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Hypoalbuminemia Predicts Poor Pregnancy Outcome among Cases of HELLP Syndrome in Nigeria

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ABSTRACT

Background: The current study determined the status of plasma albumin and the relationship between hypoalbuminemia and adverse/poor pregnancy outcomes among cases of HELLP syndrome (HELLPsyn) in Port Harcourt, Nigeria.
Methods: A retrospective cross-sectional study was conducted among women diagnosed with HELLPsyn in the University of Port Harcourt Teaching Hospital (UPTH) between 2011 and 2020. Data of all eligible cases were extracted from hospital registers, case notes, nurses' charts, laboratory, and medical files using pretested datasheet and analyzed.
Results: Two hundred and ten (210) HELLPsyn cases certified the eligible criteria and were included in the analysis. The overall hypoalbuminemia was recorded among 140(66.6%) of which 73(52.1%) and 67(47.9%) were in the clinically significant hypoalbuminemic and clinically insignificant hypoalbuminemic subgroups, respectively. The overall hypoalbuminemia and the clinically significant hypoalbuminemia subtype were more predominant among the severe HELLPsyn cases. The clinically significant hypoalbuminemic HELLP cases had increased risk of acute kidney injury (OR:8.456;95%CI:6.854-11.345), sepsis/infection (OR:4.346;95%CI:2.761-6.709), intensive care unit admission (OR:6.412;95%CI:4.356-8.104), and emergency cesarean section (OR:2.308;95%CI:1.206-3.896) compared to the normoalbuminemic/clinically insignificant hypoalbuminemic HELLP cases. Offspring of the clinically significant hypoalbuminemic HELLP cases also had increased risk of preterm delivery (OR:6.843;95%CI:4.346-8.766), intrauterine growth restriction (OR:3.408;95%CI: 2.166-4.988), birth asphyxia (OR:5.233;95%CI:3.764-7.412), and special care baby unit admission (OR:2.077;95%CI:1.106-3.674) compared to the normoalbuminemic/clinically insignificant hypoalbuminemic HELLP cases.
Conclusion: Hypoalbuminemia, especially the clinically significant hypoalbuminemia subtype, is associated with adverse/poor maternal and perinatal outcomes among cases of HELLPsyn. However, we recommend further studies with a robust design to evaluate the clinical relevance of our findings.

***Keywords*:** HELLP syndrome, hypoalbuminemia, clinically significant hypoalbuminemia

INTRODUCTION

HELLP syndrome is one of the pregnancy-related disorders which tend to occur majorly as a complication or progression of severe preeclampsia.[1,2] However, some scholarly opinion believe that the syndrome may evolve as a separate entity since it can manifest without pre-existing features of severe preeclampsia as a precursor condition.[3,4] The syndrome is one of the dreaded complications with the potential for catastrophic consequences in pregnancy associated with high maternal and perinatal morbidity and mortality.[4-6]

The cardinal underlying pathophysiology of HELLP syndrome is poorly understood and ill-defined to date. However, the syndrome is terminally associated with widespread intravascular lesions in various organs notably the liver.[4-8] The intravascular lesions result in ischemia-induced distortions of hepatocytes integrity resulting in elevated liver enzymes especially the transaminases (aspartate and alanine), microangiopathic hemolysis resulting in elevated bilirubin levels and increased lactate dehydrogenase (LDH) enzymes and platelet adhesion on the widespread intravascular lesions leading to platelet consumption (thrombocytopenia).[4]

The syndrome is also associated with a marked reduction in plasma albumin levels.[7,8] The reduction occurs mainly due to systemic small vessel spasm, increased secretion of angiotensin, and damaged and increased permeability of vascular endothelium, thereby leading to a large number of proteins and liquid leaking into tissues. The loss of large number of plasma proteins including albumin induces reduced plasma oncotic pressure leading to intravascular dehydration.[5-8] Intravascular dehydration may accelerate the appearance of more widespread intravascular lesions which may heighten the severity/ progression of the syndrome. Hepatic blood flow is also diminished in HELLP syndrome (secondary to hypovolemia created by ensuing higher capillary filtration pressure), which tend to reduce albumin synthesis and gradual development of hypoalbumi-nemia.[7,8]

The reduction of plasma albumin level (hypoalbuminemia) in cases of HELLP syndrome has been reported in association with adverse/poor maternal and perinatal outcomes.[3,5-8] However, these previous reports have largely been documented from western populations with a dearth of data within our region.[7,8]

Hence, the present study was conceived to evaluate the status of plasma albumin levels and the relationship between hypoalbuminemia and adverse/poor maternal and perinatal outcomes among cases of HELLP syndrome in Port Harcourt, Nigeria.

2. MATERIALS AND METHODS

2.1. Study Design and Site

This was a retrospective cross-sectional study carried out among pregnant women who were diagnosed with HELLP syndrome over ten years in the University of Port Harcourt Teaching Hospital (UPTH), Nigeria. The hospital is one of the tertiary hospitals located in Port Harcourt, Southern Nigeria. It serves as a referral health center in Rivers State and the neighboring states within the region.

2.2. Ethical Considerations

The study was approved by the UPTH research ethics committee center before the commencement of the study. All data was anonymized and treated with the utmost confidentiality and the study conduct aligned with institutional guidelines and the Helsinki declaration.

2.3. Study Instruments

The hospital data in the Department of Records and Pathology (Chemical Pathology and Hematology) of all eligible cases of HELLP syndrome diagnosed/ managed during the study period was used as study instruments.

2.4. Eligibility Criteria

Criteria for inclusion are as follows: data of all cases of HELLP syndrome diagnosed and managed in UPTH over 10 years (1st January 2011 to the 31st December 2020).

Criteria for exclusion include antecedent or existing liver/ hepatobiliary/ gallbladder diseases, diabetes, thyroid disorders, chronic renal diseases, hemoglobinopathies, thrombotic microangiopathies, chronic and gestational hypertension, acute fatty liver disease of pregnancy, heart failure, and those infected with HIV infection. Also excluded were: those with incomplete data,

preeclampsia/eclampsia superimposed on chronic hypertension, renal transplant recipients, those diagnosed with drug-induced liver injury, those who are malnourished, and those diagnosed outside the study period.

2.5. Data Acquisition

Data was acquired anonymously without any unique identifiers using well-trained research assistants. The variables of which data was collected within the study period included total numbers of deliveries and the number of cases of HELLP syndrome diagnosed within the study period. For each eligible case, all the relevant socio-demographic, medical history acquisitions, clinical, gynecological, obstetric, biochemical, and hematological data were abstracted at the point of diagnosis.

2.6. Data Definitions

2.6.1. HELLP syndrome was defined based on previously published Mississippi triple-class criteria as followings:[9]

Class 1: a. Total plasma bilirubin (TPB) ≥ 1.2mg/dl (20.5 µmol/L) or lactate dehydrogenase (LDH) activity ≥ 600 IU/L b. Plasma aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activity ≥ 70 IU/L c. PLT count < 50 x 10^9/L

Class 2: a. TPB ≥ 1.2mg/dl (20.5 µmol/L) or LDH of ≥ 600 IU/L b. Plasma AST and ALT activities ≥ 70 IU/L c. PLT count 50-100 x 10^9/L

Class 3: a. TPB ≥ 1.2mg/dl (20.5 umol/L) or LDH of ≥ 600 IU/L b. Plasma AST and ALT activities ≥ 40 IU/L c. PLT count 100-150 x 10^9/L

2.6.2. Hypoalbuminemia was defined as plasma albumin level of ≤34g/L.

2.6.3. Adverse/poor maternal and perinatal (fetal/neonatal) outcomes are defined as having any complication of interest that was potentially life-threatening, those leading to serious adverse sequelae, complications requiring prolonged hospitalization, and death.[6]

The adverse/poor maternal outcomes include eclampsia, abruptio placenta, acute kidney injury, disseminated intravascular coagulation, shock, sepsis/infection, primary/secondary postpartum hemorrhage, intensive care unit admission, oligohydramnios, emergency cesarean section, stroke, liver failure/infarction, deep vein thrombosis, adult respiratory distress syndrome, cardio-pulmonary failure, uterine rupture, and assisted ventilation.

The adverse/poor perinatal outcomes include preterm birth, fetal growth restriction, respiratory distress syndrome, birth asphyxia, birth trauma, intensive care unit admission, sepsis, small for gestational age, stillbirth, and perinatal death.

2.7. Data stratification

Hypoalbuminemia was dichotomized into the following two classes:

Class 1 (Mild): clinically insignificant hypoalbuminemia (plasma albumin level ≥25g/L to ≤34g/L)

Class 2 (severe): clinically significant hypoalbuminemia (plasma albumin level <25g/L)

2.8. Specimen acquisition and laboratory analysis

The acquisition of specimens for all laboratory analysis was conducted using standard protocols while observing universal safety precautions. The analysis was done using fully automated chemistry and hematological systems by well-experienced and trained analysts. To evaluate the analytical intra-assay and inter-assay coefficient of variations during analytical processes, at least two levels of commercially-produced quality control materials were used.

2.9. Data Processing and Analysis

Data was initially inputted into Statistical Package for Social Science software version 25. The distribution of continuous data was explored using the Shapiro-Wilk test. Continuous variables that

are not normally distributed were log-transformed before analysis and presented as mean±standard deviation; comparison explored using the independent-samples t-test or analysis of variance, where applicable.

The categorical variables were presented as proportions in numbers/percentages; comparison made using the Chi-square test or Fisher's exact test with Yate's continuity correction applied when necessary. Adjusted multiple logistics regression model was used to evaluate the relationships between adverse/poor outcomes and plasma albumin status. An alpha value of ≤0.05 was chosen as the threshold for statistical significance.

RESULTS

During the period under study, 298 women were diagnosed and managed for HELLP syndrome in the study center. Out of the 298 cases, 210 certified the eligibility criteria for the study and were subsequently included in the analysis.

Table 1: Status of plasma albumin and its distribution by HELLP syndrome subclasses

		HELLP Syndrome Subclasses			
Variables	**tHELLP n=210 n (%)**	**Class 1 n=30 n (%)**	**Class 2 n=110 n (%)**	**Class 3 n=70 n (%)**	**p-value Class 1 vs. 2 vs. 3**
A. Plasma albumin status					
NALB (35-55g/L)	70 (33.4)	5 (16.7)	36 (32.7)	29 (41.4)	<0.001*
Overall hypoalbuminemia (≤34g/L)	140 (66.6)	25 (83.3)	74 (67.3)	41 (58.6)	<0.001*
B. Hypoalbuminemia subgroups	n=140	n=25	n=74	n=41	NA
CIHYPOALB (mild) (25-34g/L)	67 (47.9)	5 (25.0)	35 (47.3)	27 (65.9)	<0.001*
CSHYPOALB (severe) (<25g/L)	73 (52.1)	20 (75.0)	39 (52.7)	14 (34.1)	0.006*

**Statistically significant; tHELLP: Total HELLP Cases; NALB: normoalbuminemia; CIHYPOALB: Clinically insignificant hypoalbuminemia; CSHYPOALB: Clinically significant hypoalbuminemia; NAD: not applicable*

Table 2: Basic characteristics of study subjects by plasma albumin status

	PLASMA ALBUMIN STATUS, n = 210			
Variables	**NALB Group n = 70**	**CIHYPOALB Group n = 73**	**CSHYPOALB Group n = 67**	**NALB vs. CIHYPOALB vs. CSHYPOALB p-value**
	Mean ± SD	Mean ± SD	Mean ± SD	
Age (years)	29.64 ± 3.68	29.96 ± 3.97	31.77 ± 3.07	0.146
Gravidity	2.74 ± 1.03	2.87 ± 1.09	3.66 ± 1.12	0.067
Parity	1.96 ± 0.98	2.06 ± 1.03	2.59 ± 1.13	0.084
GA at diagnosis, weeks	35.16 ± 1.22	35.30 ± 1.02	35.47 ± 1.60	0.578
SBP, mmHg	153.34 ± 8.97	155.57 ± 9.16	160.45 ± 10.67	0.024*
DBP, mmHg	119.67 ± 4.91	118.84 ± 5.73	119.39 ± 6.79	0.087
TPB, µmol/L	62.44 ± 6.96	64.51 ± 7.88	64.71 ± 6.94	0.103
AST activity, IU/L	201.34 ± 6.07	204.53 ± 7.91	205.17 ± 8.31	0.097
ALT activity, IU/L	287.84 ± 5.96	294.73 ± 6.89	323.63 ± 7.93	0.004*
LDH activity, IU/L	784.67 ± 24.73	798.54 ± 27.36	829.93 ± 26.94	0.046*
PLT count, x 10^9 /L	99.14 ± 8.96	94.83 ± 9.45	89.43 ± 9.24	0.028*
PCV, %	30.07 ± 3.93	29.32 ± 4.06	28.51 ± 3.87	0.167
Plasma creatinine, umol/L	108.13 ± 8.84	121.09 ± 9.74	141.47 ± 10.08	0.001*
Plasma uric acid, mmol/L	1.64 ± 0.84	1.73 ± 0.67	2.45 ± 0.39	<0.001*
Plasma total protein, g/L	63.17 ± 2.68	59.12 ± 2.73	55.77 ± 3.01	0.019*
Plasma albumin, g/L	37.45 ± 5.69	29.64 ± 4.73	21.72 ± 3.47	<0.001*
RPG, mmol/L	6.33 ± 0.97	8.74 ± 1.41	9.64 ± 1.12	0.234
QDP, +	+2.04 ± 0.09	+2.83 ± 0.33	+3.86 ± 0.42	0.036*

**Statistically significant; NALB: normoalbuminemia; CIHYPOALB: Clinically insignificant hypoalbuminemia; CSHYPOALB: clinically significant hypoalbuminemia; M±SD: mean ± standard deviation; GA: gestation age; SBP: systolic blood pressure; DBP: diastolic blood pressure; mmHg: millimeter mercury; TPB: total plasma bilirubin; AST: aspartate aminotransferase enzyme; ALT: alanine aminotransferase enzyme; LDH: lactate dehydrogenase enzyme; PLT: platelet cell; PCV: packed cell volume; RPG: random plasma glucose; QDP: qualitative dipstick proteinuria*

Depicted in Table 1, 140(66.6%) of the 210 HELLP syndrome cases had hypoalbuminemia (overall) of which 73(52.1%) and 67(47.9%) of the 140 hypoalbuminemic cases were in the clinically significant and clinically insignificant hypoalbuminemic subgroups, respectively. The overall hypoalbuminemic status and the specific clinically significant hypoalbuminemia subgroup were more predominant among the severe class 1 HELLP syndrome subclass (Table 1).

Decreasing proportions of the clinically significant hypoalbuminemic cases were observed with decreasing severity of HELLP syndrome (class 1: 75.0% vs. class 2: 52.7% vs. class 3: 34.1%; p=0.006) (Table 1).

Shown in Table 2, the clinically significant hypoalbuminemics had higher mean systolic blood pressure (SBP), alanine aminotransferase (ALT)/lactate dehydrogenase (LDH) activities, plasma creatinine, and qualitative dipstick proteinuria (QDP) but lower platelet (PLT) count and plasma albumin levels compared to the normoalbuminemic/clinically insignificant hypoalbuminemic subgroups (p<0.05).

Table 3: Comparison of maternal outcomes by plasma albumin status

	PLASMA ALBUMIN STATUS, n = 210			
Variables	**NALB Group n=70**	**CIHYPOALB Group n = 67 n (%)**	**CSHYPOALB Group n = 73 n (%)**	**NALB vs. CIHYPOALB vs. CSHYPOALB p-value**
Eclampsia	2 (2.8)	2 (2.9)	2 (2.7)	0.164
Abruptio placenta	5 (7.1)	6 (8.9)	7 (9.5)	0.067
Acute kidney injury	8 (11.4)	17 (25.4)	33 (45.2)	<0.001*
DIC	0 (0)	1 (1.5)	1 (1.4)	0.340
PPH	3 (4.2)	3 (4.5)	4 (5.4)	0.240
Shock	9 (12.9)	10 (14.9)	10 (13.6)	0.060
Sepsis/infection	7 (10.0)	17 (25.4)	26 (35.6)	0.007*
ICU admission	6 (8.6)	13 (19.4)	24 (32.9)	<0.001*
Oligohydramnios	7 (10.0)	8 (11.5)	8 (10.9)	0.094
Stroke	1 (1.4)	0 (0)	1 (1.4)	0.234
CPF	5 (7.1)	5 (7.9)	6 (8.2)	0.066
DVT	0 (0)	2 (2.9)	0 (0)	NA
ARDS	1 (1.4)	1 (1.5)	2 (2.7)	0.057
PROM	7 (10.0)	9 (14.2)	10 (13.6)	0.223
Ascites	0 (0)	0 (0)	2 (2.7)	NA
Emergency CS	13 (18.6)	29 (46.0)	47 (64.3)	<0.001*
Maternal death	1 (1.4)	0 (0)	1 (1.4)	0.080

**Statistically significant; NALB: normoalbuminemia; CIHYPOALB: clinically insignificant hypoalbuminemia; CSHYPOALB: clinically significant hypoalbuminemia; DIC: disseminated intravascular coagulation; PPH: post-partum hemorrhage; ICU: intensive care unit;*

Table 4: Comparison of perinatal outcomes by plasma albumin status

	PLASMA ALBUMIN STATUS, n = 210			
Variables	**NALB n=70 n (%)**	**CIHYPOALB n = 67 n (%)**	**CSHYPOALB n = 73 n (%)**	**NALB vs. CIHYPOALB vs. CSHYPOALB p-value**
Preterm birth	12 (17.1)	27 (40.3)	48 (65.7)	<0.001*
IUGR	11 (15.7)	26 (38.8)	45 (61.6)	<0.001*
RDS	32 (45.7)	33 (49.3)	34 (46.6)	0.075
Birth asphyxia	16 (22.8)	32 (47.7)	39 (53.4)	0.014*
Birth trauma	0 (0)	5 (7.5)	0 (0)	NA
SCBU admission	10 (14.2)	25 (37.3)	47 (63.4)	<0.001*
Stillbirth	0 (0)	0 (0)	6 (8.2)	NA
Perinatal death	9 (12.9)	9 (13.4)	10 (13.7)	0.163

**Statistically significant; NALB: normoalbuminemia; CIHYPOALB: clinically insignificant hypoalbuminemia; CSHYPOALB: clinically significant hypoalbuminemia; NA: not applicable; IUGR: intrauterine growth restriction; RDS: respiratory distress syndrome; SCBU: special care baby unit*

Table 5: Relationships between clinically significant hypoalbuminemia with adverse/poor maternal and perinatal outcomes

	NALB	**CIHYPOALB**	**CSHYPOALB**
Variables	OR (Reference); 95% CI	OR**; 95% CI	OR**; 95% CI
A. Poor maternal outcome			
AKI	1.0	1.022; 0.567-2.644	8.456; 6.854-11.345
Sepsis/Infection	1.0	1.124; 0.606-2.791	4.346; 2.761–6.709
ICU admission	1.0	2.101; 1.247-3.096	6.412; 4.356–8.104
Emergency CS	1.0	1.446; 0.683-2.364	2.308; 1.206–3.896
B. Poor perinatal outcome			
Preterm delivery	1.0	1.366; 0.809-2.077	6.843; 4.346–8.766
IUGR	1.0	1.233; 0.741-2.281	3.408; 2.166–4.988
Birth asphyxia	1.0	2.144; 1.568-3.262	5.233; 3.764–7.412
SCBU	1.0	1.264; 0.803-2.341	2.077; 1.106–3.674

***Statistically significant; **adjusted for systolic blood pressure, alanine aminotransferase/lactate dehydrogenase activities, plasma creatinine, and qualitative dipstick proteinuria and platelet count; OR: odd ratio; CI: confidence interval; NALB: Normoalbuminemia; CIHYPOALB: clinically insignificant hypoalbuminemia; CSHYPOALB: clinically significant hypoalbuminemia; ICU: intensive care unit; IUGR: intrauterine growth restriction; SCBU: special care baby unit*

The clinically significant hypoalbuminemics had higher proportions of those with maternal acute kidney injury, sepsis/infection, intensive care unit (ICU) admission and emergency cesarean sections compared to the normoalbuminemic/ clinically insignificant hypoalbuminemics subgroups ($p<0.05$) (Table 3).

The offspring of those with clinically significant hypoalbuminemia had higher proportions of those with preterm births, intrauterine growth restriction, birth asphyxia, and special care baby unit (SCBU) admission compared to the normoalbuminemic and the clinically insignificant hypoalbuminemic groups ($p<0.05$) (Table 4).

The clinically significant hypoalbuminemic HELLP cases had increased risk of acute kidney injury (OR:8.456;95%CI: 6.854-11.345), sepsis/infection (OR:4.346;95%CI:2.761-6.709), maternal intensive care unit admission (OR:6.412;95%CI:4.356-8.104), and emergency cesarean sections (OR:2.308;95%CI: 1.206-3.896) compared to the normoalbuminemic/clinically insignificant hypoalbuminemic cases following adjustment for systolic blood pressure, alanine aminotransferase/lactate dehydrogenase activities, plasma creatinine, and qualitative dipstick proteinuria and platelet count (Table 5).

Additionally, offspring of the clinically significant hypoalbuminemic HELLP cases also had an increased risk of preterm delivery (OR:6.843;95%CI: 4.346-8.766), intrauterine growth restriction (OR:3.408;95%CI: 2.166-4.988), birth asphyxia (OR:5.233;95%CI:3.764-7.412), and special care baby unit admission (OR:2.077;95%CI:1.106-3.674) compared to the normoalbuminemic/clinically insignificant hypoalbuminemic cases following adjustment for systolic blood pressure, alanine aminotransferase/lactate dehydrogenase activities, plasma creatinine, and qualitative dipstick proteinuria and platelet count (Table 5).

4. DISCUSSION

In the current study, we have demonstrated that the overall hypoalbuminemic status (albumin level ≤34g/L) is a common finding among cases of HELLP syndrome. Moreover, the majority of the overall hypoalbuminemic status that was observed among these cases of HELLP syndrome were mostly of the clinically significant hypoalbuminemic (albumin level <25g/L) variants. The overall hypoalbuminemic status and the more specific clinically significant hypoalbuminemic variants were more predominant with worsening severity of the syndrome. These findings are features that have consistently been reported as components of the pathophysiologic mechanisms of HELLP syndrome especially the severe variant and its acclaimed precursor agent–the severe preeclampsia.[7,8.10,11]

The clinically significant hypoalbuminemic HELLP cases also had higher mean systolic blood pressure, alanine aminotransferase/lactate dehydrogenase activities, plasma creatinine, and qualitative dipstick proteinuria but lower platelet count and plasma albumin levels compared to the normoalbuminemic and the clinically insignificant hypoalbuminemic subgroup. These findings could indicate the severity of the syndrome as previously documented.[12-15]

The loss of the physiologic role of albumin due to hypoalbuminemia may exacerbate the HELLP syndrome process and escalate its progression.[7,8] Albumin plays crucial physiologic role in health. It maintains the osmotic pressure of the extracellular fluids.[16-20] Albumin has antioxidant properties and scavenges many plasma small molecules, including heam.[16-18,20] This scavenging function underlines the anti-inflammatory effect of albumin. In addition, albumin also has been identified to have emerging biological roles in maintaining vascular integrity, as an antithrombotic factor, and also has a heparin-like activity and reduces platelet

aggregation.[16.17] These functions are distorted in hypoalbuminemia and could explain the worsening of HELLP syndrome severity among the clinically significant hypoalbuminemic cases.

We also observed that the clinically significant hypoalbuminemic HELLP cases had higher risk of maternal acute kidney injury, sepsis/infection, ICU admission, emergency cesarean section and higher risk of offspring with preterm delivery, intrauterine growth restriction, birth asphyxia and special care baby unit admission compared to the normoalbuminemic and the clinically insignificant hypoalbuminemic HELLP cases. These adverse/poor outcomes have previously been documented and underline the role hypoalbuminemia plays in HELLP syndrome.[3,5-8,21-23]

The current study was limited by its retrospective nature so that it could not determine the causal impact of hypoalbuminemia on maternal and perinatal outcomes among the HELLP cases. Furthermore, since it is a single-institution study, the number of patients included is also rather limited and may result in an inadequately powered study. So, the study findings may not accurately reflect the entire population within the studied region. Therefore, future robust prospective studies with a larger sample size are recommended to further verify the findings of this study.

5. CONCLUSION

We have demonstrated that the hypoalbuminemic (overall) status is a common finding among cases of HELLP syndrome. Moreover, the majority of the overall hypoalbuminemic status that was observed among these cases of HELLP syndrome were mostly of the clinically significant hypoalbuminemic variants. The hypoalbuminemic status and the more specific clinically significant hypoalbuminemic variants were more predominant with worsening severity of the syndrome. The clinically significant hypoalbuminemic HELLP cases had a heightened risk of acute kidney injury, sepsis/infection, intensive care unit admission, emergency cesarean section, and heightened risk of offspring with preterm delivery, perinatal intrauterine growth restriction, birth asphyxia, and special care baby unit admissions.

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STATEMENT OF ETHICS

The ethical approval of the study was obtained from the Institutional Research Ethics Committee following the review of the study protocols and the study was carried out in compliance with the principles embodied in the Helsinki Declaration.

DISCLOSURE STATEMENT

The authors declared no conflicts of interest.

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AUTHORS' CONTRIBUTIONS

All the authors were involved substantially in the concept and design of the study, data acquisition, analysis and interpretation of the data, drafting the article, revising the article critically for its intellectual content, and in the final approval of the version to be published.

DATA AVAILABILITY

The data analyzed and used in this study may be shared with other researchers on reasonable request provided the data comply with the same standards as the main dataset.

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