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Influence of Abo Blood Group on Pregnancy Outcomes Among Pregnant Mothers with Hypertensive Disorders in Abakaliki: A Case Controlled Study

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Abstract

Objective: *To determine the relationship between maternal ABO blood group and adverse pregnancy outcomes among pregnant women with hypertensive disorders in pregnancy.*

Design: *This was a prospective case-control study.*

Setting: *This study was carried out in the Department of Obstetrics and Gynaecology, Alex Ekwueme Federal University Teaching Hospital Abakaliki (AEFUTHA)*

Population: *Participants for this study include patients with hypertensive disorders of pregnancy who were managed at the AEFUTHA.*

Method: *Socio-demographic and clinical data were collated at the time of enrolment using a proforma. Data was tabulated and statistically analyzed using IBM Statistical Package for Social Science (SPSS) software version 20 Chicago USA. Chi square test (X2) for matched paired studies was used for comparison of categorical variables while student t- test was used for comparison of continuous variables. The association between blood group and hypertensive disorders of pregnancy were estimated using odds ratios and 95% confidence intervals. Level of statistical significance was taken as P value < 0.05.*

Main Outcome Measures

1. *To determine the distribution of ABO blood group among patients with Hypertensive disorders of pregnancy and control.*
2. *Development and severity of preeclampsia among different blood groups.*
3. *Fetal and maternal complications associated with preeclampsia among different blood groups.*

Results: *The blood group O was more common among parturients with preeclampsia (58.8%) while blood group AB was least common (2.0%). The study also noted that the participants with blood group O, AB, B, A had an odd ratio of 3.13, 1.00, 0.59 and 0.41 respectively, of developing preeclampsia. Patients with blood group O are also more likely to develop severe pre-eclampsia, although not statistically significant. It was also noted that fetuses of parturients with blood group O are more likely to have reduced Apgar scores, fetal birth weight, and admission into neonatal intensive care unit, more risk of stillbirths and maternal complications, when compared with the non-O blood group. The same pattern was also noticed for pregnancy induced hypertension, with blood group O parturients more likely to develop severe PIH, and poor neonatal outcomes.*

Conclusion: *The study noted that there is more risk of hypertensive disorder of pregnancy (pre-eclampsia and pregnancy in-*

duced hypertension) with increased severity, fetal and maternal complication among the O blood group than the non-O blood group. It also noted that O blood group is strongly associated with development of hypertensive disorders of pregnancy, while non- O blood group have least association with development of hypertensive disorder of pregnancy.

Keywords: Pregnancy Induced Hypertension, Pre-eclampsia, ABO Blood Group, Adverse Pregnancy Outcomes

Introduction

Hypertensive disorders of pregnancy represent one of the most common problems of pregnancy and it is the leading cause of maternal and perinatal morbidity and mortality globally [1]. However, it is the second cause of maternal morbidity and mortality, next to obstetric haemorrhage in sub-Saharan Africa. Hypertension in pregnancy is defined as systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg or both, measured four hours apart. According to ASSHP, hypertensive disorders of pregnancy may be pregnancy induced hypertension, chronic hypertension, chronic hypertension with superimposed pre-eclampsia and eclampsia [2]. Hypertensive disorders of pregnancy complicate 5-10% of pregnancies world-wide1. Its prevalence varies from one region to another and from one country to the other. The World Health Organization reported an overall prevalence of 2.7%1. High prevalence of 17% has been reported in Sokoto while in Abakaliki, it accounted for 29.2% among pregnant women with medical disorders of pregnancy [3].

There are many maternal risk markers that predict hypertensive disorders of pregnancy, two- to four-fold [4]. Some of these include pre-existing hypertension, diabetes mellitus, renal disease, previous preeclampsia, antiphospholipid antibody syndrome, body mass index, inter-pregnancy interval ≥ 10 years, and multiple pregnancies [5]. Others include first trimester systolic blood pressure, mean arterial blood pressure, maternal ethnicity.

Biomarkers that have been used to predict the disorders include uterine artery Doppler, placental growth factor and pregnancy associated plasma protein. Some prediction models have been developed for gestational hypertension and preeclampsia for developed countries. However, they have not been tested for suitability and application in low resource settings. Seventy seven percent of all prediction models combined biomarkers with maternal characteristics such as pregnancy associated plasma protein-A (PAPP-A) and placental growth factor (PGF). Prediction models estimate risk of the future occurrence of a particular outcome or event in individuals at risk of such an event. Additionally, they have been used to identify women at high risk of developing hypertensive disorders of pregnancy later in pregnancy. These will help to provide closer monitoring from early pregnancy. Low dose aspirin has been used as a prophylaxis, and it has been shown to reduce the risk of developing preeclampsia.

ABO blood group has also been used as a biomarker for hypertensive disorders of pregnancy, mainly, preeclampsia [6]. Low plasma concentrations of coagulation factors VIII and von Willebrand factor in blood group of individuals may lead to increasing risk of excess bleeding while elevated plasma concentrations of coagulation factor VIII and vWF in non-O blood group individuals have been implicated in increasing risk of preeclampsia, thromboembolic and ischemic heart diseases [7, 8]. Evidence suggests that vWf promotes platelet adhesion, aggregation and atherosis formation leading to vascular endothelial dysfunction, which is known to be involved in the pathogenesis of hypertensive disorders. There have been studies associating ABO blood group with poor pregnancy outcomes such as preeclampsia and intrauterine fetal growth restriction (IUGR). There are conflicting findings on the association between ABO blood group and hypertensive disorders of pregnancy. Blood group AB women are said to be at higher risk of developing preeclampsia in some studies while it has been disproved by other studies. The blood groups A, B, and AB have shown more susceptibility to arterial and venous thrombotic diseases with no rheological delineation (change in shape and flow of blood) [9]. These blood groups are determined by the presence or absence of the inherited antigenic substances on the erythrocyte membrane which are responsible for the alterations in membrane and cytoskeletal properties that could affect the rheology of blood. In the work done by Okoye et al, women with blood group O were more at risk of developing preeclampsia, however, the finding was not significant.

The relationship between ABO blood group and hypertensive disorders of pregnancy is controversial and conflicting. While some studies have shown association, others have refuted such association. More studies have been advocated to be able to either prove or refute such association. Thus, this forms the basis for this study to further consider if there is any association between ABO blood group, hypertensive disorders and adverse pregnancy outcomes. The findings will help in the management of pregnant women as well as in the efforts to prevent its occurrence.

Research Question

Is there any relationship between ABO blood group and adverse pregnancy outcomes in pregnant women with hypertensive disorders of pregnancy?

Null Hypothesis

There is no relationship between maternal ABO blood group and adverse pregnancy outcomes among pregnant women with hypertensive disorders of pregnancy.

Alternative Hypothesis

There is a significant relationship between maternal ABO blood group and adverse pregnancy outcomes among pregnant women with hypertensive disorders of pregnancy.

Aim: The aim of the study is to determine the relationship between maternal ABO blood group and adverse pregnancy outcomes among pregnant women with hypertensive disorders in pregnancy.

Specific Objectives

1. To determine the distribution of ABO blood group among patients with Hypertensive disorders of pregnancy and control.
2. To determine the association between ABO blood group and hypertensive disorders of pregnancy.
3. To determine the association of ABO blood group and severity of hypertensive disorders of pregnancy.
4. To determine the relationship between ABO blood group and adverse perinatal and maternal outcomes

Materials and Method

Study Population

Participants for this study include patients with hypertensive disorders of pregnancy who were managed at the Alex Ekwueme Federal University Teaching Hospital, Abakaliki. Normo-tensive pregnant women at a gestational age greater than 20 weeks with no complications will be recruited as controls. They were recruited over a 6 months period.

Inclusion Criteria

- Rhesus positive pregnant women with singleton gestation and a diagnosis of preeclampsia or pregnancy induced hypertension (PIH).

Exclusion Criteria

1. Patients with renal disease or chronic hypertension
2. Women with evidence of urinary tract infection
3. Patients with sickle cell anaemia
4. Patients with history of smoking
5. Women with diabetes mellitus in pregnancy
6. Patients with multiple gestations
7. Patients who declined consent to participate in the study.
8. Rhesus negative pregnant women

Sample Size Determination

The minimum sample size for the study was calculated based on the formula for estimating sample size for case control studies [10].

$$N = \frac{(r\ 1/r)\ (p)\ (1\ P)\ (Z\alpha\ \ Z\beta)2}{(P1 - P2)2}$$

r= ratio of control to cases 1:1

Zα= the desired power set at 80%= 0.84

Zß= the level of statistical significance=1.96

(P1 - P2)2= effect size (the difference in proportion)

P = population prevalence from previous study (4.7%=0.047) Agwu et al [11]

Assuming an effect size of 15% for this study

$$N = \frac{(1+1)\ (0.047)\ (1 - 0.047)\ (0.84 + 1.96)2}{1\qquad (0.15-0.047)2}$$

$$= \frac{(2)\ (0.047)\ (0.953)\ (2.8)2}{(0.103)2}$$

$$= \frac{(2)\ (0.047)\ (0.953)\ (7.84)}{0.002809}$$

$$= \frac{0.702322}{0.010609}$$

$$= 66.2 \approx 67$$

Twenty percent of the minimum sample size would be added to correct for attritions

20/100 x 67 = 13.4 ≈ 14

Final size per arm = 67 + 14 = 81.

Total sample size = 81+ 81 = 162.

Recruitment of Participants

Consecutive Rhesus positive patients with preeclampsia and PIH who meets the inclusion criteria were recruited from the antenatal clinic, the antenatal ward, Labour ward and the emergency unit. Rhesus positive normotensive pregnant women after 20 weeks gestation without any complication were recruited as control. Matched pairing of both cases and controls on age, parity and gestational age at presentation. They were adequately counselled about the study by the researcher or any of the research assistants, and they were recruited into the study when the informed consent form was signed.

Definitions

- preeclampsia; that is blood pressure of 140/90 mmHg or more, on two occasions, at least 4 hours apart, or a blood pressure reading of ≥ 160/110 mmHg after the 20 weeks gestational age with significant proteinuria (urinalysis of 2+ or more of protein on dipstick or 1+ on dipstick with pH less than 8 and specific gravity of less than 1.030), measured with Accu-Answer Uric 11v® reagent strips for urinalysis.
- pregnancy induced hypertension; that is blood pressure of 140/90 mmHg or more, on two occasions, at least 4 hours apart, or a blood pressure reading of ≥ 160/110 mmHg after the 20-week gestational age with absence of significant proteinuria.

Study Procedure

Materials: Alcohol swab, ethylenediamine tetraacetic acid (EDTA) bottles, Pasteur pipettes, sterile cotton balls, sterile gloves, ice tray, sterile 5ml syringes, test tubes, normal saline, white tiles, small wooden sticks, commercially acquired monoclonal antisera (anti-A, anti-B, anti-AB and anti-Rh D sera), commercially acquired A red cells and B red cells.

Blood Sample Collection: The researcher or any of the research assistants collected 5mls of blood sample from antecubital surface of the participants, under aseptic condition. The blood sample was put in labelled ethylene diamine tetraacetic acid (EDTA) bottle, mixed gently but thoroughly to prevent cell lysis and ensure anticoagulation. The sample was stored in the refrigerator at temperature of 2-8°C until it was analyzed. The sample was used for ABO and Rhesus grouping tests [12].

Principle of Blood Grouping Test: A person's ABO blood group is based on the A, B, or O gene located on chromosome 9. A person who inherits A gene belongs to blood group A and expresses A antigen on the red blood cells. A person who inherits B gene belongs to blood group B and expresses B antigen on the red cells. A person who inherits A and B genes belongs to blood group AB and expresses both A and B antigens on the red cells. A person who inherits O gene belongs to blood group O and does not express A or B antigens on the red cells [13]. Agglutination test was done, positive agglutination is observed by the clumping of red cells on white tile whereas negative reaction is observed by uniform distribution of red cells on white tile.

Table A: Agglutination Reaction in Cell and Serum Grouping

Cell grouping				Serum grouping		Interpretation
Anti-A	Anti-B	Anti-AB	Anti-D	A cells	B cells	Blood group
+	-	+	+	-	+	A
-	+	+	+	+	-	B
+	+	+	+	-	-	AB
-	-	-	+	+	+	O

+ = Agglutination, - = No Agglutination

Statistical Analysis

Data were collected and statistically analyzed using IBM Statistical Package for Social Science (SPSS) software version 20 Chicago USA. Chi square test (X2) for matched paired studies was used for comparison of categorical variables while student t- test was used for comparison of quantitative variables. The association between blood group and hypertensive disorders of pregnancy (pre-eclampsia and PIH) were estimated using odds ratios and 95% confidence intervals. Level of statistical significance was taken as P value < 0.05.

Quality Control

The study procedure was performed by a haematologist in conjunction with the researchers. A second haematologist repeats the procedure at every 5th blood sample from both cases and controls to ensure that the result obtained are correct. Performing both cell and serum grouping greatly reduces the risk of errors as it serves as double check

Results

Table 1 shows the differences in the socio-demographic characteristics of the participants were not statistically significant. Also, there were statistically significant differences in the systolic and diastolic blood pressures among the participants, and length of hospital stay was higher among the cases. Table 2 shows the distribution of ABO blood group among the participants with preeclampsia. The incidence of blood group O was highest (58.8%) among parturient with preeclampsia, while that of blood group A was highest among the control (37.3%). There is a statistically significant association between ABO blood group and development of preeclampsia. Table 3 shows that the cases with blood group O were 3 times more likely to develop pre-eclampsia when compared with the control and this was statistically significant.

Table 1: Socio-demographic and Obstetric Variables

Parameters	Cases (n=81)	Controls(n=81)	χ2	P-value
Age (years)				
< 20	7 (8.6%)	10(12.3%)	5.174*	0.397
20–24	31(38.3%)	36(44.4%)		
25–29	31(38.3%)	20(24.7%)		
30–34	7 (8.6%)	6 (7.4%)		
35–39	4 (4.9%)	5 (6.2%)		
40–44	1 (1.2%)	4 (4.9%)		
Parity				
0	35(43.2%)	34(41.9%)	0.050	0.997
1	30(37.0%)	30(37.0%)		
2–4	12(14.8%)	13(16.4%)		
5 and above	4 (4.9%)	4 (4.9%)		
Occupation				
Trading/Business	19(23.5%)	20(24.7%)	2.783	0.427
Farming	35(43.2%)	41(50.6%)		
Civil Servant	16(19.8%)	15(18.5%)		
Others	11(13.6%)	5 (6.2%)		

Highest educational qualification				
None	19(23.5%)	12(14.8%)	7.760	0.051
Primary	22(27.2%)	17(21.0%)		
Secondary	33(40.7%)	33(40.7%)		
Tertiary	7 (8.6%)	19(23.5%)		
Booking status				
Booked	23(28.4%)			
Unbooked	28 (34.6%)			
58(71.6%)	0.723			
53(65.4%)	0.398			
Mode of delivery				
Vaginal delivery	47(58.0%)	52(64.2%)	0.653	0.420
CS	34(42.0%)	29(35.8%)		

*Fisher's Exact Test Used

Table 2: Comparison of Abo Blood Group of Pre-eclamptic and Pregnancy Induced Hypertensive Patients with Controls

(A) Preeclampsia ABO Blood Group	Cases (n=51)	Controls (n=51)	$\chi 2$	P-value
A	10(19.6%)	19(37.3%)	8.051*	0.044
B	10(19.6%)	15(29.4%)		
AB	1 (2.0%)	1 (2.0%)		
O	30(58.8%)	16(31.4%)		
(B) PIH A	8 (26.7%)	15(50.0%)	9.134*	0.028
B	6 (20.0%)	10(33.3%)		
AB	1 (3.3%)	0 (0.0%)		
0	15(50.0%)	5 (16.7%)		

*Fisher's exact test used, PIH = Pregnancy Induced Hypertension.

Table 3: Association Between ABO Blood Group and Hypertensive Disorders of Pregnancy.

ABO Blood Group	Odds Ratio	95% Confidence Interval		P-value
Preeclampsia		Lower bound	Upper bound	
A	0.41	0.17	1.00	0.079
B	0.59	0.23	1.46	0.357
AB	1.00	0.06	16.44	1.000
O	3.13	1.39	7.05	0.005
PIH				
A	0.36	0.12	1.07	O.063
B	0.50	0.15	1.62	0.243
AB	NA	NA	NA	NA
O	5.00	1.51	16.56	0.006

NA = Not applicable, PIH = Pregnancy Induced Hypertension.

Table 4 shows that more participants with O, B and AB blood groups had severe preeclampsia than mild pre-eclampsia, but there was a statistically significant risk of developing severe preeclampsia than mild preeclampsia for parturients with blood group A. Also form Table 3, it was noted that blood groups O was higher among parturients with PIH and blood group A was higher among normotensive control, and association of ABO blood type with development of PIH was statistically significant. Also, the cases with blood group O were 5 times more likely to develop PIH. However, blood group A and B are less likely to develop PIH. Table 4 shows the distribution of ABO blood group in respect to severity of PIH. For O, A and AB blood groups, more of the participants had severe PIH than mild PIH, whereas, for participants with blood group B more had mild PIH than severe PIH, and the difference was statistically significant.

Table 4: Comparison of ABO Blood Group of Patients with Hypertensive Disorders of Pregnancy with that of Controls

Blood Group	Controls (n=51)	Degree of hypertension		χ2	P-value
		Mild(n=9)	Severe(n=42)		
Preeclampsia					
A	19(37.3%)	2(22.2%)	8 (19.0%)	9.644*	0.141
B	15(29.4%)	3(33.3%)	7 (16.7%)		
AB	1 (2.0%)	0 (0.0%)	1 (2.4%)		
0	16(31.4%)	4(44.4%)	26(61.9%)		
PIH					
A	15(50.0%)	2(14.3%)	4(25.0%)	14.771*	0.022
B	10(33.3%)	6(42.9%)	2(12.5%)		
AB	0 (0.0%)	0 (0.0%)	1 (6.3%)		
0	5 (16.7%)	6(42.9%)	9(56.3%)		

*Fisher's exact test used, PIH = Pregnancy Induced Hypertension.

Table 5a, 5b, 5c and 5d shows that blood group A, B, AB and C adverse fetal and maternal outcomes among parturients with preeclampsia. There is an associated between blood group types and adverse fetal and maternal outcome among parturients with preeclampsia, and blood group O is the major culprit. Also, Table 6a, 6b, 6c and 6d show the association between blood group type and adverse maternal and neonatal outcomes among parturients with PIH. Blood group O is associated with adverse pregnancy outcome.

Table 5a: Fetomaternal Outcome for Patient with Pre-eclampsia

Fetomaternal Outcome	Blood Group A		χ2	P-value
	Cases (n=10)	Controls (n=19)		
Birth weight (kg)				
Mean ±SD	2.98±0.22	3.18±0.19	2.551a	0.017
APGAR Score at 1st minute				
<7	5(50.0%)	2 (10.5%)	5.581*	0.018
≥7	5(50.0%)	17(89.5%)		
APGAR Score at 5th minute				
<7	2(20.0%)	1 (5.6%)	1.533*	0.215
≥7	8(80.0%)	18(94.5%)		
APGAR Score at 10th minute				
<7	7(70.0%)	1 (5.6%)	13.754*	<0.001
≥7	3(30.0%)	18(94.5%)		
NIC admission				
Yes	2(20.0%)	3 (15.8%)	0.081*	0.775
No	8(80.0%)	16(84.2%)		
Stillbirth				
Yes	1 (10.0%)	1 (5.6%)	0.233*	0.632
No	9(90.0%)	18(94.5%)		
Maternal Complication**				
Eclampsia	2(20.0%)	0(0.0%)	4.081*	0.043
Abruptio placentae	2(20.0%)	0(0.0%)	4.081*	0.043
ARF	1(10.0%)	0(0.0%)	1.973*	0.161
HELLP syndrome	0 (0.0%)	0(0.0%)		
DIC coagulation	0 (0.0%)	0(0.0%)		
Maternal Death	0 (0.0%)	0(0.0%)		

a t-test used **Multiple responses allowed * Fisher's exact test used

Table 5b: Feto-Maternal Outcome for Patient with Pre-eclampsia

Feto-maternal Outcome	Blood Group B		χ2	P-value
	Cases (n=10)	Controls (n=15)		
Birth weight (kg)				
Mean ±SD	3.01±0.20	3.19±0.23	2.022a	0.056
APGAR Score at 1st minute				
<7	7(70.0%)	6(40.0%)	2.162*	0.141
≥7	3(30.0%)	9(60.0%)		
APGAR Score at 5th minute				
<7	4(40.0%)	3 (20.0%)	1.191*	0.275
≥7	6(60.0%)	12(80.0%)		
APGAR Score at 10th minute				
<7	7(70.0%)	12(80.0%)	0.333*	0.566
≥7	3(30.0%)	3 (20.0%)		
NIC admission				
Yes	4(40.0%)	3 (20.0%)	1.191*	0.275
No	6(60.0%)	12(80.0%)		
Stillbirth				
No	10(100.0%)	15(100.0%)	0.000	1.000
Maternal Complication**				
Eclampsia	4(40.0%)	0(0.0%)	7.144*	0.008
Abruptio placentae	3(33.3%)	0(0.0%)	5.111*	0.024
ARF	3(33.3%)	0(0.0%)	5.111 *	0.024
HELLP syndrome	1(10.0%)	0(0.0%)	1.564*	0.211
DIC	1(10.0%)	0(0.0%)	1.564 *	0.211
Maternal Death	0 (0.0%)	0(0.0%)		

**Multiple responses allowed * Fisher's exact test used

Table 5c: Fetomaternal Outcome for Patient with Pre-eclampsia

Fetomaternal Outcome	Blood Group AB		χ2	P-value
	Cases (n=1)	Controls (n=1)		
Birth weight (kg)				
Mean ±SD	2.98	3.01	NA	
APGAR Score at 1st minute				
≥7	1(100%)	1(100%)	NA	
APGAR Score at 5th minute				
≥7	1(100%)	1(100%)	NA	
APGAR Score at 10th minute				
≥7	1(100%)	1(100%)	NA	
NIC admission				
No	1(100%)	1(100%)	NA	
Stillbirth				
No	1(100%)	1(100%)	NA	
Maternal Complication*				
Eclampsia	0 (0.0%)	0 (0.0%)	NA	
Abruptio placentae	0 (0.0%)	0 (0.0%)	NA	
HELLP syndrome	0 (0.0%)	0 (0.0%)	NA	
DIC	0 (0.0%)	0 (0.0%)	NA	
ARF	0 (0.0%)	0 (0.0%)	NA	
Maternal Death	0 (0.0%)	0 (0.0%)	NA	

*Multiple responses allowed NA – Not applicable

Table 5d: Fetomaternal Outcome for Patient with Pre-eclampsia

Fetomaternal Outcome	Blood Group O		χ2	P-value
	Cases (n=30)	Controls (n=16)		
Birth weight (kg)				
Mean ±SD	2.94±0.26	3.17±0.28	2.783a	0.008
APGAR Score at 1st minute				
<7	20(66.7%)	7 (43.8%)	2.264	0.133
≥7	10(33.3%)	9 (56.2%)		
APGAR Score at 5th minute				
<7	16(53.3%)	4 (25.0%)	3.411	0.065
≥7	14(46.7%)	12(75.0%)		
APGAR Score at 10th minute				
<7	17(56.7%)	13(81.3%)	2.784	0.0095
≥7	13(43.3%)	3 (18.7%)		
NIC admission				
Yes	13(43.3%)	2 (12.5%)	4.513	0.034
No	17(56.7%)	14(87.2%)		
Stillbirth				
Yes	3 (10.0%)	1 (6.3%)	0.179*	0.667
No	27(90.0%)	15(93.7%)		
Maternal Complications**				
Eclampsia	15(50.0%)	0(0.0%)	11.874*	0.001
Abruptio placentae	11(36.7%)	0(0.0%)	7.713*	0.005
ARF	9 (30.0%)	0(0.0%)	5.971*	0.015
HELLP syndrome	8 (26.7%)	0(0.0%)	5.159*	0.023
DIC	6 (20.0%)	0(0.0%)	3.681*	0.055
Maternal Death	1 (3.3%)	0(0.0%)	0.554*	0.460

**Multiple responses allowed * Fisher's exact test used

Table 6a: Fetomaternal Outcome for Patient with Pregnancy Induced Hypertension

Fetomaternal Outcome	Blood Group A		χ2	P-value
	Cases (n=8)	Controls (n=15)		
Birth weight (kg)				
Mean ±SD	2.93±0.27	3.11±0.21	1.771a	0.091
APGAR Score at 1st minute				
<7	3(37.5%)	2 (13.3%)	1.793*	0.181
≥7	5(62.5%)	13(86.7%)		
APGAR Score at 5th minute				
<7	2(25.0%)	1 (7.1%)	1.554*	0.214
≥7	6(75.0%)	14(93.3%)		
APGAR Score at 10th minute				
<7	6(75.0%)	2 (13.3%)	8.749*	0.003
≥7	2(25.0%)	13(86.7%)		
NIC admission				
Yes	2(25.0%)	1 (7.1%)	1.552*	0.214
No	6(75.0%)	14(93.3%)		
Stillbirth				
Yes	1(12.5%)	0 (0.0%)	1.958*	0.161
No	7(87.5%)	15(100%)		
Maternal Complication**				

Eclampsia	1(12.5%)	0(0.0%)	1.958*	0.161
Abruptio placentae	1(12.5%)	0(0.0%)	1.958*	0.161
ARF	1(12.5%)	0(0.0%)	1.958*	0.161
HELLP syndrome	0 (0.0%)	0(0.0%)		
DIC coagulation	0 (0.0%)	0(0.0%)		
Maternal Death	0 (0.0%)	0(0.0%)		

a t-test used **Multiple responses allowed * Fisher's exact test used

Table 6b: Fetomaternal Outcome for Patient with Pregnancy Induced Hypertension

Fetomaternal Outcome	Blood Group B		$\chi 2$	P-value
	Cases (n=8)	Controls (n=15)		
Birth weight (kg)				
Mean ±SD	2.87±0.21	2.95±0.19	0.779a	0.446
APGAR Score at 1st minute				
<7	4(66.7%)	4(40.0%)	1.072*	0.302
≥7	2(33.3%)	6(60.0%)		
APGAR Score at 5th minute				
<7	2(33.3%)	3(30.0%)	0.022*	0.889
≥7	4(66.7%)	7(70.0%)		
APGAR Score at 10th minute				
<7	4(66.7%)	4(40.0%)	1.072*	0.302
≥7	2(33.3%)	6(60.0%)		
NIC admission				
Yes	3(50.0%)	1(10.0%)	3.204*	0.074
No	3(50.0%)	9(90.0%)		
Stillbirth				
No	6(100.0%)	10(100.0%)	0.000	1.000
Maternal Complication**				
Eclampsia	2(33.3%)	0(0.0%)	3.811*	0.051
Abruptio placentae	1(16.7%)	0(0.0%)	1.779*	0.182
ARF	1(16.7%)	0(0.0%)	1.779*	0.182
HELLP syndrome	2(33.3%)	0(0.0%)	3.811*	0.051
DIC	1(16.7%)	0(0.0%)	1.779*	0.182
Maternal Death	0 (0.0%)	0(0.0%)		

**Multiple responses allowed * Fisher's exact test used

Table 6c: Fetomaternal Outcome for Patient with Pregnancy Induced Hypertension

Fetomaternal Outcome	Blood Group AB		$\chi 2$	P-value
	Cases (n=1)	Controls (n=0)		
Birth weight (kg)				
Mean ±SD	2.89		NA	
APGAR Score at 1st minute				
≥7	1(100%)	0 (0.0%)	NA	
APGAR Score at 5th minute				
≥7	1(100%)	0 (0.0%)	NA	
APGAR Score at 10th minute				
≥7	1(100%)	0 (0.0%)	NA	
NIC admission				
No	1(100%)	0 (0.0%)	NA	
Stillbirth				

No	1(100%)	0 (0.0%)	NA	
Maternal Complication*				
Eclampsia	0 (0.0%)	0 (0.0%)	NA	
Abruptio placentae	0 (0.0%)	0 (0.0%)	NA	
HELLP syndrome	0 (0.0%)	0 (0.0%)	NA	
DIC	0 (0.0%)	0 (0.0%)	NA	
ARF	0 (0.0%)	0 (0.0%)	NA	
Maternal Death	0 (0.0%)	0 (0.0%)	NA	

*Multiple responses allowed NA – Not applicable

Table 6d: Fetomaternal Outcome for Patient with Pregnancy Induced Hypertension

Fetomaternal Outcome	Blood Group O		χ2	P-value
	Cases (n=15)	Controls (n=5)		
Birth weight (kg)				
Mean ±SD	2.94±0.26	3.17±0.28	0.444a	0.662
APGAR Score at 1st minute				
<7	10(66.7%)	2(40.0%)	1.111*	0.292
≥7	5(33.3%)	3(60.0%)		
APGAR Score at 5th minute				
<7	8(53.3%)	1(20.0%)	1.681*	0.194
≥7	7(46.7%)	4(80.0%)		
APGAR Score at 10th minute				
<7	9(60.0%)	1(20.0%)	2.404*	0.121
≥7	6(40.0%)	4(80.0%)		
NIC admission				
Yes	6(40.0%)	0 (0.0%)	2.862*	0.091
No	9(60.0%)	5(100.0%)		
Stillbirth				
Yes	2 (13.3%)	0 (0.0%)	0.741*	0.389
No	13(86.7%)	5(100.0%)		
Maternal Complications**				
Eclampsia	8(53.3%)	0(0.0%)	4.444*	0.035
Abruptio placentae	6(40.0%)	0(0.0%)	2.862*	0.091
ARF	2(13.3%)	0(0.0%)	0.741*	0.389
HELLP syndrome	8(53.3%)	0(0.0%)	4.444*	0.035
DIC	4(26.7%)	0(0.0%)	1.674*	0.197
Maternal Death	1 (6.7%)	0(0.0%)	0.0352*	0.554

**Multiple responses allowed * Fisher's exact test used

Discussion

Main Findings: There are conflicting evidence of the association between ABO blood group and development of Hypertensive disorders of pregnancy and associated adverse pregnancy outcomes. From this study, more of the cases have O blood group and more of the control have A blood group. The finding in this study is similar to the reports by Okoye et al and Mukhtar et al1 but differs from study by Amiri et al Where women with blood types A, B and AB were more susceptible to preeclampsia [14]. It also differs from study by Zhang et al and Mishra et al where preeclampsia was highest with blood group AB and A respectively [15, 16]. The difference in the study may be related to difference in race and environmental factors, as this study was done in Nigeria. This study showed that O blood group has stronger association with the risk of developing pre-eclampsia (p-value of 0.005). This is similar to study by Mukhtar et al1 but differs from findings in a review by Franchini et al [17]. The differences may be related to different in race, place of study and environmental factors. The study showed that 0 blood group is associated with severe pre-eclampsia. This differs from study by Zhang et al who noted that non-O blood group especially blood group AB have increased risk of developing severe preeclampsia. The different in the study may be related to different in study population, as they recruited primiparous women alone in their study.

This study also noted that parturients with O blood group are more at risk of developing severe PIH. This was similar to study by Mishra et al but differs from what was reported by Zhang et al where women of blood group AB had an increased risk of PIH. In a study done by Mukhtar et al, ABO phenotypes showed no association with development of PIH. The difference in the study may be related to differences in study design and environmental factors. Also, more of our participants with blood group B had mild pregnancy induced hypertension and the difference was statically significant.

This study also noted that there was no significant associated between different maternal blood groups and fetal birth weights. The fetal Apgar scores in the 1st, 5th and 10th minutes were determined for each of ABO blood group with PIH and showed that the participants with O blood group had a low in Apgar scores at 1st, 5th and 10th minute compared with the non-O blood group. Also noted that O blood groups carries at least double the risk of NICU admission and stillbirth when compared to non-O blood groups. The findings in the study differs from what was reported by Reshma S. et al where low birth weight and preterm delivery are more among parturients with A blood group and lowest among those with O blood group. The study also noted a more maternal complications, with one maternal death in the O blood group when compared with the non-O blood group.

Strength

The increased sample size has improved the strength of the study. It is a prospective case control study.

Limitation

It is a single center-based study; hence result may not be generalized. The cases were followed up to point of discharge, hence the complications developed by the cases after discharge were not included in the study. Some of the participants who had mild hypertension and managed as an outpatient but were recruited into the study as majority of them were lost to follow up.

Interpretation

Women with O blood group should be offered special care by preventing the factors that predispose to hypertensive disorder of pregnancy (pre-eclampsia and PIH). More multi-centre studies should be done to substantiate the findings in this study.

Conclusion

The study noted that there is more risk of hypertensive disorder of pregnancy, with increased severity, fetal and maternal complications among the O blood group than the non-O blood group in Abakaliki.

Declaration

Authors Contribution: Principal Author is CN Edene, Study design and formation of methodology by EE Ede, Data was analyzed by AA Olaleye and JC Obasi, Manuscript writing by CN Edene and BN Ejikeme, and sample collection by U Onwukwe, N Ekpe, W Oliobi, and E Onyekelu. Result and discussion were written by AA Olaleye, and J Egede.

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Ethical Statement

Ethical approval to carry out this study was obtained from the Research and Ethic Committee of Alex Ekwueme Federal University Teaching Hospital, Abalkaliki, Ebonyi State on the 28th October, 2022.

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