeters	PL
Placenta Weight	grams	PW
Umbilical Cord Lentgh	In centimeters	UCL
Umbilical Cord Diameter	In centimeters	UCD
Total Cholesterol	Miligram per deciliter	Cholesterol
Body-Mass-Index	Kilogram per square meter	BMI
High-Density-Cholesterol	Miligram per deciliter	HDL
Low-Density-Cholesterol	Miligram per deciliter	LDL
White Blood Cells	Volume of white blood cells in Millimeter cube	WBC
Red Blood Cells	Volume of red blood cells in Millimeter cube	RBC
Haemoglobin	Grams per deciliter	Hb

3. RESULTS AND DISCUSSION

The goal of this study is to identify risk and protective factors associated with pregnancy induced hypertension in Ghana using the Bolgatanga Regional Hospital as a case study. The study's findings are presented in this section. Results of descriptive statistics that provided the mean, standard deviation, maximum and minimum of the variables as well as results of inferential (empirical) statistics which also provided the odds ratios, standard errors, marginal effects and the p-values of the variables from the logistic regression are presented and discussed.

3.1 Descriptive Analysis

The summary of statistics of the variables used in this study are presented in Table 2. The sampled mothers' maternal ages (Age) ranged from 16 to 41 years old, according to the table. The standard deviation (SD) for maternal mothers' ages was found to be 6.55 years, or 27.84 years on average. The study's participants' parity was between 0 and 6 births, with a mean parity of 1.54 births and a standard deviation of 1.58.

The number of pregnancies (gravidity), however, was seen to range from 0 to 7, with a mean of 2.56 and a standard deviation of 1.67. Gestational weight (GW) was between 43.7 kg and 130 kg, with a mean weight of 70.44 kg and a standard deviation of 16.22 kg. When the blood sugar (glucose) levels of each study participant were measured, it was discovered that each one's range was between 7.9 mg/dL and 35 mg/dL, with a standard deviation of 9.42 mg/dL and average blood sugar level was 28.17 mg/dL.

An inelastic tape measure was used to measure the length of the placenta in women after delivery, and the results were documented. Placenta lengths for the research population ranged from 7.5 to 35 cm, with a mean length of 20.09 cm and standard deviation of 4.52 cm.

The average weight of the placenta was 613g, with a standard deviation of *170.77g*. The least weight of the placentas of the 50 women, was 300g and the maximum weight was found to be 1000g. As a result of the study, it was discovered that the mothers' umbilical cords ranged in length from 20cm to 85cm. On the average, the length of the umbilical cord was found to be 50.96 cm, with a standard deviation of 11.72cm. According to the study, mothers who were the subject of the investigation had cords with an average diameter of 1.23cm and a range of 0.3cm to 2.2cm, with a standard deviation of 0.55cm.

The mothers' cholesterol levels were seen to be between 17.3mg/dL and 57mg/dl, with a mean of 35.52mg/dl and a standard deviation (SD) of 9.01mg/dl. Similarly, the Body mass index (BMI) for the women were between 7.3kg/m2 and 47.2kg/m2. The average BMI was found to be 25. 72 kg per square meter, with a standard deviation of 6.80kg per square meter.

High-density cholesterol (HDL) had mean and standard deviation of 1.96 mg/dL and 0.86 mg/dL, respectively, according to the results. High-density cholesterol could only be measured to a maximum of 4 mg/dL, with a minimum of 0 mg/dL.

Low-density cholesterol (LDL) levels ranged from 0mg/dL to 16mg/dL at their highest and lowest values, respectively. LDL had a mean value of 6.435 mg/dL, with a SD of 4.66 mg/dL.

The mean of the White Blood Cells (WBC) count was 13.59 with a standard deviation of 6.26., a maximum value of 30.95 and a minimum value of 4.78, whereas the Red Blood Cell (RBC) count value was between 2.24 and 5.13, with a mean of 3.82 and a standard deviation of 0.56.

The average hemoglobin (Hb) level for the study group was found to be 10.38 with a standard deviation of 1.46, the lowest hemoglobin level was found to be 5 and the highest level was 12.

Table 2: Descriptive statistics of variables.

Variable Name	Mean	Standard Deviation	Minimum	Maximum
Age	27.84	6.55	16	41
Parity	1.54	1.58	0	6
Gravidity	2.56	1.67	0	7
GW	70.44	16.22	43.7	130
Glucose	28.17	9.42	7.9	52.9
PL	20.09	4.52	7.5	35
PW	613	170.78	300	1000
UCL	50.96	11.72	24	85
UCD	1.23	0.55	0.3	2.2

Cholesterol	35.52	9.01	17.3	57
BMI	25.72	6.80	7.29	47.2
HDL	1.96	0.86	0	4
LDL	6.44	4.66	0.3	16.62
WBC	13.59	6.26	4.78	30.95
RBC	3.82	0.56	2.24	5.13
HB	10.38	1.46	5.2	12.8

Source: Authors' own estimation

3.2 Empirical Results

Results from the logistic regression model in Table 3 show that, there is a significant relationship between the dependent and independent variables used in this study and that the model fits the data well at 1% level of significance, indicating that the overall model is statistically significant. The model has an LR chi-squared value of 37.64 and a P-value of 0.0017, which is highly significant at 1% level. The model also has a log likelihood value of -14.8294 and a pseudo R^2 value of 0.5593.

Gestational weight (GW) has an odds ratio of 0.82 for the various independent factors, with a p-value of 0.079 indicating that there is some association between GW and pregnancy-induced hypertension, which is significant at the 10% level. An odds ratio of 0.82 means that the odds of a pregnant woman being hypertensive grow by 0.82 times larger for each additional weight gained during the pregnancy period. Further, because the odds ratio is less than 1, GW is identified as a protective factor with a marginal effect of -0.0260. This finding supports the findings of [28; 29; 30; 31].

The results were similar for placenta weight (PW), where the odds ratio was 0.994 with a p-value of 0.085, also significant at 10% level, and a marginal effect of -0.001, showing that if the placenta's weight increases by a kilogram, a pregnant woman's risk of pregnancy-induced hypertension decreases by 0.08%, a seemingly contradictory result. PW was identified as a protective factor.

Body mass index (BMI) was found to be statistically significant (p-value of 0.025) at the 5% level of significance; an odds ratio of 2.208, which is more than 1, indicates a substantial relationship between BMI and pregnancy-induced hypertension. Additionally, it has a 0.101 marginal effect. Accordingly, a pregnant woman's risk of developing pregnancy-induced hypertension rises by around 10% for every kilogram she accumulates. The findings of [32; 33], which demonstrated that obesity and, by extension, a higher BMI, are bigger risk factors for preeclampsia, are supported by this finding. The study identified BMI as a risk factor (odds ratio greater than 1).

The findings showed that LDL was highly statistically significant at 5% with a p-value of 0.027, suggesting a relationship between LDL and pregnancy-induced hypertension. The odds ratio of 0.645 and marginal value of -0.056. This means that the probability of a pregnant woman becoming hypertensive during her pregnancy increases by 64.5% for every unit increase of LDL. These findings are consistent with those made by [34].

The odds ratio (0.79) of the White Blood Cells is significant (p-value 0.01) at the 5% level with a marginal effect of -0.042. This shows that there is a relationship between WBC and gestational hypertension. Research by [35] provided conclusive evidence that preeclampsia is also influenced by changes in the morphology of leukocytes, or white blood cells. The Red Blood Cells (RBC) and Haemoglobin, (Hb) on the other hand, were found to be statistically insignificant and to have no relation to pregnancy-induced hypertension.

Table 3: Logit Model estimates of the Probability of Prenancy-Induced-Hypertension.

Variable Name	Odds Ratio	Standard Error	Marginal	P-value
Age	0.943	0.098	-0.007	0.576
Parity	1.745	2.172	0.071	0.655
Gravidity	0.952	1.057	-0.006	0.965
GW	0.815	0.095	-0.026	0.079*
Glucose	0.963	0.063	-0.005	0.569

PL	0.943	0.096	-0.007	0.565
PW	0.994	0.004	-0.001	0.085*
UCL	1.096	0.066	0.011	0.126
UCD	0.696	0.673	-0.046	0.708
Cholesterol	1.061	0.079	0.008	0.423
BMI	2.208	0.781	0.101	0.025**
HDL	0.608	0.463	-0.063	0.514
LDL	0.645	0.128	-0.056	0.027**
WBC	0.719	0.092	-0.042	0.01***
RBC	0.110	0.149	-0.282	0.105
Hb	0.700	0.318	-0.046	0.432

** = p < 0.10, **= p < 0.05, *** = p < 0.01*
Source: *Authors' own estimation*

4. CONCLUSION

The aim of this study was to identify some risk and protective factors associated with pregnancy-related hypertension in Ghana, using the Bolgatanga Regional Hospital of the Upper East Region of Ghana as a case study. 50 pregnant women who had hypertensive-related conditions were used for the study and the logistic regression model of STATA 14 was used to analyze the data. Results from the study indicates that pregnant women who gain weight or become obese during their gestational period are more likely to develop or experience pregnancy-induced-hypertension.
The study identified body mass index (BMI) as a risk factor (because it's odd ratio was more than one) whilst gestational weight, placenta weight, low-density lipoprotein cholesterol, and white blood cell count were identified as protective factors (because their odds ratios were less than one).
Considering the study's findings, it was recommended that some extended prospective studies be done to confirm or otherwise of this findings as this study was a one case study and so the finding could not be generalized for the region or nation. The confirmation or otherwise of our findings would help develop strategies or policies that would help prevent the prevalence of pregnancy-induced-hypertension in the region and the nation at large. This policies of prevention should include health campaigns and education. To raise awareness of the risks of pregnancy-induced hypertension, it is advised that women be educated on the risk factors of this condition even before becoming pregnant. The Regional Health Management Team's medical and paramedical professionals might coordinate campaigns and health education on pregnancy-induced hypertension in the region and the country at large.

DATA AVAILABILITY

The data for this study are not available due to confidentiality of the participants' privacy

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