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# Proximate Determinants of Fertility among Women of Reproductive Age in Gombe State, Nigeria: Evidence from Negative Binomial Regression

**A. U. Shelleng[1*] and H. U. Bello[1], M. A Kolo[2] and M. N. Mohammed[3]**

[1]Department of Statistics, Gombe State University, Gombe, Nigeria

[2]National Mathematical Centre, Abuja, Nigeria

[3]Department of Disaster Management, NARSDA, Gombe, Nigeria

*Correspondence: umssie@gmail.com

**Abstract**

High fertility remains a persistent demographic and public health challenge in Northern Nigeria, with Gombe State recording approximately 5.5 children per woman, according to recent data from the Nigeria Demographic and Health Survey (NDHS, 2024) and health reports. This rate remains higher than the national average of approximately 4.8 children per woman. While socio-economic factors are widely studied, less empirical attention has been given to proximate determinants that directly regulate biological exposure to pregnancy. This study examines the influence of proximate determinants of fertility among women of reproductive age in Gombe State, Nigeria. A cross-sectional hospital-based survey of 576 women aged 15–49 years was conducted across all eleven Local Government Areas (LGAs). Fertility was measured as children ever born (CEB) and modelled using Negative Binomial regression to account for over-dispersed count data. Key proximate determinants examined included contraceptive use, age at first marriage, breastfeeding duration proxy, child mortality experience, and birth spacing behaviour. Results indicate that modern contraceptive use significantly reduced fertility (IRR < 1, $p < 0.001$), while early age at first marriage and experience of child death significantly increased fertility ($p < 0.05$). Women with shorter birth intervals also exhibited significantly higher fertility levels. These findings confirm that biological and behavioural mechanisms operate alongside socio-cultural influences to sustain high fertility in Gombe State. The study concludes that fertility reduction strategies must prioritise delayed marriage and consistent access to modern contraception. Strengthening community-based reproductive health education and postpartum family planning services is critical for accelerating fertility transition in high-burden northern states.

**Keywords:** Fertility, Proximate determinants, Negative Binomial regression, Contraceptive use.

## 1. Introduction

Nigeria continues to face significant challenges in achieving Sustainable Development Goal (SDG) 3.7, which targets universal access to sexual and reproductive health services by 2030 (United Nations, 2024). Fertility levels remain particularly high in Northern Nigeria, where early marriage, limited contraceptive uptake, and high child mortality persist (NPC & ICF, 2019). Nigeria's na-

tional average total fertility rate is approximately 4.8 children per woman, according to the Nigeria Demographic and Health Survey 2024. Demographic theory distinguishes between underlying socio-economic determinants and proximate determinants that directly regulate exposure to conception (Bongaarts, 1978). Proximate determinants include marriage patterns, contraceptive use, postpartum infecundability, abortion, and sterility. These factors translate social conditions into biological outcomes. While socio-economic drivers are well documented, understanding proximate determinants is crucial because policy interventions often operate through these mechanisms.

Previous studies in Nigeria emphasise education, wealth, and urbanisation as fertility predictors (Adewole *et al*, 2018; Oritogun *et al.,* 2023). However, fertility decline ultimately depends on behavioural factors such as contraceptive adoption, delayed marriage, and birth spacing. In high-fertility contexts, child mortality further sustains reproductive replacement behaviour (Bongaarts & Casterline, 2018). Despite their importance, proximate determinants are often insufficiently modelled in state-level fertility studies.

This study therefore focuses specifically on proximate determinants of fertility among women in Gombe State. By isolating biological and behavioural pathways, the study provides actionable evidence for reproductive health programming beyond structural socio-economic reforms.

*1.1 Theoretical Framework*

From an academic perspective, the study contributes to the growing literature on family environment and adolescent development by employing quantitative statistical techniques, including descriptive statistics, Pearson correlation analysis, and regression analysis, to examine the relationships between parental support and multiple dimensions of personality development. The findings may also serve as a valuable reference for future researchers interested in family studies, developmental psychology, education, public health, and applied statistics.

The theoretical framework for this study is based on the Proximate Determinants of Fertility Framework developed by Davis and Blake (1956) and further refined by Bongaarts (1978, 1982). The framework proposes that fertility is determined through a set of immediate biological and behavioural mechanisms that connect broader socioeconomic and cultural conditions to reproductive outcomes. In this study, five variables are used to represent important pathways to fertility: contraceptive use, age at first marriage, birth-spacing behaviour, child mortality experience, and breastfeeding duration. Contraceptive use directly reduces the probability of conception, while age at first marriage determines the length of reproductive exposure. Birth spacing reflects the timing of successive births, breastfeeding delays the return of fecundity after childbirth, and child mortality may influence subsequent fertility through replacement or insurance behaviour. These mechanisms are particularly relevant to Northern Nigeria, where early marriage, relatively high fertility, breastfeeding practices, variations in contraceptive use, and concerns about child survival may jointly shape reproductive behaviour.

The first pathway is through contraceptive use, measured as Yes/No. Contraception reduces the probability that sexual exposure will result in conception and therefore is expected to have a negative relationship with fertility. Thus, women who use contraception are theoretically expected to experience fewer pregnancies and consequently lower fertility than women who do not use contraception (Bongaarts, 1978, 1982).

The second pathway is age at first marriage. Earlier marriage increases the number of years during which a woman is exposed to the possibility of pregnancy and therefore creates greater opportunities for childbearing. The pathway is accordingly: Early marriage → longer reproductive exposure → greater opportunity for conception → higher fertility. Conversely, later marriage shortens reproductive exposure and is expected to reduce fertility. This pathway is especially relevant in Northern Nigeria because marriage occurs relatively early in many populations, making the timing of marriage an important determinant of cumulative fertility.

The third pathway is birth-spacing behaviour, represented in this study by reported intervals between births. Longer birth intervals reduce the number of pregnancies that can occur during a

woman's reproductive life, whereas shorter intervals increase the potential number of births. Birth spacing is therefore expected to have an inverse relationship with fertility. Thus, reported birth intervals provide an important measure of how proximate determinants translate into the timing and accumulation of births.

The fourth pathway operates through breastfeeding duration. Prolonged breastfeeding can delay the return of ovulation and menstruation following childbirth, thereby increasing the interval before the next conception. The pathway can be summarised as longer breastfeeding → prolonged postpartum infecundability → delayed conception → longer birth interval → lower fertility. This mechanism is particularly relevant to Northern Nigeria because breastfeeding has traditionally played an important role in child care and birth spacing.

The fifth pathway concerns child mortality experience, measured as Yes/No. Unlike contraception, marriage and breastfeeding, child mortality is not one of the four original proximate determinants identified by Bongaarts. In this framework, it is treated as a fertility-response mechanism. The death of a child may encourage parents to have another child to replace the lost child or to compensate for uncertainty about child survival. This is commonly described through the replacement and insurance hypotheses. The pathway is therefore child mortality → reduced number of surviving children → replacement/insurance response → additional births → higher subsequent fertility. This mechanism may be particularly important in areas where child mortality remains a concern, including parts of Northern Nigeria.

Overall, the framework proposes that fertility in Northern Nigeria is the result of the combined and interacting effects of these proximate pathways. Early marriage increases reproductive exposure, contraceptive use reduces the probability of conception, longer birth intervals reduce the number of possible births, prolonged breastfeeding delays subsequent conception, while child mortality may stimulate additional childbearing. These relationships operate within a broader socioeconomic and cultural environment involving education, wealth, religion, residence, gender norms and access to reproductive-health services. The framework therefore provides a theoretical basis for examining how the selected proximate determinants contribute to fertility differentials among women in Northern Nigeria.

## 2. Materials and Methods

### *2.1. Study Design and Population*

A cross-sectional hospital-based survey was conducted among 576 women aged 15–49 years in Gombe State, Nigeria. The state comprises eleven LGAs with diverse socio-cultural and ecological characteristics. The target population were women who attended outpatient or reproductive health clinics in the selected hospitals during the data collection window in 2025.

### *2.2. Sampling Procedure and Sample Size*

A multistage sampling approach was employed. Health facilities per LGA were purposively selected to ensure geographic representation. Systematic random sampling was applied using clinic attendance registers. Sample size was calculated using Cochran's formula with finite population correction and a design effect of 1.5, yielding a final sample of 576 respondents, proportionally allocated across LGAs based on population projections.

### *2.3. Data Collection Instrument*

Data were collected using a structured interviewer-administered questionnaire deployed via KoboToolbox on GPS-enabled mobile devices. The instrument was validated by subject experts and pilot-tested (n = 30), achieving Cronbach's alpha ≥ 0.70. Data captured fertility history, marital characteristics, contraceptive use, child survival experience, and breastfeeding practices.

*2.4. Method of Data Analysis*

The 576 respondents were selected and distributed proportionally across the 11 Local Government Areas (LGAs) based on the population size of each area. This approach was used to ensure that all areas were fairly represented and that comparisons across LGAs would be meaningful. Table 1 presents the population distribution alongside the corresponding sample size allocated to each LGA.

**Table 1.** Proportional Sample Distribution by LGAs

| LGA | Population | % of Total | Sample Size |
|---|---|---|---|
| AKKO | 619,785 | 14.27% | 82 |
| BALANGA | 388,455 | 8.94% | 52 |
| BILLIRI | 372,273 | 8.57% | 49 |
| DUKKU | 381,417 | 8.78% | 51 |
| FUNAKAYE | 436,573 | 10.05% | 58 |
| GOMBE | 490,127 | 11.29% | 65 |
| KALTUNGO | 294,601 | 6.78% | 39 |
| KWAMI | 356,321 | 8.20% | 47 |
| NAFADA | 257,485 | 5.93% | 34 |
| SHONGOM | 277,254 | 6.39% | 37 |
| YAMALTU/DEBA | 469,706 | 10.82% | 62 |
| TOTAL | 4,343,997 | 100% | 576 |

*Source: Gombe State Population Projection (2025) and Field Survey (2025)*

*2.5. Variables*

a. **Outcome Variable:**
Children Ever Born (CEB), treated as count data.

b. **Key Proximate Determinants:**
- Contraceptive use (Yes/No)
- Age at first marriage
- Birth spacing behaviour (proxy via reported intervals)
- Child mortality experience (Yes/No)
- Breastfeeding duration proxy

2.6. *Statistical Analysis*

Descriptive statistics summarised respondent characteristics. Poisson regression was initially considered but rejected due to significant over-dispersion (variance > mean). Negative Binomial regression was therefore employed using:

$$\log(\mu_i) = \beta_0 + \sum_{k=1}^{p} \beta_k X_{ik} \quad (1)$$

where $\mu_i$ is the expected fertility for individual$i$. Results are presented as Incidence Rate Ratios (IRRs) with 95% confidence intervals. Statistical significance was assessed at $\alpha = 0.05$. Analysis was conducted using R (MASS package).

## 3. Results and Discussions

The mean age of respondents was 30.8 years (SD = 7.5), with a mean CEB of 1.74 (SD = 2.49). Mean age at first marriage was 19.4 years, indicating widespread early marriage. Only 21% of women reported current contraceptive use. Child mortality experience was reported by a notable proportion of respondents, particularly in rural LGAs.

**Table 2**. Descriptive Statistics for study variables

| Variable | Total | Mean | SD | Median | Range | Interpretation |
|---|---|---|---|---|---|---|
| Age (years) | 17,565 | 30.8 | 7.27 | 31 | 15–49 | Majority within prime reproductive years (25–35). |
| Children ever born | 11,320 | 1.7 | 2.79 | 1 | 0–15 | Positively skewed; most women have few children. |
| Household size | 3,000 | 6.6 | 2.73 | 6 | 2–15 | Large family systems are common. |
| Age at first marriage | 1,225 | 19.4 | 2.79 | 19 | 15–29 | Early marriage is prevalent. |
| Breastfeeding duration (months) | 3,914 | 5.2 | 2.02 | 5 | 2–12 | Shorter breastfeeding durations observed. |
| Male family size preference | 3,127 | 5.4 | 1.99 | 5 | 1–11 | Men prefer large families (approximately 5–6 children). |

Table 2 summarises the central tendency and spread of selected continuous variables such as age, number of children ever born, and age at first marriage used in the study.

*3.2. Regression Results*

Negative Binomial regression revealed significant associations between proximate determinants and fertility outcomes.

**Table 3.** Proximate determinants of fertility among women of reproductive age in Gombe State (N = 576).

| Characteristic | IRR | 95% CI | p-value |
|---|---|---|---|
| Age at First Marriage (years) | 0.93 | 0.88 – 0.98 | 0.003** |
| Age at First Sex (years) | 0.98 | 0.80 – 1.20 | 0.900 |
| Age at First Childbirth (years) | 0.99 | 0.81 – 1.19 | 0.900 |
| Birth Interval | | | |
| < 2 years (ref) | 1.00 | – | – |
| > 3 years | 0.76 | 0.56 – 1.05 | 0.091* |
| Contraceptive Use (yes = 1) | 0.35 | 0.25 – 0.50 | 0.001*** |
| Number of Child Deaths | 0.94 | 0.72 – 1.25 | 0.700 |
| Postpartum Abstinence | | | |
| 3 – 6 months (ref) | 1.00 | – | – |
| Above 6 months | 0.90 | 0.63 – 1.28 | 0.500 |
| Less than 3 months | 0.84 | 0.56 – 1.26 | 0.400 |
| Breastfeeding Duration | | | |
| 6 – 12 months (ref) | 1.00 | – | – |
| Above 12 months | 0.88 | 0.61 – 1.25 | 0.500 |
| Less than 6 months | 1.02 | 0.67 – 1.57 | 0.900 |
| Ever Had Abortion | | | |
| No (ref) | 1.00 | – | – |
| Yes | 0.87 | 0.48 – 1.62 | 0.700 |

*Significance: *** p < 0.001, ** p < 0.05, * p < 0.10.*

The results from Table 3 show that age at first marriage is a statistically significant predictor of fertility (IRR = 0.93, 95% CI: 0.88–0.98, p = 0.003). Specifically, each additional one-year increase in age at first marriage is associated with a 7% decrease in the expected number of children ever born, holding all other variables constant. This finding suggests that delaying marriage significantly reduces fertility, likely because it shortens the reproductive period.

Contraceptive use emerged as the strongest predictor of fertility in the model (IRR = 0.35, 95% CI: 0.25–0.50, p < 0.001). Women who reported using contraceptives had an expected number of children ever born that was 65% lower than those who did not use contraceptives, controlling for all other variables. This finding highlights the substantial role of contraceptive use in reducing fertility.

Although age at first sexual intercourse (IRR = 0.98, 95% CI: 0.80–1.20, p = 0.900) and age at first childbirth (IRR = 0.99, 95% CI: 0.81–1.19, p = 0.900) both exhibit negative associations with fertility, neither variable is statistically significant. This indicates that, after adjusting for other reproductive factors, these variables do not independently influence the expected number of children ever born.

Regarding birth interval, women whose birth interval exceeded three years had an expected fertility rate that was 24% lower than those with intervals of less than two years (IRR = 0.76, 95% CI: 0.56–1.05, p = 0.091). Although this relationship is not statistically significant at the 5% level, it is marginally significant at the 10% level, suggesting that longer birth spacing may contribute to lower fertility.

The results indicate that other variables like the number of child deaths, postpartum abstinence, breastfeeding duration, and history of abortion were not significant determinants of fertility among the women studied. Although women with more than six months of postpartum abstinence, longer

breastfeeding duration, or a history of abortion generally exhibited lower expected fertility than their respective reference groups, these differences were not statistically significant ($p > 0.05$). Likewise, neither the number of child deaths nor shorter breastfeeding and postpartum abstinence durations significantly influenced the expected number of children ever born after controlling for other reproductive factors. Overall, these findings suggest that these variables did not have an independent effect on fertility in the study population.

The results support classical demographic theory that fertility transition operates through proximate determinants. Contraceptive use emerged as the strongest fertility-limiting factor, consistent with national evidence from NDHS data (NPC & ICF, 2019) and regional studies in Northern Nigeria (Oritogun *et al*., 2023). Early marriage remains a critical fertility amplifier. Women marrying before age 20 experience longer reproductive exposure and reduced contraceptive negotiation power, reinforcing high fertility trajectories. Child mortality further compounds fertility through both physiological and psychological replacement mechanisms.

The persistence of short birth intervals suggests limited access to postpartum family planning services, especially in rural clinics. This gap undermines maternal health outcomes and accelerates parity progression. Importantly, these findings demonstrate that fertility reduction strategies must prioritise proximate behavioural mechanisms alongside structural socio-economic reforms. Without improving contraceptive continuity, delaying marriage, and reducing child mortality, fertility decline will remain slow even with improvements in education and income.

## 4. Conclusion

This study demonstrates that proximate determinants, particularly contraceptive use, age at first marriage, birth spacing, and child survival, play decisive roles in shaping fertility outcomes in Gombe State. Interventions that focus solely on education and economic development are insufficient without addressing these direct biological pathways. The study thus recommends expanding community-based contraceptive distribution, especially postpartum services; strengthening girl-child retention in secondary education to delay age at first marriage; integrating child survival programs with fertility counselling to reduce replacement behaviour; Promote male involvement in birth spacing decisions to improve contraceptive uptake.

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