



Assessment of Serum Folate and Vitamin B12 Status in Neonates of Preeclamptic and Eclamptic Mothers in Northwestern Nigeria

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Abstract

Background: The physiological journey of pregnancy inextricably links maternal well-being to infant health outcomes. Complications occurring within the placenta and maternal systems, specifically eclampsia and preeclampsia, severely disrupt the developing fetus's homeostatic balance. Consequently, this investigation was designed to evaluate the serum concentrations of vitamin B12 and folate in newborns delivered by women enduring these hypertensive conditions.

Materials and Methods: A hospital-based, comparative cross-sectional research framework was implemented, focusing on mother-infant dyads at the Specialist Hospital and Usmanu Danfodiyo University Teaching Hospital located in Sokoto. The study successfully enrolled 56 pairs distributed across normotensive, eclamptic, and preeclamptic clinical categories. Structured questionnaires were utilized to systematically gather clinical demographics. Three milliliters of venous blood from the mothers and an equal volume of umbilical cord blood from their newborns were drawn into

unmedicated collection tubes. To quantify vitamin B12 and folate concentrations, researchers employed Calbiotech ELISA kits, analyzing the samples spectrophotometrically at a wavelength of 450 nm. All statistical evaluations were processed via SPSS version 27.0. After verifying data normality with the Shapiro-Wilk test, means and standard deviations were scrutinized using ANOVA and independent t-tests, adopting a statistical significance threshold of $p \leq 0.05$.

Results: Infants born to mothers battling eclampsia and preeclampsia demonstrated substantially elevated average serum vitamin B12 concentrations (357.10 ± 163.6 pg/mL and 371.48 ± 163.8 pg/mL, respectively) when contrasted with the healthy control cohort (254.01 ± 85.8 pg/mL), yielding a highly significant p-value of <0.001 . Conversely, analysis of umbilical cord serum folate revealed no statistically significant variance across the three maternal groups (23.83 ± 4.07 ng/mL for controls, 22.73 ± 3.92 ng/mL for eclampsia, and 22.22 ± 3.53 ng/mL for preeclampsia; $p = 0.079$). Furthermore, the specific intensity of the mother's preeclampsia did not dictate any shifts in the newborn's vitamin B12 or folate profiles. A robust positive correlation linked maternal and infant serum vitamin B12 across every single clinical category evaluated ($p < 0.001$). Maternal and fetal folate levels also shared a positive correlation strictly within the preeclamptic cohort.

Conclusion: This research highlighted that newborns exposed to maternal preeclampsia and eclampsia retain notably higher serum vitamin B12 levels than infants born to normotensive women. Meanwhile, umbilical cord folate pools remained relatively uniform regardless of the mother's blood pressure status or the severity of her hypertensive disease.

Keywords: Hypertensive pregnancy disorders, neonatal micronutrients, umbilical cord serum, cobalamin, folic acid, maternal-fetal health, Northern Nigeria.

Introduction

A healthy, uncomplicated pregnancy triggers profound shifts in a woman's physiological baseline, notably inducing a roughly 50% drop in circulating plasma folate when compared to her pre-pregnancy state. When complications such as eclampsia and preeclampsia arise, they introduce severe disturbances to the fetal environment and its developmental trajectory. Collectively, this preeclampsia-eclampsia spectrum stands as a primary driver of life-threatening morbidities for both pregnant individuals and their offspring. While the precise biological origins of these hypertensive syndromes remain elusive, the systemic inflammation intrinsic to the disorders heavily impairs fetal homeostasis.

Insufficient folate reserves have been shown to trigger apoptosis within human cytotrophoblast cells. This cellular death severely restricts trophoblast tissue invasion and halts proper placental formation, thereby escalating the likelihood of hypertensive crises during gestation. Furthermore, maternal deficiencies in both vitamin B12 and folate promote a dangerous accumulation of blood homocysteine. This hyperhomocysteinemia amplifies oxidative stress, which actively destroys the vascular endothelium of the maturing placenta. Such placental injury paves the way for severe obstetric disasters, including premature delivery, recurrent miscarriages, placental abruption, stunted intrauterine growth, and the onset of preeclampsia.

Maternal and fetal micronutrient compartments share an intimate, regulated connection. Developing fetuses actively sequester vitamin B12 and folate against standard maternal concentration gradients,

typically securing plasma levels by the time of delivery that are double those of their mothers. However, women diagnosed with preeclampsia consistently present with profoundly depleted serum vitamin B12 and folate concentrations when compared to healthy pregnant populations.

Eclampsia and preeclampsia manifest as complex, multi-organ hypertensive disorders uniquely tied to pregnancy, characterized heavily by these micronutrient shortfalls. Within the specific demographic of Sokoto, preeclampsia burdens approximately 6% of all pregnancies, while eclampsia complicates another 4.29%, driving substantial health crises in the region. Despite these alarming statistics, limited clinical research has explored how these maternal conditions directly dictate the nutritional status of the newborn. Consequently, this investigation seeks to quantify the serum vitamin B12 and folate profiles of infants and meticulously compare them against their mothers who are experiencing eclamptic and preeclamptic pregnancies.

Methodology

Study Design, Area, and Population

This research utilized a comparative cross-sectional framework, sequentially enrolling 56 mother-infant pairs into the study. The clinical cohorts were stratified into normotensive, eclamptic, and preeclamptic groups. Participants were sourced directly from the labor and preeclampsia units of two premier Nigerian medical facilities: the Specialist Hospital and Usmanu Danfodiyo University Teaching Hospital located in Sokoto, with recruitment spanning from March 2023 through November 2023.

Inclusion Criteria

The study welcomed newborns and their respective mothers provided the maternal diagnosis was confirmed as normotensive, preeclamptic, or eclamptic.

Exclusion Criteria

Strict exclusion parameters were applied to infants exhibiting severe birth asphyxia or congenital anomalies. Mothers were deemed ineligible if they had not been routinely prescribed folic acid supplements. Additionally, pregnant women suffering from connective tissue disorders, renal diseases, chronic hypertension, diabetes mellitus, or hypertension appearing prior to the 20th week of gestation were excluded from the cohort.

Definition of Clinical Variables

- **Normotensive Pregnancy:** Diagnosed when a woman carries a viable fetus at or beyond 20 weeks of gestation (verified via ultrasound) while consistently maintaining blood pressure readings below 140/90 mmHg.
- **Preeclampsia:** Identified in previously healthy women at ≥ 20 weeks gestation who exhibit a blood pressure of $\geq 140/90$ mmHg across two separate evaluations spaced at least six hours apart. This must be accompanied by proteinuria (registering $\geq 1+$ on two random urine tests analyzed six hours apart).
- **Mild Preeclampsia:** A specific subset characterized by a diastolic pressure between 90 and 109 mmHg and a systolic pressure ranging from 140 to 159 mmHg.
- **Severe Preeclampsia:** Defined by dangerously elevated readings, specifically a diastolic metric of ≥ 110 mmHg or a systolic metric of ≥ 160 mmHg.

- **Eclampsia:** The abrupt onset of convulsions in a patient already managing preeclampsia.

Laboratory Tests

Medical personnel extracted three milliliters of venous blood from the mothers, alongside three milliliters of umbilical cord blood from their infants, placing the specimens into standard, unmedicated bottles. The samples were allowed to clot and were subsequently centrifuged within an hour to isolate the serum. This serum was frozen at -40 degrees Celsius and slated for analysis within a two-week window. Analyte concentrations were quantified using highly sensitive enzyme-linked immunosorbent assay (ELISA) kits procured from Calbiotech, Inc. (El Cajon, CA, USA). These advanced colorimetric microplate immunoassays were evaluated at a wavelength of 450 nm using a spectrophotometer to precisely capture vitamin B12 and folate metrics.

Data Analysis and Management

All statistical evaluations were meticulously executed using IBM SPSS Statistics version 27.0. To verify the normality of the data distribution, researchers applied the Shapiro-Wilk test. Normally distributed quantitative metrics—such as infant birth weight, maternal blood pressure, gestational age at booking, parity, gravidity, and maternal age—were articulated as means paired with standard deviations. Data that proved skewed were presented via medians and interquartile ranges, whereas qualitative traits (occupation, educational background, ethnicity, and marital status) were summarized simply as percentages.

To effectively contrast the physiological parameters between the mothers and their newborns, the research team utilized analysis of variance (ANOVA) alongside independent-samples t-tests. Chi-square testing evaluated potential links between external sociodemographic factors (including poor healthcare access, maternal age, parity, and education) and the observed hematological outcomes during hypertensive crises. Inter-variable relationships within the mother-infant dyads were probed deeply using Spearman's and Pearson's correlation coefficients. Statistical significance was firmly established at a p-value of ≤ 0.05 , leveraging a 95% confidence interval.

Ethical Considerations

Institutional review boards and the Ethical and Research Committees at both participating clinical centers granted full clearance for this protocol. Furthermore, written informed consent was mandated and secured from every participant—or their legally authorized proxies—prior to any clinical enrollment or data collection.

Results

The investigation successfully cataloged 56 mother-newborn dyads across three distinct maternal blood pressure profiles. The average maternal ages recorded across the preeclamptic, eclamptic, and normotensive cohorts were 26.18 ± 6.23 years, 26.21 ± 5.25 years, and 26.20 ± 4.51 years, respectively, yielding a statistically significant variance ($p = 0.028$).

Analysis of the umbilical cord serum revealed no significant statistical deviation in folate concentrations among the neonates. Babies born to mothers managing preeclampsia and eclampsia documented average folate levels of 22.22 ± 3.53 ng/mL and 22.73 ± 3.92 ng/mL, which statistically mirrored the 23.83 ± 4.07 ng/mL baseline observed in the normotensive control group ($p = 0.079$).

In stark contrast, neonatal serum vitamin B12 was dramatically impacted by maternal hypertensive states. Infants of preeclamptic (371.48 ± 163.8 pg/mL) and eclamptic (357.10 ± 163.6 pg/mL) mothers possessed significantly higher cobalamin reserves than control infants (254.01 ± 85.80 pg/mL), resulting in a highly significant p-value of <0.001 . Interestingly, when comparing the eclamptic and preeclamptic infant groups against one another, their elevated vitamin B12 levels did not differ significantly.

Table 1: Comparison of Umbilical Cord Serum Folate and Vitamin B12 Profiles

Biomarker	Preeclampsia Cohort	Eclampsia Cohort	Normotensive Cohort	ANOVA (F-Test)	Significance (p-value)
Folate (ng/mL)	22.22 (3.53)	22.73 (3.92)	23.83 (4.07)	2.58	0.079
Vitamin B12 (pg/mL)	371.48 (163.8)	357.10 (163.6)	254.01 (85.80)	11.31	<0.001

Note: Data presented as Mean (Standard Deviation). Statistical significance defined as $p < 0.05$.

Maternal Serum Biomarkers

Women suffering from eclampsia and preeclampsia presented with severely depleted serum folate compared to healthy pregnant women. Their respective averages plummeted to 16.55 ± 3.63 ng/mL and 16.51 ± 3.51 ng/mL, sitting well below the normotensive average of 21.04 ± 3.46 ng/mL ($p < 0.001$). However, the difference in folate depletion between the two hypertensive states themselves was virtually nonexistent ($p = 0.998$). Similarly, circulating vitamin B12 pools were significantly compromised in diseased mothers. Preeclamptic women recorded an average of 208.91 ± 80.60 pg/mL, and eclamptic women recorded 205.81 ± 81.81 pg/mL, both trailing far behind the 275.10 ± 90.03 pg/mL observed in the healthy control group ($p < 0.001$).

Table 2: Maternal Serum Folate and Vitamin B12 Concentrations

Biomarker	Preeclampsia Cohort	Eclampsia Cohort	Normotensive Cohort	ANOVA (F-Test)	Significance (p-value)
Folate (ng/mL)	16.51 (3.63)	16.55 (3.63)	21.04 (3.46)	29.86	<0.001
Vitamin B12 (pg/mL)	208.91 (80.60)	205.81 (81.81)	275.10 (90.03)	12.05	<0.001

Note: Data presented as Mean (Standard Deviation). Statistical significance defined as $p < 0.05$.

Clinical analysis confirmed that the sheer severity of the hypertensive disease—ranging from mild to severe preeclampsia and progressing to full eclampsia—exerted no statistically significant influence on the infant's cord blood vitamin B12 or folate reserves ($p > 0.05$).

Maternal-Fetal Correlational Findings

Deepening the statistical analysis uncovered robust parallel trends between the maternal and infant blood profiles. Within the preeclampsia cohort, an infant's vitamin B12 concentration strongly mirrored its mother's systemic levels ($r = 0.913$; $p < 0.001$). A similarly robust positive correlation was documented for folate within this specific disease group ($r = 0.817$; $p < 0.001$).

Table 3: Correlational Matrix for the Preeclampsia Cohort

Umbilical Cord Parameter	Maternal Parameter	Pearson's Coefficient (r)	Significance (p-value)
Vitamin B12	Vitamin B12	0.913**	<0.001
Folate	Folate	0.817**	<0.001

() Indicates statistical significance at the 0.001 threshold.

For pregnancies complicated by eclampsia, the maternal and neonatal vitamin B12 levels remained tightly linked in a positive trajectory ($r = 0.905$; $p < 0.001$). Interestingly, folate demonstrated a weak but statistically significant negative correlation in this highly symptomatic group ($r = -0.304$; $p = 0.023$).

Table 4: Correlational Matrix for the Eclampsia Cohort

Umbilical Cord Parameter	Maternal Parameter	Pearson's Coefficient (r)	Significance (p-value)
Vitamin B12	Vitamin B12	0.905**	<0.001
Folate	Folate	-0.304*	0.023

() Indicates statistical significance at the 0.001 threshold. () Indicates significance at 0.05.*

Finally, the healthy normotensive cohort consistently maintained a highly significant positive correlation concerning maternal and fetal vitamin B12 transmission ($r = 0.917$; $p < 0.001$).

Table 5: Correlational Matrix for the Normotensive Cohort

Umbilical Cord Parameter	Maternal Parameter	Pearson's Coefficient (r)	Significance (p-value)
Vitamin B12	Vitamin B12	0.917**	<0.001

() Indicates statistical significance at the 0.001 threshold.

Discussion

The current clinical investigation established that maternal hypertensive crises do not meaningfully compromise the folate concentrations delivered to the fetus. Paradoxically, neonates navigating eclamptic or preeclamptic environments manage to accumulate substantially more vitamin B12 than their counterparts in uncomplicated pregnancies. This distinct divergence contrasts sharply with earlier findings published by Bolat et al., who previously reported no meaningful shifts in either micronutrient among infants based on maternal blood pressure variability. From a physiological standpoint, fetuses are incredibly efficient at sequestering folate against a maternal gradient, ensuring their circulatory levels effectively double those of the mother just prior to delivery. Consequently, the accumulated data suggest that maternal eclampsia and preeclampsia do not inherently predispose a newborn to cobalamin (vitamin B12) deficiency.

Conversely, the mothers actively battling these syndromes exhibited a severe and marked depletion of both essential nutrients. The observation of critically diminished maternal folate aligns flawlessly with multiple previous scholarly investigations. While researchers like Shahbazian et al. similarly documented suppressed maternal vitamin B12 during hypertensive episodes, other academics, such as Mahmoud et al., found no such cobalamin discrepancy between preeclamptic and healthy

women. The fetus's robust, active uptake mechanisms explain exactly why these infants successfully maintain adequate—or even heavily elevated—nutritional levels despite their mothers facing stark metabolic deficits.

When carefully examining the intensity of the disease, offspring delivered by women managing mild preeclampsia surprisingly possessed significantly greater vitamin B12 reserves than those born to mothers suffering from severe preeclampsia or full eclampsia. The study also successfully mapped strong proportional relationships between the micronutrient profiles of the dyads across every clinical group. For instance, maternal and infant vitamin B12 concentrations rose and fell in tandem universally, while folate followed a similarly paired trajectory specifically within the preeclamptic subset. To fully validate and solidify these correlational nuances, future clinical researchers are encouraged to deploy considerably larger sample sizes.

Conclusion

This research successfully illuminated that newborns exposed to the hostile environment of maternal preeclampsia possess notably enriched serum vitamin B12 when compared directly to those emerging from normotensive pregnancies. Cord blood folate concentrations remained incredibly resilient, demonstrating no significant physiological deviation irrespective of the mother's blood pressure fluctuations. Strong positive correlational links were actively mapped between maternal and fetal vitamin B12 across all health profiles, with the preeclampsia group also showcasing a matched positive correlation for systemic folate. Ultimately, while pregnant women endure substantial and dangerous depletions of these critical nutrients during hypertensive crises, their infants appear remarkably protected. Subsequent longitudinal investigations must be launched to clarify the long-term neonatal impacts of this temporary maternal micronutrient deprivation. Furthermore, therapeutic trials should rigorously investigate whether dual supplementation of folic acid and vitamin B12 can stabilize maternal hematological parameters and further optimize these neonatal outcomes.

Limitation of the Study

The cross-sectional nature of this clinical inquiry, strictly dictated by logistical time and resource constraints, represents its primary limitation. Because participants were not monitored longitudinally throughout their gestations, dynamic, real-time shifts in these biochemical parameters could not be tracked or appreciated. Although a cohort of 56 dyads per clinical category ultimately yielded robust and viable statistical insights, expanding the participant base in future clinical efforts would undoubtedly enhance the statistical fortitude and generalizability of the findings.

Recommendations

The global medical community urgently requires expanded, targeted research to ascertain if proactively co-prescribing vitamin B12 alongside routine prenatal folic acid can effectively rescue and elevate maternal serum stores. Evaluating exactly how this combined nutritional intervention influences subsequent neonatal hematology in the context of eclampsia and preeclampsia remains a vital obstetric priority.

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Data availability

No datasets were generated or analyzed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable. This study did not involve human or animal subjects.

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Competing interests

The authors declare that they have no competing interests.

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