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**Individual and Contextual Factors Associated with Skilled Birth
Attendance in Kogi State, Nigeria: Evidence from the 2021 Multiple
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ABSTRACT

Skilled birth attendance (SBA) is a core indicator of progress toward reducing maternal and newborn mortality, yet substantial subnational disparities persist across Nigeria, and evidence specific to Kogi State remains scarce. This study analyzed data on women aged 15–49 years with a live birth in the two years preceding the 2021 Nigeria Multiple Indicator Cluster Survey (MICS6), restricted to the Kogi State subsample ($n = 155$). Survey-weighted prevalence was estimated, and multilevel logistic regression models with a random intercept for PSU were fitted to identify correlates of SBA, with model selection guided by AIC, BIC, and likelihood-ratio comparison; a survey-weighted regression served as a sensitivity check. Weighted SBA prevalence was 73.5% (95% CI: 58.8–84.3%), rising from 52.6% in poorer households to 93.7% in richer households, and higher in urban (93.1%) than rural areas (59.5%). A model containing residence, wealth, and household size (Model 2) provided the best fit (AIC = 175.69, BIC = 193.95). Women in richer households had substantially higher odds of SBA than those in poorer households (adjusted odds ratio [AOR] = 6.14, 95% CI: 1.60–23.48), while rural residence and household size were not independently associated with SBA after adjustment, though the small sample limits precision. Meaningful between-cluster variation was observed (ICC = 0.215, MOR = 2.47), and the sensitivity analysis produced directionally consistent estimates. Household wealth is the dominant correlate of SBA in Kogi State; interventions reducing financial and geographic barriers for poorer and rural households are likely to yield the largest gains in SBA coverage.

Keywords: skilled birth attendance; maternal health; Multiple Indicator Cluster Survey; multilevel logistic regression

1.0 INTRODUCTION

Maternal mortality remains one of the most persistent public health challenges in Nigeria. Estimates derived from the 2018 Nigeria Demographic and Health Survey placed the national maternal mortality ratio at 512 deaths per 100,000 live births, among the highest in the world (Federal Ministry of Health and Social Welfare [FMoHSW], National Population Commission [NPC], & ICF, 2024; Oweibia et al., 2025). More recent cross-country comparisons continue to rank Nigeria as the country with the highest absolute burden of maternal death on the African continent, accounting for a disproportionate share of global maternal deaths despite representing a much smaller share of global births (Statista, 2024). Behind this aggregate figure lies wide variation across Nigeria's geopolitical zones, states, and rural–urban divides, and the North Central zone where Kogi State is located has received comparatively less targeted research attention than the northern and southern zones.

Skilled birth attendance (SBA), a delivery assisted by a doctor, nurse, midwife, or comparably trained health professional is widely regarded as one of the single

most effective interventions for reducing intrapartum and immediate postpartum maternal and newborn deaths, because the majority of fatal complications arise suddenly during labour and delivery and cannot be reliably predicted in advance (Negash et al., 2025). National data show gradual but uneven progress: the 2023–24 Nigeria Demographic and Health Survey reported an increase in SBA from 43% to 46% nationally relative to 2018, with rural–urban and zonal disparities persisting throughout (Oweibia et al., 2025). Subnational analyses using the Multiple Indicator Cluster Survey (MICS) series have similarly documented rising but still inadequate SBA coverage; one pooled analysis of MICS rounds from 2011 to 2021 found SBA among young women in northern Nigeria increased from only 25.6% to 33.1% over the decade (Afape et al., 2024).

A consistent body of evidence across Nigeria and the wider sub-Saharan African region identifies household wealth, maternal education, and urban or rural residence as the principal correlates of SBA utilisation. Afape et al. (2024) found that young Nigerian women from richer households had nearly double the odds of SBA compared with those from poorer households



(AOR = 1.84, 95% CI: 1.11–3.14), and that secondary or higher maternal education was associated with substantially higher odds of SBA than no education. Similar wealth- and education-related gradients have been reported in Ogun State (Adefala et al., 2024) and in broader scoping reviews of antenatal and skilled delivery care across sub-Saharan Africa, which consistently implicate wealth status, residence, maternal literacy, and distance to health facilities as the dominant determinants (Lateef et al., 2024). Multilevel analyses that explicitly model the clustering of deliveries within communities have further shown that a meaningful share of the variation in SBA is attributable to between-cluster differences rather than individual characteristics alone, underscoring the role of local health-system supply and community context (Negash et al., 2025).

Despite this growing evidence base, dedicated state-level analyses for Kogi remain limited, and existing national or zonal studies may mask important within-state heterogeneity in SBA coverage and its correlates. Given the persistent rural–urban and wealth-based disparities documented elsewhere in Nigeria, and the well-established practice of accounting for survey design and geographic clustering when analysing MICS and DHS data (Oyedele, 2023), a state-specific multilevel analysis is needed to identify which factors most strongly predict SBA among women in Kogi and to clarify whether community-level clustering plays a meaningful role locally.

This study therefore used data from the Kogi State subsample of the 2021 Nigeria Multiple Indicator Cluster Survey (MICS6) to (i) estimate the survey-weighted prevalence of skilled birth attendance among women with a recent live birth, (ii) describe how prevalence varies across maternal and household characteristics, and (iii) identify the independent correlates of SBA using multilevel logistic regression that accounts for clustering of deliveries within primary sampling units (PSUs), with a survey-weighted model fitted as a sensitivity check.

2.0 METHODOLOGY

2.1 Study design and data source

This study used a secondary, cross-sectional analysis of data from the 2021 Nigeria Multiple Indicator Cluster Survey (MICS6), a nationally representative household survey implemented by the National Bureau of Statistics in collaboration with the National Primary Health Care Development Agency and with technical support from UNICEF (UNICEF, 2021). MICS6 employed a multi-stage, stratified cluster sampling design in which enumeration areas (clusters) were selected within strata, followed by systematic selection of households within clusters; estimates are not self-weighting, and sampling weights, strata, and primary sampling unit (PSU) identifiers are provided to support

design-consistent analysis (World Bank Microdata Library, 2023). The present analysis is restricted to the Kogi State subsample of the Women's Questionnaire.

2.2 Study population

The study population comprised women aged 15–49 years in Kogi State who reported at least one live birth in the two years preceding the survey. Women with a valid skilled-birth-attendance outcome, survey weight, stratum, PSU identifier, and complete values for the pre-specified model covariates were included. No missing data imputation was undertaken. The eligible prevalence sample and complete-case regression sample were both 155 women nested within 48 primary sampling units; therefore, no additional exclusions occurred after covariate screening.

2.3 Outcome variable

The outcome of interest was skilled birth attendance, derived from the respondent's report of who assisted with the delivery of her most recent live birth. Consistent with standard MICS/DHS classification, deliveries assisted by a doctor, nurse, midwife, or other health professional with the requisite skills to manage normal deliveries and identify, manage, or refer obstetric complications were coded as skilled birth attendance (coded 1); deliveries assisted only by traditional birth attendants, community health worker, relatives or friend, or other unskilled persons, or unattended deliveries, were coded as not skilled (coded 0). Women with no valid delivery assistance response were excluded.

2.4 Explanatory variables

Candidate explanatory variables were selected based on prior literature on SBA determinants in Nigeria and sub-Saharan Africa more broadly (Afape et al., 2024; Lateef et al., 2024) and comprised: maternal age (grouped 15–24, 25–34, 35–49 years), parity (1 birth, 2–4 births, 5+ births), maternal education (none/primary, secondary, higher/tertiary), area of residence (urban, rural), household wealth (derived from the MICS wealth index and grouped into poorer, middle, and richer tertiles), and household size. Household size was descriptively categorised into three groups (1–4, 5–7, 8+ members) for the prevalence estimates in Table 1, but was collapsed into a binary variable (1–7 members vs. 8+ members) in the regression models to preserve statistical power given small cell frequencies in the 1–4 and 8+ categories. Maternal education was presented descriptively as none/primary, secondary, and higher/tertiary education. For multilevel models 1 and 3, maternal education was collapsed into none/primary versus secondary/higher education to reduce sparse-category instability arising from the small higher/tertiary subgroup. Household wealth was based on the national MICS wealth-index quintile and was collapsed into poorer households, comprising the poorest and second

quintiles; middle households, comprising the middle quintile; richer households, comprising the fourth and richest quintiles. No Kogi-specific asset index was constructed.

2.5 Statistical analysis

Descriptive analyses applied MICS sampling weights, strata, and PSU identifiers to produce survey-weighted estimates of SBA prevalence overall and by maternal and household characteristics, with 95% confidence intervals calculated using Taylor series linearisation to account for the complex survey design.

2.5.1 Multilevel logistic regression model

To identify independent correlates of SBA while explicitly accounting for the clustering of deliveries within communities, we fitted a two-level random-intercept logistic regression model, with women (level 1) nested within primary sampling units (level 2). Let Y_{ij} denote the binary skilled-birth-attendance outcome for woman i in cluster j ($1 =$ skilled attendance, $0 =$ otherwise), and let $p_{ij} = \Pr(Y_{ij} = 1)$ denote the corresponding probability. The level-1 model is:

$$\text{logit}(p_{ij}) = \ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_{0j} + \beta_1 X_{1ij} + \dots + \beta_k X_{kij} \quad (1)$$

where $X_{1ij}, \dots, X_{kij}$ are the maternal and household covariates described in Section 2.4 (maternal age, parity, maternal education, residence, wealth group, household size, depending on the model), and $\beta_1, \dots, \beta_k$ are fixed effects common to all clusters. The cluster-specific intercept β_{0j} is allowed to vary randomly across PSUs at level 2:

$$\beta_{0j} = \beta_0 + u_j,$$

$$u_j \sim N(0, \tau^2)$$

2)

where β_0 is the overall (population-average) log-odds of SBA, u_j is the random effect for cluster j , assumed normally distributed with mean zero and between-cluster variance τ^2 , and clusters are assumed independent. Exponentiating a fixed-effect coefficient, $\exp(\beta_k)$, gives the adjusted odds ratio (AOR) reported in Tables 2 and 3, interpreted as the multiplicative change in the odds of SBA associated with a one-unit (or category) change in the corresponding covariate, holding other covariates and the random cluster effect constant.

2.5.2 Null model, ICC, and median odds ratio

An unconditional null model (Model 0), containing only the intercept and the random cluster effect, was fitted first to quantify baseline between-cluster variation before adjusting for covariates:

$$\text{logit}(p_{ij}) = \beta_0 + u_j \quad (3)$$

From this model, the intraclass correlation coefficient (ICC) was calculated using the logistic latent-variable

approach (Merlo et al., 2006), which treats the level-1 residual variance as fixed at $\pi^2/3 \approx 3.29$ on the logit scale:

$$\text{ICC} = \frac{\tau^2}{\tau^2 + \frac{\pi^2}{3}} \quad (4)$$

The ICC represents the proportion of total variance in the propensity for SBA that lies between clusters rather than between individual women within a cluster. Because the ICC can be difficult to interpret on the latent logit scale, we additionally report the median odds ratio (MOR), which re-expresses the same between-cluster variance on the more intuitive odds-ratio scale (Merlo et al., 2006):

$$\text{MOR} = \exp(0.6745 \times \sqrt{2\tau^2}) \quad (5)$$

where 0.6745 is the 75th percentile of the standard normal distribution. The MOR is interpreted as the median increase in the odds of SBA that would be observed if a woman moved from a lower-risk to a higher-risk cluster, comparing two clusters drawn at random, holding individual characteristics constant; by construction, $\text{MOR} \geq 1$.

2.5.3 Model comparison and proportional change in variance

Three nested models were then compared against the null model: Model 1 (maternal characteristics: age, parity, education), Model 2 (household characteristics: residence, wealth, household size), and Model 3 (a full model combining maternal and household characteristics). Models were compared using the Akaike Information Criterion,

$$\text{AIC} = -2 \ln(L) + 2k$$

and the Bayesian Information Criterion,

$$\text{BIC} = -2 \ln(L) + k \ln(n)$$

where L is the maximised likelihood, k is the number of estimated parameters, and n is the number of level-1 observations. Lower AIC and BIC indicate better fit after penalising model complexity. Where one model nested within another, a likelihood-ratio test was used, with the test statistic $-2(\ln L_0 - \ln L_1)$ compared against a χ^2 distribution with degrees of freedom equal to the difference in the number of parameters between the two models.

The proportional change in cluster-level variance (PCV) relative to the null model was calculated for each subsequent model m as:

$$\text{PCV}_m = \left(\frac{\tau_0^2 - \tau_m^2}{\tau_0^2} \right) \times 100\%$$

where τ_0^2 is the cluster-level variance from the null model and τ_m^2 is the cluster-level variance from model m . PCV quantifies how much of the baseline between-cluster variation is explained by the covariates added in model m . The best-fitting parsimonious model by AIC and BIC, with no significant improvement from further covariates by likelihood-ratio test, was retained as the primary adjusted model. Because the sample size and number of clusters were modest, a non-significant likelihood-ratio test was not treated as definitive

evidence that the additional covariates in Model 3 had no effect; rather, AIC and BIC, which penalise complexity directly and do not rely on asymptotic null distributions in the same way, were given primary weight in model selection, with the likelihood-ratio result treated as corroborating rather than decisive evidence.

2.5.4 Survey-weighted sensitivity model

As a sensitivity analysis, we additionally fitted a survey-weighted logistic regression model containing the same covariates as the primary adjusted model. This design-based approach applies the MICS sampling weight w_{ij} directly to each observation, together with the survey strata and PSU identifiers, rather than modelling clustering through a random effect:

$$\text{logit}(p_{ij}) = \gamma_0 + \gamma_1 X_{1ij} + \dots + \gamma_k X_{kij} \quad (9)$$

with coefficients γ_k estimated by pseudo-maximum-likelihood using w_{ij} as analytic weights, and standard errors obtained by Taylor series linearisation accounting for the stratified, clustered design. This sensitivity analysis assessed whether the design-based and model-based (random-intercept) approaches yielded consistent conclusions about the covariates most strongly associated with SBA. All analyses were conducted using R; multilevel models were fitted by maximum likelihood estimation, and model convergence and singularity were checked for each fitted model. A two-sided p-value below 0.05 was considered statistically significant for the adjusted odds ratios reported in the primary model. However, given the exploratory nature of the analysis and the modest sample size, effect estimates and their 95% confidence intervals, rather than p-values in isolation, were prioritised when interpreting the strength and precision of associations throughout the Results and Discussion.

3.0 RESULTS AND DISCUSSION

3.1 Sample characteristics and overall prevalence

The analytic sample comprised 155 women in Kogi State with a live birth in the two years preceding the survey, nested within 48 primary sampling units. Overall, 108 women reported delivery assisted by a skilled birth attendant and 47 did not. The survey-weighted prevalence of skilled birth attendance was 73.5% (95% CI: 58.8–84.3%), with the relatively wide confidence interval reflecting the modest sample size and substantial between-cluster variability described further below.

3.2 SBA prevalence by maternal and household characteristics

Table 1 presents the weighted distribution of the sample and SBA prevalence across maternal and household characteristics. Prevalence increased with maternal age up to the 25–34-year group (82.2%) before declining somewhat among women aged 35–49 years (69.2%), and was lowest among women aged 15–24 years (60.9%). Women with two to four previous births had the highest SBA prevalence (81.0%), compared with 64.7% among women with one birth and 64.4% among women with five or more births.

The most pronounced gradients were observed for residence, education, and wealth. SBA prevalence was substantially higher among urban women (93.1%) than rural women (59.5%). Prevalence rose steadily with maternal education, from 71.2% among women with no or only primary education and 68.4% among those with secondary education to 98.6% among women with higher or tertiary education. The clearest gradient was by household wealth: SBA prevalence rose from 52.6% in poorer households to 67.1% in middle-wealth households and 93.7% in richer households. Household size showed a smaller and non-monotonic pattern, ranging from 70.1% to 77.3% across categories.

Table 1

Maternal and Household Characteristics and Skilled Birth Attendance Prevalence Among Women With Recent Live Births in Kogi State

Rogt State					
Variable	Category	Unweighted n	Weighted %	Weighted SBA prevalence (%)	Weighted 95% CI
Maternal age	15–24 years	42	27.6	60.9	37.5–80.2
	25–34 years	76	50.5	82.2	66.3–91.6
	35–49 years	37	21.9	69.2	44.7–86.2
Parity	1 birth	39	23.0	64.7	44.7–80.6
	2–4 births	76	54.4	81.0	62.6–91.5
	5+ births	40	22.6	64.4	41.5–82.2
Residence	Urban	46	41.6	93.1	74.7–98.4
	Rural	109	58.4	59.5	47.2–70.7
Maternal education	None/primary	56	36.6	71.2	46.0–87.8

Variable	Category	Unweighted n	Weighted %	Weighted SBA prevalence (%)	Weighted 95% CI
Wealth group	Secondary	82	50.0	68.4	53.2–80.5
	Higher/tertiary	17	13.4	98.6	87.0–99.9
	Poorer	54	32.5	52.6	35.4–69.2
	Middle	47	25.7	67.1	48.9–81.3
	Richer	54	41.7	93.7	78.9–98.3
Household size	1–4 members	58	38.3	70.1	50.7–84.3
	5–7 members	67	41.4	77.3	62.3–87.5
	8+ members	30	20.3	72.1	47.7–88.0

Note. Frequencies are unweighted. Weighted percentages and SBA prevalence estimates account for MICS sampling weights, stratification, and PSU clustering.

3.3 Null model and between-cluster variation

The unconditional null model indicated meaningful clustering of SBA outcomes by PSU, with a cluster-level variance of 1.65, an intraclass correlation coefficient (ICC) of 0.335, and a median odds ratio (MOR) of 3.41. This MOR indicates that, comparing two women with identical characteristics drawn at random from two different clusters, the median increase in the odds of SBA attributable to cluster-level differences alone would be 3.41-fold, a magnitude broadly comparable to, or exceeding, the effect of several individual-level characteristics examined in this study. This finding justified the use of a multilevel modelling approach rather than standard logistic regression, which would ignore this clustering and could understate the uncertainty around covariate effects.

3.4 Model comparison

Table 2 summarises the fit of the four multilevel models compared. Model 2 (residence, wealth, and household size) provided the best fit, with the lowest AIC (175.69) among all models, including the full model. Model 1 (maternal characteristics only) offered

a negligible improvement over the null model (AIC 183.68 vs. 184.06) and explained only 16.59% of the baseline cluster-level variance (PCV), whereas Model 2 explained 45.54%. Model 3, which combined maternal and household characteristics, did not improve on Model 2: a likelihood-ratio test comparing Model 2 and Model 3 was non-significant ($\chi^2 = 2.89$, $df = 3$, $p = 0.409$), indicating that adding maternal age, education, and parity to the household-characteristics model did not meaningfully improve fit. Model 2 was therefore retained as the primary adjusted model because it has the lowest AIC, it significantly improved on the null model ($\chi^2 = 16.37$, $df = 4$, $p = 0.026$), it reduced PSU-level variance by 45.5% relative to the null model. Given the modest sample size ($n = 155$) and number of clusters (48 PSUs), the non-significant likelihood-ratio comparison between Model 2 and Model 3 is interpreted as an indication of limited power to detect additional, smaller effects rather than definitive evidence that maternal age, education, and parity have no association with SBA once household characteristics are accounted for. All models converged without singularity.

Table 2
Multilevel Logistic Regression Model Comparison for Skilled Birth Attendance

Model	AIC	BIC	LogLik	Cluster var.	ICC	MOR	PCV (%)	Conv.
Model 0: Null model	184.06	190.15	−90.03	1.6546	0.3346	3.411	—	Yes
Model 1: Maternal characteristics	183.68	198.90	−86.84	1.3800	0.2955	3.067	16.59	Yes
Model 2: Household characteristics	175.69	193.95	−81.85	0.9011	0.2150	2.473	45.54	Yes
Model 3: Full model	178.80	206.19	−80.40	0.9158	0.2178	2.491	44.65	Yes

Note. ICC calculated using the logistic latent-variable approximation. MOR denotes median odds ratio. PCV (proportional change in variance) denotes the percentage reduction in PSU-level variance relative to the null model (Model 0). Two likelihood-ratio (LR) comparisons underpin model selection: Model 2 vs. Model 0 was statistically significant ($\chi^2 = 16.37$, $df = 4$, $p = 0.026$), confirming that

household characteristics improved fit over the null model; Model 3 vs. Model 2 was non-significant ($\chi^2 = 2.89$, $df = 3$, $p = 0.409$), indicating no reliable improvement in fit from adding maternal age, education, and parity to the household-characteristics model. Given the modest sample size, the non-significant Model 3 vs. Model 2 comparison is interpreted

cautiously as consistent with, rather than proof of, no additional effect (see Section 2.5.3).

3.5 Adjusted odds ratios from the primary model

Table 3 presents adjusted odds ratios (AORs) from Model 2. Household wealth was the only variable independently and significantly associated with SBA after adjustment. Women in richer households had more than six times the odds of SBA compared with those in poorer households (AOR = 6.14, 95% CI: 1.60–23.48, $p = 0.008$). Women in middle-wealth households also had higher odds than those in poorer

households, though this did not reach statistical significance (AOR = 1.95, 95% CI: 0.69–5.48, $p = 0.208$). Rural residence was associated with lower odds of SBA relative to urban residence, consistent with the descriptive gradient in Table 1, but this association did not reach statistical significance after adjustment for wealth and household size (AOR = 0.33, 95% CI: 0.08–1.31, $p = 0.114$). Household size of eight or more members was not significantly associated with SBA relative to smaller households (AOR = 0.74, 95% CI: 0.27–2.06, $p = 0.569$).

Table 3
Adjusted Odds Ratios From the Primary Multilevel Model for Skilled Birth Attendance

Variable	Category	AOR	95% CI	p-value
Residence	Urban	Ref.	—	—
	Rural	0.33	0.08–1.31	0.114
Wealth group	Poorer	Ref.	—	—
	Middle	1.95	0.69–5.48	0.208
	Richer	6.14	1.60–23.48	0.008
Household size	1–7 members	Ref.	—	—
	8+ members	0.74	0.27–2.06	0.569

Note. Reference categories: urban residence, poorer households, and households with 1–7 members. AOR = adjusted odds ratio; CI = confidence interval. Estimates derived from Model 2, the selected primary multilevel model.

Figure 1 displays the adjusted odds ratios and 95% confidence intervals from the primary model on a logarithmic scale. The estimate for richer households is the only one whose confidence interval excludes the null value of 1.0, visually confirming wealth as the dominant correlate of SBA in this analysis; the intervals for rural residence, middle wealth, and larger household size all span 1.0.

3.6 Forest plot of adjusted odds ratios

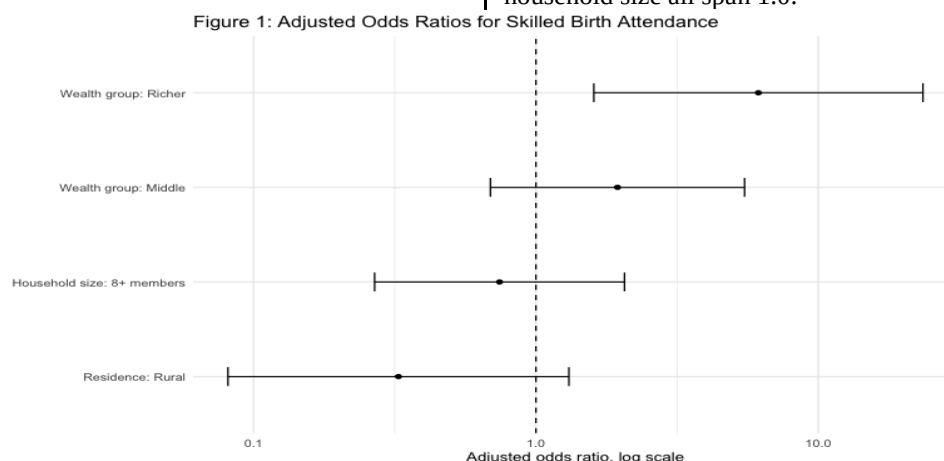


Figure 1. Adjusted odds ratios for skilled birth attendance, Model 2 (log scale).

3.7 Sensitivity analysis

Table 4 presents the survey-weighted logistic regression sensitivity analysis, fitted with the same covariates as Model 2 but using design-based weighting rather than a random-effects specification. The direction and approximate magnitude of associations were consistent with the primary multilevel model. Richer households again showed

significantly higher odds of SBA relative to poorer households (AOR = 5.91, 95% CI: 1.16–30.27, $p = 0.034$), while rural residence (AOR = 0.26, 95% CI: 0.05–1.34, $p = 0.105$), middle wealth (AOR = 1.29, 95% CI: 0.43–3.90, $p = 0.639$), and larger household size (AOR = 0.93, 95% CI: 0.41–2.15, $p = 0.871$) remained non-significant. The consistency between the two modelling approaches strengthens confidence that

the wealth effect identified in the primary analysis is not an artefact of the multilevel specification.

Table 4
Survey-Weighted Logistic Regression Sensitivity Analysis for Skilled Birth Attendance

Variable	Category	AOR	95% CI	p-value
Residence	Urban	Ref.	—	—
	Rural	0.26	0.05–1.34	0.105
Wealth group	Poorer	Ref.	—	—
	Middle	1.29	0.43–3.90	0.639
	Richer	5.91	1.16–30.27	0.034
Household size	1–7 members	Ref.	—	—
	8+ members	0.93	0.41–2.15	0.871

Note. This sensitivity analysis used survey-weighted logistic regression with MICS sampling weights, strata, and PSU clustering. Reference categories were urban residence, poorer households, and households with 1–7 members.

3.8 Discussion

This study found that nearly three-quarters of women in Kogi State with a recent live birth delivered with the assistance of a skilled birth attendant, a figure that compares favourably with several national and zonal estimates from other parts of Nigeria but conceals a steep wealth-based gradient: SBA prevalence ranged from roughly half of women in poorer households to over nine in ten women in richer households. After adjustment for residence and household size, wealth remained the only statistically significant correlate of SBA, with women in richer households having more than six times the odds of skilled delivery compared with those in poorer households. This finding aligns closely with the broader Nigerian and sub-Saharan African literature, in which household wealth is one of the most consistently reported determinants of SBA utilisation (Afape et al., 2024; Lateef et al., 2024). The wealth gradient observed here is plausibly explained by the direct and indirect costs associated with facility-based delivery in Nigeria, including formal and informal facility fees, transportation, and the opportunity cost of travel to better-equipped facilities, all of which disproportionately burden poorer households. Recent national policy responses, including the introduction of free emergency caesarean section provision for poor and vulnerable women in late 2024, were designed explicitly to address this kind of wealth-related barrier to skilled care (Dogbanya, 2025); the magnitude of the wealth effect observed in Kogi State suggests that continued and possibly expanded financial-protection measures could meaningfully narrow the SBA gap if extended to routine (non-emergency) skilled delivery care.

Although rural residence was associated with substantially lower unadjusted SBA prevalence (59.5% versus 93.1% in urban areas), this association did not

remain statistically significant once wealth and household size were accounted for in the multilevel model, and the same pattern held in the survey-weighted sensitivity analysis. This suggests that much of the apparent rural disadvantage in this sample may operate through household wealth rather than residence per se, that is, rural households in this sample tend to be poorer, and it is the wealth disadvantage, not rurality independently, that is driving lower SBA. This interpretation should be treated cautiously given the modest sample size and correspondingly wide confidence interval for the residence estimate (AOR = 0.33, 95% CI: 0.08–1.31), which does not exclude a clinically meaningful residence effect; a larger sample might well detect an independent rural disadvantage that this analysis was underpowered to confirm.

Maternal education showed a clear descriptive gradient, rising from 71.2% among women with no or primary education to 98.6% among those with higher or tertiary education, consistent with the substantial education-related AORs reported elsewhere in Nigeria, including the very large effect for higher education found by Afape et al. (2024) among young women in northern Nigeria. However, education did not improve model fit when added to the household-characteristics model in this Kogi State sample (Model 3 vs. Model 2 likelihood-ratio test, $p = 0.409$), and maternal age and parity likewise added little explanatory value beyond wealth, residence, and household size. This does not necessarily mean education and age are unimportant in this population; rather, their associations with SBA may be substantially mediated by, or confounded with, household wealth, and the limited sample size restricts the ability of the full model to estimate several correlated predictors simultaneously.

The null model's intraclass correlation coefficient (0.335) and median odds ratio (3.41) indicate that a substantial share of the variation in SBA in Kogi State occurs between communities rather than between individual women, a pattern consistent with multilevel

