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**The parity paradox in maternal hypertension:  
A stratified multicenter case-control analysis  
of socio-economic and dietary determinants  
of preeclampsia in Northern Nigeria**

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**Abstract**

**Background.** Preeclampsia remains a leading cause of maternal mortality in low- and middle-income countries. In rural Northern Nigeria, where antenatal-care coverage is only 53 %, isolating parity-specific risk profiles is essential for the design of targeted, high-impact interventions.

**Purpose.** To identify, stratify and compare socio-demographic, economic, nutritional and obstetric determinants of preeclampsia between nulliparous and multiparous cohorts in Jigawa State.

**Materials and methods.** A prospective multi-centre case-control study was conducted across four public perinatal hospitals. A total of 395 pregnant women (146 preeclampsia cases and 249 normotensive controls) were enrolled and stratified into nulliparous (N = 269; 97 cases, 172 controls) and multiparous (N = 126; 49 cases, 77 controls) groups. Multivariate binary logistic regression models were fitted independently for each parity stratum in SPSS 27.0 to derive adjusted odds ratios (AOR) with 95 % confidence intervals.

**Results.** Among nulliparous women structural barriers predominated: complete absence of formal education increased preeclampsia odds nearly nine-fold (AOR = 8.92; 95 % CI: 1.66–47.96; P = 0.012) and monthly income below ₦70 000 quadrupled risk (AOR = 3.94; 95 % CI: 1.65–9.40; P = 0.002). Frequent pre-pregnancy coffee consumption showed a strong protective effect (AOR = 0.12; 95 % CI: 0.03–0.57; P = 0.007). Among multiparous women the risk profile shifted predominantly to biological and re-

productive stressors: maternal anemia (AOR = 2.69; 95 % CI: 1.00–7.20; P = 0.049), short interpregnancy interval (< 2 years; AOR = 2.68; 95 % CI: 1.00–7.20; P = 0.049) and partner change (AOR = 2.80; 95 % CI: 1.10–7.15; P = 0.032). General Hospital Jahun accounted for 56.2 % of all recorded cases.

**Conclusion.** Preeclampsia in Northern Nigeria follows distinct parity-specific pathways. Nulliparous women are primarily endangered by socio-economic barriers, while multiparous women are threatened by cumulative biological depletion. Health systems must therefore adopt stratified antenatal screening and resource-allocation strategies.

**Keywords:** preeclampsia; parity; socio-economic factors; nutritional status; anemia; Northern Nigeria

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## **Парадокс паритета при материнской гипертензии: стратифицированный многоцентровый анализ случай-контроль социально-экономических и диетических факторов как детерминант преэклампсии в Северной Нигерии**

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### **Аннотация**

**Обоснование.** Преэклампсия остается одной из ведущих причин материнской смертности в странах с низким и средним уровнем дохода. В сельских районах Северной Нигерии, где охват антенатальной помощью составляет лишь 38 %, выявление паритет-специфических профилей риска приобретает жизненно важное значение для разработки целенаправленных медицинских вмешательств.

**Цель.** Изолировать, стратифицировать и сравнить социально-демографические, экономические, нутритивные и акушерские детерминанты преэклампсии между когортами нерожавших и повторнородящих женщин в штате Джигава.

**Материалы и методы.** Проспективное исследование «случай-контроль» проведено на базе четырех государственных перинатальных больниц. В выборку включено 395 беременных женщин (146 случаев преэклампсии и 249 нормотен-

живных контролей), стратифицированных на нерожавших ( $N = 269$ ) и повторно-родящих ( $N = 126$ ). Риски оценивались с помощью многофакторной бинарной логистической регрессии в SPSS 27.0.

**Результаты.** У нерожавших женщин доминировали структурные барьеры: полное отсутствие формального образования повышало шансы преэклампсии почти в девять раз ( $AOR = 8,92$ ; 95 % CI: 1,66–47,96), а ежемесячный доход ниже ₦70 000 – в четыре раза ( $AOR = 3,94$ ; 95 % CI: 1,65–9,40). Частое употребление кофе до беременности оказывало выраженный защитный эффект ( $AOR = 0,12$ ; 95 % CI: 0,03–0,57). У повторнородящих женщин профиль риска смещался в сторону биологических и репродуктивных факторов: материнская анемия ( $AOR = 2,69$ ; 95 % CI: 1,00–7,20), короткий межродовой интервал ( $<2$  лет;  $AOR = 2,68$ ; 95 % CI: 1,00–7,20) и смена партнера ( $AOR = 2,80$ ; 95 % CI: 1,10–7,15). Больница общего профиля Джахун аккумулировала 56,2 % всех случаев. Заключение. Преэклампсия в Северной Нигерии следует различными паритет-специфическими путями, что требует дифференцированных стратегий антенатального скрининга и перераспределения ресурсов.

**Ключевые слова:** преэклампсия; паритет; социально-экономические факторы; нутритивный статус; анемия; Северная Нигерия

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## Introduction

Preeclampsia is the most common and clinically severe form of hypertensive disorder of pregnancy. It is a poorly understood multi-system syndrome that can affect virtually every organ system and remains one of the leading causes of maternal and perinatal morbidity and mortality worldwide [18, p. 1; 19, p. 1]. According to the World Health Organization, preeclampsia is defined as new-onset hypertension appearing after the 20th week of gestation, characterised by persistent blood pressure  $\geq 140/90$  mm Hg accompanied by proteinuria  $> 0.3$  g per 24 hours or by evidence of acute organ dysfunction [22, p. 4].

Hypertensive disorders of pregnancy constitute the second leading global cause of maternal death and account for approximately 14 % of all maternal deaths [5, p. 2]. In sub-Saharan Africa the contribution rises to 16 %, while country-specific estimates for Ethiopia reach 16.9 % [2, p. 1; 10, p. 584]. Within

this group, preeclampsia and eclampsia exert the greatest impact on both maternal and perinatal outcomes [3, p. 342; 8, p. 2]. Globally the prevalence of preeclampsia is estimated at 4.6 %; in developing countries the figure ranges from 1.8 % to 16.7 % [2, p. 1]. In Nigeria the burden is particularly heavy in the northern geopolitical zones, where structural poverty, limited antenatal coverage and cultural barriers converge [1, p.14; 10, p. 585].

Preeclampsia produces a wide spectrum of adverse outcomes for mother and infant. These include increased rates of caesarean delivery, prolonged hospital stays, postpartum haemorrhage, HELLP syndrome, placental abruption, heart failure, perinatal death, preterm birth, low birth weight, birth asphyxia, neonatal intensive-care admission and stillbirth [6, p. 6; 18, p. 2]. Although overall maternal mortality has declined in many low-income countries over the past two decades, deaths attributable to pregnancy-induced hypertension continue to rise in several settings, including parts of Nigeria [10, p. 584].

Despite decades of intensive research, the precise etiology and pathogenesis of preeclampsia remain obscure. There is still no proven primary prevention method applicable across all populations, and the only definitive treatment is timely delivery of the placenta [17, p. 2]. Previous studies have identified nulliparity, personal history of preeclampsia, family history of hypertension, multiple pregnancy, alcohol consumption, extreme maternal age, diabetes and severe anemia as associated factors [2, p. 1; 3, p. 342; 8, p. 2]. Other investigations, however, have produced contradictory findings regarding the same variables, underscoring the need for context-specific research [16, p. 4171; 14, p. 7].

Maternal parity is one of the most consistently reported modifiers of pre-eclampsia risk. Immunologically, nulliparous women lack prior maternal-fetal immunotolerance; this leads to incomplete spiral-artery remodeling, persistent placental hypoxia and an exaggerated systemic inflammatory response [15, p. 1095]. Multiparous women, by contrast, accumulate vascular stress over successive gestations and become more susceptible to the effects of short interpregnancy intervals, chronic micronutrient depletion and exposure to a new partner's paternal antigens [3, p. 342; 17, p. 2].

Existing maternal-health literature in Nigeria frequently treats parity merely as a binary covariate rather than as a fundamental epidemiological split [10, p. 585]. This methodological limitation is especially problematic in rural Northern Nigeria (Jigawa State). In this region a unique convergence of macro-level stressors - regional poverty exceeding 87 %, antenatal-care coverage of about 53%, and seasonal environmental exposures such as Harmattan dust - interacts with parity-specific biological pathways [1, p. 14; 12, p. 2].

To bridge this critical gap, the present prospective multi-centre case-control study identifies, stratifies and compares the socio-demographic, economic, nutritional and obstetric determinants of preeclampsia between nulliparous and multiparous cohorts within Jigawa State. By unpacking these stratified risk architectures, the study aims to provide an empirical blueprint for targeted, high-utility antenatal screening protocols tailored to resource-limited settings and thereby to contribute to the reduction of preventable maternal deaths.

## **Materials and methods**

### *Study Design and Setting*

This institution-based, prospective case-control study was implemented from July to December 2024 across four specialized public hospitals in Jigawa State, North-Western Nigeria: General Hospital Jahun (rural), Rasheed Shekoni Specialist Teaching Hospital Dutse (urban/suburban), General Hospital Dutse (regional) and Buji (suburban). By deploying a prospective design with real-time clinical screening and face-to-face enrollment, the study minimized the recall biases inherent to retrospective medical chart reviews.

### *Participants and Selection Criteria*

Pregnant women presenting to the maternity, antenatal, or labor wards of the participating facilities who had reached a gestational age  $\geq 20$  weeks were eligible for screening.

- **Cases (n = 146):** Diagnosed strictly in accordance with WHO and international consensus guidelines. Criteria required new-onset hypertension (systolic blood pressure  $\geq 140$  mm Hg and/or diastolic blood pressure  $\geq 90$  mm Hg recorded on two separate occasions at least 4 hours apart) occurring after 20 weeks of gestation, accompanied by proteinuria ( $\geq 300$  mg per 24-hour urine collection or a dipstick reading  $\geq +1$ ).
- **Controls (n = 249):** Comprised normotensive pregnant women matching the gestational age of the cases within a window of  $\pm 2$  weeks, recruited from the same clinical sites during the concurrent study time-frame.

*Exclusion Criteria:* Patients presenting with confirmed pre-existing chronic hypertension, missing or highly fragmented clinical charts, or those who declined to provide written or witnessed informed consent were excluded from the study.

### *Data Collection and Quality Control*

Primary data collection was facilitated by a structured, 45-item multidimensional questionnaire covering socio-demographic profiles, monthly household

income, dietary and nutritional metrics (including Mid-Upper Arm Circumference [MUAC], maternal hemoglobin levels, and pre-pregnancy/intra-pregnancy consumption habits), and detailed obstetric and medical histories. The tool was forward- and backward-translated into Hausa, locally pre-tested, and validated, demonstrating a high internal consistency. The tool was administered face-to-face in private interview spaces by 10 certified, native Hausa-speaking midwives over 20–30-minute sessions. Self-reported survey data were paired with biological metrics (serial blood pressure measurements, dipstick urinalysis, and automated hemoglobin counts) extracted directly from real-time hospital charts. Quality control protocols included double-blind data entry into SPSS, as shown in Figure 1 below.

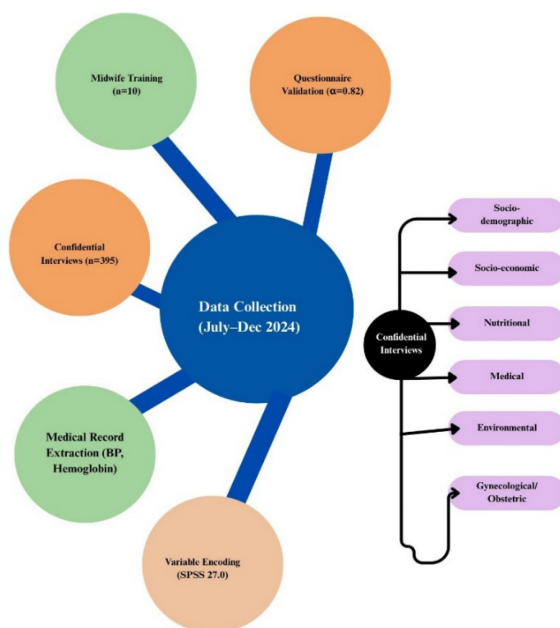


**Fig. 1.** Data Collection Scheme

### *Statistical Analysis*

Statistical processing was conducted using SPSS version 27.0. Missing values (< 5%) were resolved utilizing multiple imputation algorithms. Descriptive statistics summarized maternal age distributions through means, standard deviations ( $\pm$ SD), and medians. Bivariate cross-tabulations were evaluated using

Pearson’s Chi-square ( $\chi^2$ ) test or Fisher’s exact test where cell frequencies fell below threshold values. Multivariate binary logistic regression models were constructed independently for the nulliparous and multiparous strata using a manual purposeful selection approach. Variables demonstrating a bivariate significance level of  $P < 0.20$  were entered into the models. Known epidemiological confounders (such as maternal age and urban/rural residence) were retained across all models to ensure stability. All statistical evaluations were two-sided, with significance established at  $P < 0.05$ .

Results and discussion

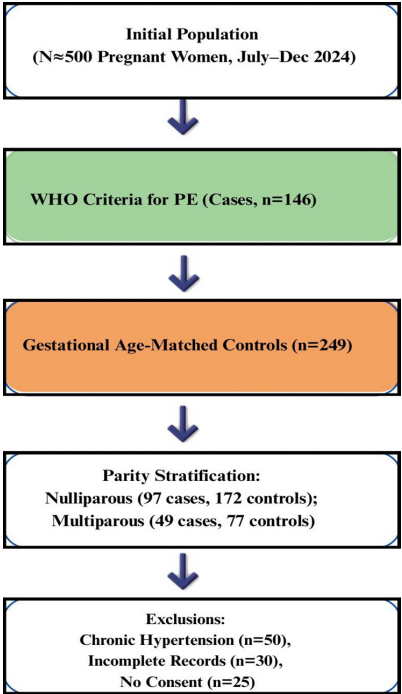


Fig. 2. Selection of Study Participants

As shown in figure 2, a total of 395 pregnant women completed the study protocol (146 preeclampsia cases, 37.0 %; 249 normotensive controls, 63.0 %). Mean gestational age at enrollment did not differ significantly between cases and controls ( $28.4 \pm 4.2$  weeks versus  $28.1 \pm 4.1$  weeks;  $P = 0.62$ ).

*Socio-demographic and socio-economic characteristics of the nulliparous cohort*

The comprehensive mapping of socio-demographic and economic profiles across both parity groups is detailed in Table 1.

In the nulliparous cohort (N = 269) the maternal age distribution was markedly skewed toward younger ages (mean  $22.83 \pm 4.23$  years; median 22 years; range 15–44 years). First-time mothers who developed preeclampsia were significantly younger than their normotensive counterparts: 33.0 % of cases were aged less than 20 years compared with only 14.5 % of controls (P < 0.001). After multivariable adjustment that controlled for location, education, income and other covariates, an absolute lack of formal education emerged as the strongest structural predictor, elevating the odds of preeclampsia by nearly nine-fold (AOR = 8.92; 95 % CI: 1.66–47.96; P = 0.012). Extreme household poverty (monthly income < ₸70 000) independently quadrupled the risk (AOR = 3.94; 95 % CI: 1.65–9.40; P = 0.002). Rural residence showed a strong crude association that attenuated after adjustment, suggesting that the effect of location operates largely through education and income pathways.

*Socio-demographic and socio-economic characteristics of the multiparous cohort*

In the multiparous cohort (N = 126) the age distribution shifted upward (mean  $30.87 \pm 5.57$  years). Extreme poverty lost independent statistical significance after adjustment (AOR = 0.51; 95 % CI: 0.12–2.23; P = 0.372). In contrast, higher education functioned as a robust protective factor, reducing the odds of preeclampsia by 76 % (AOR = 0.24; 95 % CI: 0.07–0.77; P = 0.016). This divergence indicates that once a woman has accumulated reproductive experience, educational attainment continues to exert a protective effect, whereas absolute poverty becomes less decisive.

Table 1.

**Socio-Demographic and Socio-Economic Risk Factors Stratified by Parity**

| Variable / Category | Nulliparous Cases (n=97) % | Nulliparous Controls (n=172) % | Nulliparous AOR (95% CI) | P-value | Multiparous Cases (n=49) % | Multiparous Controls (n=81) % | Multiparous AOR (95% CI) | P-value |
|---------------------|----------------------------|--------------------------------|--------------------------|---------|----------------------------|-------------------------------|--------------------------|---------|
| <b>Age Group</b>    |                            |                                |                          |         |                            |                               |                          |         |
| < 20 years          | 32 (33.0%)                 | 25 (14.5%)                     | 0.11 (0.01–1.60)         | 0.103   | 0 (0.0%)                   | 0 (0.0%)                      | —                        | —       |
| 20–34 years         | 63 (64.9%)                 | 146 (84.9%)                    | 0.09 (0.01–1.15)         | 0.063   | 33 (67.3%)                 | 67 (82.7%)                    | 0.42 (0.15–1.20)         | 0.105   |
| ≥ 35 years          | 2 (2.1%)                   | 1 (0.6%)                       | 1.00 [Ref]               | —       | 16 (32.7%)                 | 14 (17.3%)                    | 1.00 [Ref]               | —       |

| Location / Residence        |               |                |                                    |              |               |            |                                   |              |
|-----------------------------|---------------|----------------|------------------------------------|--------------|---------------|------------|-----------------------------------|--------------|
| Rural                       | 57<br>(58.8%) | 62 (36.0%)     | 0.62<br>(0.21–1.77)                | 0.357        | 25<br>(51.0%) | 24 (29.6%) | 1.31<br>(0.26–6.53)               | 0.745        |
| Urban                       | 40<br>(41.2%) | 110<br>(64.0%) | 1.00 [Ref]                         | —            | 24<br>(49.0%) | 57 (70.4%) | 1.00 [Ref]                        | —            |
| Educational Status          |               |                |                                    |              |               |            |                                   |              |
| Educated                    | 38<br>(39.2%) | 115<br>(66.9%) | 2.33<br>(0.65–8.33)                | 0.198        | 27<br>(55.1%) | 62 (76.5%) | 0.26<br>(0.04–2.01)               | 0.198        |
| Uneducated                  | 59<br>(60.8%) | 57 (33.1%)     | 1.00 [Ref]                         | —            | 22<br>(44.9%) | 19 (23.5%) | 1.00 [Ref]                        | —            |
| Level of Education          |               |                |                                    |              |               |            |                                   |              |
| Higher Education            | 8 (8.2%)      | 42 (24.4%)     | 0.53<br>(0.18–1.55)                | 0.256        | 10<br>(20.4%) | 39 (48.1%) | <b>0.24</b><br><b>(0.07–0.77)</b> | <b>0.016</b> |
| None (No Education)         | 46<br>(47.4%) | 30 (17.4%)     | <b>8.92</b><br><b>(1.66–47.96)</b> | <b>0.012</b> | 10<br>(20.4%) | 14 (17.3%) | 0.39<br>(0.04–3.84)               | 0.416        |
| Primary                     | 20<br>(20.6%) | 35 (20.3%)     | 2.50<br>(0.60–10.48)               | 0.215        | 14<br>(28.6%) | 7 (8.6%)   | 1.96<br>(0.25–15.31)              | 0.520        |
| Secondary                   | 23<br>(23.7%) | 65 (37.8%)     | 1.00 [Ref]                         | —            | 15<br>(30.6%) | 21 (25.9%) | 1.00 [Ref]                        | —            |
| Monthly Income              |               |                |                                    |              |               |            |                                   |              |
| < ₮70,000                   | 78<br>(80.4%) | 80 (46.5%)     | <b>3.94</b><br><b>(1.65–9.40)</b>  | <b>0.002</b> | 25<br>(51.0%) | 28 (34.6%) | 0.51<br>(0.12–2.23)               | 0.372        |
| ₮160,000–<br>₮250,000       | 4 (4.1%)      | 9 (5.2%)       | 3.46<br>(0.84–14.22)               | 0.862        | 5 (10.2%)     | 17 (21.0%) | 0.58<br>(0.15–2.21)               | 0.422        |
| ₮80,000–<br>₮150,000        | 15<br>(15.5%) | 83 (48.3%)     | 1.00 [Ref]                         | —            | 19<br>(38.8%) | 36 (44.4%) | 1.00 [Ref]                        | —            |
| Maternal Occupation         |               |                |                                    |              |               |            |                                   |              |
| Housewife                   | 88<br>(90.7%) | 144<br>(83.7%) | —                                  | —            | 43<br>(87.8%) | 65 (80.2%) | —                                 | —            |
| Employee / Trader / Student | 9 (9.3%)      | 28 (16.3%)     | —                                  | —            | 6 (12.2%)     | 16 (19.8%) | —                                 | —            |

Note: Bold *p*-values indicate statistically significant associations ( $P < 0.05$ ).

*Nutritional indicators*

The systematic breakdown of micro-nutritional indicators and consumption habits is shown in Table 2.

Among nulliparous women, baseline cross-tabulations revealed pronounced nutritional vulnerability: 56.7 % of preeclamptic cases exhibited mid-upper-arm circumference (MUAC) < 23 cm compared with 32.0 % of controls ( $P < 0.001$ ). After adjustment for household wealth the association attenuated (AOR = 1.48; 95 % CI: 0.73–3.02), suggesting that acute wasting is largely a marker of underlying poverty. Conversely, MUAC  $\geq$  28 cm remained independently associated with elevated odds (AOR = 7.92; 95 % CI: 2.57–24.39;  $P < 0.001$ ).

Frequent pre-pregnancy coffee consumption demonstrated a striking protective effect (AOR = 0.12; 95 % CI: 0.03–0.57;  $P = 0.007$ ). Women who reported drinking coffee only rarely or never had substantially higher odds of developing preeclampsia.

Among multiparous women nutritional depletion manifested principally as clinical anemia. A hemoglobin concentration below 11 g/dL nearly tripled the risk of preeclampsia (AOR = 2.69; 95 % CI: 1.00–7.20;  $P = 0.049$ ), underscoring the cumulative effect of successive pregnancies on iron stores.

Table 2.

**Nutritional Indicators and Dietary Intake Factors Stratified by Parity**

| Variable / Category         | Nulliparous Cases (n=97) % | Nulliparous Controls (n=172) % | Nulliparous AOR (95% CI) | P-value      | Multiparous Cases (n=49) % | Multiparous Controls (n=81) % | Multiparous AOR (95% CI) | P-value |
|-----------------------------|----------------------------|--------------------------------|--------------------------|--------------|----------------------------|-------------------------------|--------------------------|---------|
| <b>MUAC Metric</b>          |                            |                                |                          |              |                            |                               |                          |         |
| < 23 cm (Wasting)           | 55 (56.7%)                 | 55 (32.0%)                     | 1.48 (0.73–3.02)         | 0.279        | 16 (32.7%)                 | 15 (18.5%)                    | 0.89 (0.23–3.34)         | 0.857   |
| $\geq$ 28 cm (Overweight)   | 15 (15.5%)                 | 16 (9.3%)                      | 7.92 (2.57–24.39)        | <0.001       | 8 (16.3%)                  | 17 (21.0%)                    | 1.12 (0.29–4.29)         | 0.870   |
| 23–28 cm                    | 27 (27.8%)                 | 101 (58.7%)                    | 1.00 [Ref]               | —            | 25 (51.0%)                 | 49 (60.5%)                    | 1.00 [Ref]               | —       |
| <b>Pre-Pregnancy Coffee</b> |                            |                                |                          |              |                            |                               |                          |         |
| Often Drink Lots            | 3 (3.1%)                   | 20 (11.6%)                     | <b>0.12 (0.03–0.57)</b>  | <b>0.007</b> | 2 (4.1%)                   | 5 (6.2%)                      | 1.25 (0.13–12.08)        | 0.849   |

|                               |               |             |                                   |              |               |            |                                   |              |
|-------------------------------|---------------|-------------|-----------------------------------|--------------|---------------|------------|-----------------------------------|--------------|
| Very Rarely (Holidays)        | 17<br>(17.5%) | 59 (34.3%)  | <b>0.44</b><br><b>(0.21–0.93)</b> | <b>0.032</b> | 20<br>(40.8%) | 37 (45.7%) | 1.19<br>(0.37–3.85)               | 0.766        |
| Never                         | 77<br>(79.4%) | 93 (54.1%)  | 1.00 [Ref]                        | —            | 27<br>(55.1%) | 39 (48.1%) | 1.00<br>[Ref]                     | —            |
| <b>Hemoglobin Count</b>       |               |             |                                   |              |               |            |                                   |              |
| < 11 g/dL (Anemia)            | 51<br>(52.6%) | 51 (29.7%)  | 1.47<br>(0.74–2.90)               | 0.272        | 26<br>(53.1%) | 21 (25.9%) | <b>2.69</b><br><b>(1.00–7.20)</b> | <b>0.049</b> |
| ≥ 11 g/dL                     | 46<br>(47.4%) | 121 (70.3%) | 1.00 [Ref]                        | —            | 23<br>(46.9%) | 60 (74.1%) | 1.00<br>[Ref]                     | —            |
| <b>Ferrous Sulfate Use</b>    |               |             |                                   |              |               |            |                                   |              |
| No                            | 13<br>(13.4%) | 5 (2.9%)    | 1.45<br>(0.36–5.86)               | 0.603        | 2 (4.1%)      | 3 (3.7%)   | Trend Only                        | 0.998        |
| Yes                           | 84<br>(86.6%) | 167 (97.1%) | 1.00 [Ref]                        | —            | 47<br>(95.9%) | 78 (96.3%) | 1.00<br>[Ref]                     | —            |
| <b>Nutritional Counseling</b> |               |             |                                   |              |               |            |                                   |              |
| No                            | 20<br>(20.6%) | 8 (4.7%)    | 2.06<br>(0.64–6.63)               | 0.228        | 4 (8.2%)      | 2 (2.5%)   | Trend Only                        | 0.998        |
| Yes                           | 77<br>(79.4%) | 164 (95.3%) | 1.00 [Ref]                        | —            | 45<br>(91.8%) | 79 (97.5%) | 1.00<br>[Ref]                     | —            |

Note: Bold *p*-values indicate  $P < 0.05$ .

### *Medical comorbidities and obstetric risk vectors*

The distribution of biological comorbidities, contraceptive histories, and mechanical pregnancy stressors is presented in Table 3.

Active infections heavily complicated maternal paths. Active urinary tract infections (UTIs) during pregnancy were associated with preeclampsia among first-time mothers (26.0% in cases vs. 10.1% in controls,  $P = 0.001$ ). Among multiparous individuals, the presence of documented non-hypertensive illnesses during the current pregnancy served as a strong independent risk factor (AOR = 4.92; 95% CI: 1.49–16.18;  $P = 0.009$ ). Obstetric stressors in multiparous women were primarily driven by mechanical and immunological challenges. A short interpregnancy interval of less than 2 years significantly increased vulnerability (AOR = 2.68; 95% CI: 1.00–7.20;  $P = 0.049$ ). Crucially, a change of partner/spouse for the current pregnancy doubled the odds of developing preeclampsia within this cohort (AOR = 2.80; 95% CI: 1.10–7.15;  $P = 0.032$ ). Twin gestations were also more frequent among multiparous cases than controls (26.5% vs. 13.0%,  $P = 0.02$ ).

Table 3.

**Medical Comorbidities and Gynecological/Obstetric Risk Vectors  
Stratified by Parity**

| Variable / Category          | Nulliparous Cases (n=97) % | Nulliparous Controls (n=172) % | Nulliparous AOR (95% CI)   | P-value      | Multiparous Cases (n=49) % | Multiparous Controls (n=81) % | Multiparous AOR (95% CI) | P-value      |
|------------------------------|----------------------------|--------------------------------|----------------------------|--------------|----------------------------|-------------------------------|--------------------------|--------------|
| <b>Pregnancy Illnesses</b>   |                            |                                |                            |              |                            |                               |                          |              |
| Urinary Tract Infection      | 25 (26.0%)                 | 17 (10.1%)                     | Bivariate Assoc.           | 0.001        | 14 (29.8%)                 | 12 (14.8%)                    | —                        | —            |
| Gestational Hypertension     | 61 (63.5%)                 | 32 (18.9%)                     | —                          | —            | 21 (44.7%)                 | 11 (13.6%)                    | —                        | —            |
| Documented Others            | 96 (99.0%)                 | 119 (69.2%)                    | <b>21.82 (2.93–162.73)</b> | <b>0.003</b> | 45 (91.8%)                 | 50 (61.7%)                    | <b>4.92 (1.49–16.18)</b> | <b>0.009</b> |
| No Active Illness            | 1 (1.0%)                   | 53 (30.8%)                     | 1.00 [Ref]                 | —            | 4 (8.2%)                   | 31 (38.3%)                    | 1.00 [Ref]               | —            |
| <b>Interpregnancy Space</b>  |                            |                                |                            |              |                            |                               |                          |              |
| Short Space (< 2 years)      | 0 (0.0%)                   | 2 (1.2%)                       | —                          | —            | 25 (51.0%)                 | 29 (35.8%)                    | <b>2.68 (1.00–7.20)</b>  | <b>0.049</b> |
| Long Space (≥ 2 years)       | 1 (1.0%)                   | 1 (0.6%)                       | —                          | —            | 13 (26.5%)                 | 37 (45.7%)                    | 1.00 [Ref]               | —            |
| New Primigravida Strata      | 90 (92.8%)                 | 165 (95.9%)                    | —                          | —            | 5 (10.2%)                  | 4 (4.9%)                      | —                        | —            |
| <b>Change of Partner</b>     |                            |                                |                            |              |                            |                               |                          |              |
| Yes                          | 9 (9.3%)                   | 10 (5.8%)                      | —                          | —            | 18 (36.7%)                 | 13 (16.0%)                    | <b>2.80 (1.10–7.15)</b>  | <b>0.032</b> |
| No                           | 88 (90.7%)                 | 162 (94.2%)                    | —                          | —            | 31 (63.3%)                 | 68 (84.0%)                    | 1.00 [Ref]               | —            |
| <b>Contraceptive History</b> |                            |                                |                            |              |                            |                               |                          |              |
| Non-User                     | 93 (95.9%)                 | 166 (96.5%)                    | —                          | —            | 31 (63.3%)                 | 49 (60.5%)                    | —                        | —            |
| Hormonal Users               | 4 (4.1%)                   | 6 (3.5%)                       | —                          | —            | 17 (34.7%)                 | 29 (35.8%)                    | —                        | —            |
| <b>Pregnancy Complexity</b>  |                            |                                |                            |              |                            |                               |                          |              |
| Twin Pregnancy               | 6 (6.2%)                   | 2 (1.2%)                       | —                          | —            | 13 (26.5%)                 | 11 (13.6%)                    | Bivariate Assoc.         | 0.020        |
| Single Pregnancy             | 9 (93.8%)                  | 170 (98.8%)                    | —                          | —            | 3 (73.5%)                  | 67 (86.4%)                    | 1.00 [Ref]               | —            |

Note: Bold p-values indicate variables that retained independent multivariate significance ( $P < 0.05$ ).

*Institutional distribution of cases*

General Hospital Jahun functioned as the principal institutional hub for critical hypertensive disease, handling 82 of the 146 recorded preeclampsia cases (56.2 %). Rasheed Shekoni Teaching Hospital and General Hospital Dutse accounted for 29.5 % and 12.3 % of cases respectively while Buji hospital recorded 2%. This marked geographic concentration highlights the referral role of Jahun and the consequent need for targeted resource allocation as detailed in Table 4 and Figure 3.

*Table 4.*

**Institutional Distribution of Preeclampsia Cases across Jigawa State Hospitals**

| Reporting Hospital Facility       | Preeclampsia Yes (n) | Preeclampsia No (n) | Total Institutional Sample (N) | Institutional Case Share (%) |
|-----------------------------------|----------------------|---------------------|--------------------------------|------------------------------|
| General Hospital Jahun            | 82                   | 36                  | 118                            | 56.2%                        |
| Rasheed Shekoni Teaching Hospital | 43                   | 134                 | 177                            | 29.5%                        |
| General Hospital Dutse            | 18                   | 79                  | 97                             | 12.3%                        |
| General Hospital Buji             | 3                    | 0                   | 3                              | 2.0%                         |
| Total Cohort Foot-print           | 146                  | 249                 | 395                            | 100.0%                       |

By analyzing first-time mothers and women who have given birth before separately, this study reveals that their risks for preeclampsia are markedly different. Standard analyses often hide this difference by grouping all women together. [8, p. 2]. The data demonstrate that preeclampsia in this resource-limited setting follows two largely separate pathways: socio-economic structural barriers among nulliparous women and cumulative biological and obstetric stressors among multiparous women.

The nearly nine-fold increase in odds associated with complete absence of formal education among nulliparous women (AOR = 8.92) illustrates how social inequities amplify biological vulnerability [20, p. 613]. In the cultural context of rural Jigawa State an uneducated first-time mother confronts multiple interlocking barriers: low medical literacy, limited autonomy over household financial decisions, and reduced recognition of early warning signs of pregnancy complications. These obstacles are further compounded by extreme household poverty, which erects direct financial barriers to transportation and facility fees and thereby severs young women from early clinical contact during the critical first trimester.

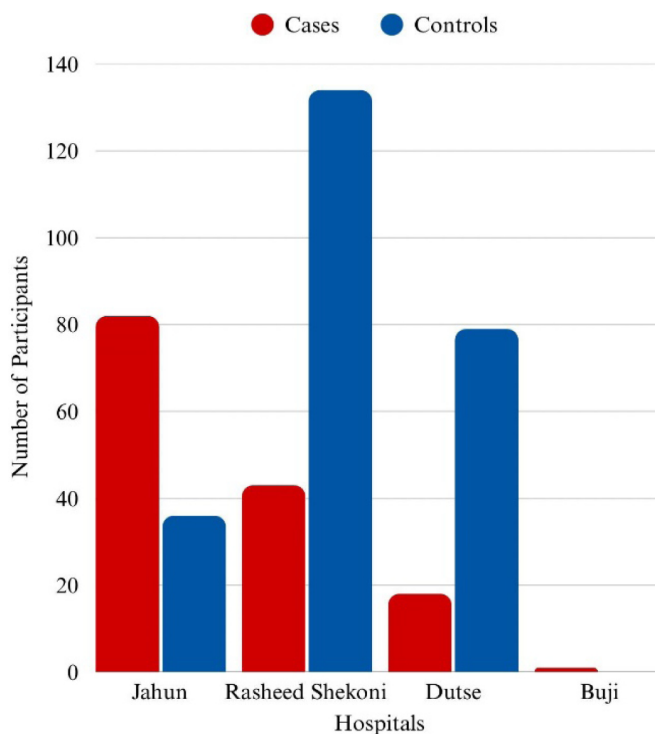


**Fig. 3.** Distribution of Cases

In the multiparous cohort the protective effect of higher education (AOR = 0.24) confirms that improved social position can still mitigate risk even among women with longer reproductive careers. Nevertheless, the dominant drivers shifted decisively toward biological depletion. Maternal anemia (AOR = 2.69) and short interpregnancy intervals (AOR = 2.68) reflect a pattern of progressive physical exhaustion commonly observed in high-fertility regions: successive closely spaced pregnancies leave insufficient time for replenishment of iron stores and full recovery of the maternal vascular endothelium [3, p. 342; 5, p. 2].

The independent association of partner change with multiparous preeclampsia (AOR = 2.80) supplies real-world epidemiological support for the paternity (immunogenetic) hypothesis first articulated by Dekker [4, p. 204]. Exposure to unfamiliar paternal HLA antigens effectively resets a multiparous woman's

immunological risk profile to a nulliparous-like state, thereby recreating the immune maladaptation that characterises first pregnancies.

The protective effect of pre-pregnancy coffee consumption among nulliparous women (AOR = 0.12) is a fascinating and novel finding for this region. While Western studies often caution against high caffeine intake due to potential vasoconstrictive effects, low-to-moderate caffeine consumption has not been consistently linked with a heightened risk of pre-eclampsia [9, p. 1818]. Coffee consumption in Northern Nigeria may serve as a marker for specific local dietary habits or better socio-economic conditions. It is also possible that regular coffee drinkers benefit from the rich mix of natural antioxidants and anti-inflammatory compounds found in the beverage, which may help protect endothelial health. However, this finding should be interpreted with caution. It requires further exploration to rule out residual confounding factors before any changes to clinical dietary advice are considered.

Finally, the concentration of 56.2 % of all diagnosed cases at General Hospital Jahun reveals a major institutional hotspot. This concentration is not random; it indicates that the facility functions as a critical regional referral hub, drawing the most severe obstetric emergencies from a vast underserved rural catchment area [8, p. 2]. The observation underscores the urgent need to reallocate maternal-health resources so that frontline referral centres receive targeted funding, specialised staffing and adequate stocks of anti-hypertensive and magnesium-sulphate supplies.

### **Conclusion**

Preeclampsia in Northern Nigeria does not operate as a single, uniform disease entity. It follows distinct, parity-specific pathways. First-time mothers are primarily endangered by severe socio-economic barriers and lack of formal education, whereas multiparous women are threatened by systemic physical depletion, maternal anemia, closely spaced pregnancies and partner change. Resource-limited health systems must therefore pivot toward tailored antenatal screening strategies. For nulliparous women, community-level education programmes and early identification of young, financially vulnerable mothers should be prioritised. For multiparous women, clinical protocols must emphasise detailed obstetric histories, systematic screening for iron-deficiency anemia, and family-planning counselling that supports healthy interpregnancy intervals of at least two years.

Implementation of these risk-stratified interventions, together with strengthened capacity at high-burden referral centres such as General Hospital Jahun,

has the potential to reduce preventable maternal deaths substantially and to advance Sustainable Development Goal 3 across sub-Saharan Africa.

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