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Caesarean section and associated factors in Nigeria: assessing inequalities between rural and urban areas—insights from the Nigeria Demographic and Health Survey 2018

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Abstract

Introduction When medically indicated, caesarean section (CS) can be a life-saving intervention for mothers and their newborns. This study assesses the prevalence of CS and its associated factors, focussing on inequalities between rural and urban areas in Nigeria.

Methods We disaggregated the Nigeria Demographic and Health Survey 2018 and performed analyses separately for Nigeria's overall, rural, and urban residences. We summarised data using frequency tabulations and identified factors associated with CS through multivariable logistic regression analysis.

Results CS prevalence was 2.7% in Nigeria (overall), 5.2% in urban and 1.2% in rural areas. The North-West region had the lowest prevalence of 0.7%, 1.5% and 0.4% for the overall, urban and rural areas, respectively. Mothers with higher education demonstrated a greater CS prevalence of 14.0% overall, 15.3% in urban and 9.7% in rural residences. Frequent internet use increased CS prevalence nationally (14.3%) and in urban (15.1%) and rural (10.1%) residences. The southern regions showed higher CS prevalence, with the South-West leading overall (7.0%) and in rural areas (3.3%), and the South-South highest in urban areas (8.5%). Across all residences, rich wealth index, maternal age ≥ 35, lower birth order, and ≥ eight antenatal (ANC) contacts increased the odds of a CS. In rural Nigeria, husbands' education, spouses' joint healthcare decisions, birth size, and unplanned pregnancy increased CS odds. In urban Nigeria, multiple births, Christianity, frequent internet use, and ease of getting permission to visit healthcare facilities were associated with higher likelihood of CS.

Conclusion CS utilisation remains low in Nigeria and varies across rural-urban, regional, and socioeconomic divides. Targeted interventions are imperative for uneducated and socioeconomically disadvantaged mothers across all regions, as well as for mothers in urban areas who adhere to Islam, traditional, or 'other' religions. Comprehensive intervention measures should prioritise educational opportunities and resources, especially for rural areas, awareness

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campaigns on the benefits of medically indicated CS, and engagement with community and religious leaders to promote acceptance using culturally and religiously sensitive approaches. Other practical strategies include promoting optimal ANC contacts, expanding internet access and digital literacy, especially for rural women (e.g., through community Wi-Fi programs), improving healthcare infrastructure and accessibility in regions with low CS prevalence, particularly in the North-West, and implementing socioeconomic empowerment programs, especially for women in rural areas.

Keywords Caesarean section, Childbirth, Emergency obstetric care, Inequalities, Maternal-child health, Nigeria, Rural-urban differences

Introduction

Caesarean section (CS) is a critical obstetric procedure involving the surgical delivery of a baby through incisions in the mother's abdomen and uterus [1, 2]. It is an essential component of specialised health facilities and interventions designed to enhance positive outcomes for pregnant women and their newborns, collectively termed 'comprehensive emergency obstetric care' (CEmOC) [1, 2]. CS is commonly recommended for high-risk pregnancies, including instances of multiple foetuses, breech presentations, obstructed labour, transmissible infections, and uterine rupture, among several other factors [3]. When medically indicated, CS can contribute to the survival and well-being of mothers and their newborns [4]. However, there is an ongoing debate about the appropriate population-based CS prevalence [1, 5, 6], highlighting the complexity of determining the optimal rate globally. Despite these contentions, population-based CS rates below 5% signify unmet needs for necessary interventions—while rates exceeding 10–15% may not yield any additional benefits for maternal and newborn survival [1, 5, 7].

The World Health Organisation (WHO) recommends universal access to CS for all women in need regardless of the prevailing population prevalence [1, 6]. However, Nigeria's CS prevalence has consistently remained low compared to several countries [8–10], even as the global estimates show an increasing trend [11]. This low population-based prevalence suggests underutilisation and is akin to the situation in many low-to-middle-income countries where maternal and neonatal mortality rates are high [8, 12]. Notably, with over 82,000 maternal deaths in 2020, representing about 28.5% of the global burden, Nigeria ranks as the country with the highest number of maternal mortality worldwide [13]. This statistic is concerning, considering Nigeria's population is less than 3% of the world's total [13]. The persistent stagnation of population-based CS rates in Nigeria, thus, raises concern about its impact on maternal and neonatal health outcomes [13].

Numerous observational studies have investigated CS utilisation and associated factors in Nigeria [9, 14–21], underscoring the significance of this subject in the country. However, before Adewuyi and colleagues' nationally representative study [9], research on CS in Nigeria primarily relied on institutional data. These institutional-based studies were recently summarised in a systematic review and meta-analysis [22]. While the studies provide invaluable perspectives, reliance on healthcare facility records limits their capacity to capture the complete picture of CS across the broader Nigerian population. Conversely, a few studies have enhanced this discourse by harnessing nationally representative data from the Nigeria Demographic and Health Survey (NDHS) 2013 [9, 23]. This approach enables a more comprehensive understanding of population-based CS utilisation across the country. Building on this evidence, two nationally representative studies have advanced this subject using the most recent NDHS 2018, providing additional insights into CS utilisation in the country's context [24, 25].

A notable limitation of the available population-based studies is their 'one-size-fits-all' approach, focussing on the entire Nigerian population using aggregated datasets [26]. This approach can inadvertently mask within-population inequities and inequalities [9, 12, 26–30]. CS utilisation inequities represent systematic disparities between various subpopulation groups, characterised by their 'unjust, unfair, and avoidable' nature. Conversely, inequality serves as a measurable metric for assessing these inequities, reflecting the observed differences across subpopulation groups [30]—a phenomenon well pronounced in maternal healthcare services utilisation [12, 27, 29]. Inequality can, for instance, manifest across various domains, including geographic divides (e.g., rural versus urban dwellings) [26, 27, 31–34], socioeconomic status (wealth index or educational attainment levels) [26, 28, 29, 31, 32], age differentials [35, 36], ethnicity [12, 26, 27], etc. Understanding these disparities is vital for designing effective and target-oriented public health interventions, policies, and healthcare services. Moreover, tailoring interventions to address the unique challenges and needs of specific geographic subpopulations is essential for achieving healthcare access equity and contributing towards realising the key targets of the Sustainable Development Goals (SDGs) 3—reducing maternal mortality (target 3.1), ending preventable newborn deaths (target 3.2), and achieving universal health coverage (target 3.8) [37]. Thus, there is a need for research

based on disaggregated data to illuminate disparities in CS utilisation within different population subgroups in Nigeria.

This research investigates CS prevalence and associated factors in Nigeria, focusing on inequality between rural and urban residences. New insights from the study promise to inform policy formulation and initiatives geared towards enhancing positive maternal and neonatal care outcomes in Nigeria. Additionally, findings have the potential to facilitate equitable access to healthcare services on a national scale, aligning with the global drive towards realising targets 3.1, 3.2, and 3.8 of the SDGs [37].

Methods

Data source

The dataset used in this study was derived from the NDHS of 2018. The NDHS is a national survey conducted every five years using globally validated and locally adapted methodology [10]. The Nigerian National Population Commission implemented the survey in collaboration with the 'ICF' and other development partners to provide up-to-date and nationally representative essential health and demographic indicator estimates [10]. The NDHS 2018 is the sixth edition in the series, and its sampling process, which used a sampling frame from the 2006 census, is detailed in the official report [10]. The survey was conducted using a two-stage stratified cluster sample selection involving 42,000 households and 1,400 clusters, and it was successfully administered in 40,427 households and 1,389 clusters [10]. Data were collected from eligible men, women, and households using predetermined selection criteria and validated questionnaires [10].

A total of 41,821 women aged 15–49 years (16,984 in urban, 24,837 in rural areas) who were either permanent residents or visitors staying in the selected households the night before the survey responded for themselves and their children [10]. The eligible women's response rate was 99.3% (99.2 in urban and 99.4 in rural residences) [10]. We used the 'children recode (KR)' dataset in the present study and analysed a weighted sample of 34,057 mothers (13096 in urban, 20963 in rural areas) who had complete information on their mode of delivery for the descriptive analysis. We included a weighted sample of 21,157 most recent live childbirths (8258 in urban, 12899 in rural areas) in the five years before the survey for the adjusted analysis. Our analysis included single and multiple births.

Variables

Outcome variable

CS was the outcome variable for our study. The NDHS data includes information on whether childbirth was caesarean, asking, 'Was (NAME) delivered by caesarean, that is, did they cut your belly open to take the baby out?' [10]. However, it does not disaggregate the type of CS deliveries as elective or emergency. Therefore, all CS were included in the present study as in previous studies [9, 23–25]. The mode of childbirth was dichotomised as 'CS=1' and 'non-CS,' i.e., vaginal delivery=0' to report the prevalence and facilitate association with the key independent variables.

Factors

We selected independent variables for this study based on key national, regional and global literature [8–10,23–26,32,33]. Maternal and husband's education was included as higher, secondary, primary and no education [9, 26, 27, 29]. Maternal and husband's working status was re-coded as 'working' if reported as working in paid work and 'not working' if not in paid work [26]. Household wealth was based on asset possession and was included as poorest, poor, middle, rich, and richest. This variable was re-categorised into poor (poorest and poor), middle and rich (rich and richest) [9, 27, 29] to facilitate our analysis. Having the final say on their health was included as women's ability to decide for themselves and was recorded as respondent alone, respondent and partner/husband, and partner/someone else [26].

Many bio-demographic factors were also included in this study. Maternal age was documented in the dataset as 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, and 45–49; we maintained this categorisation in our study to provide specific insights across age differences [26]. Furthermore, birth order was recorded as a continuous variable, and we re-categorised it into 1, 2–3 and 4 or more [9, 26, 27, 29]. Birth sizes were categorised into large, average, and small. We used birth size as a proxy for birth weight as a substantial proportion of mothers could not report the birth weight of their children. Birth type was included as single and multiple births [26]. Preceding birth interval was also a continuous variable, which we categorised into <24 months and 24 or more months [9, 26, 27, 29]. Antenatal care (ANC) contacts were documented as a continuous variable and were subsequently categorised here into seven or fewer (underuse) and eight or more (optimal use) ANC contacts [26]. The place of delivery was re-categorised into three parts: private health facility, public health facility and home, to facilitate analysis.

Other key sociodemographic factors were also included in our study. Maternal religion was included as Christianity (Catholic and other Christians), Traditionalist/others, and Islam [9, 26, 27, 29]. Residences were documented as rural and urban [9, 26, 27]. The regions of residences were used as provided in the data: North-Central, North-East, North-West, South-East, South-South and South-West

[10, 26]. Nigeria has diverse ethnic groups [10]; these were categorised into four major groups for this analysis: Hausa/Fulani, Yoruba, Igbo, and Others, as in previous studies [9, 26, 27, 29]. Distance to the health facility, permission to visit health facility, getting money for health services and companionship to health facility were documented in the survey as 'a big problem' and 'not a big problem', and we maintain the same categorisation in the present study [26, 27]. Health insurance coverage was categorised as yes or no, while access to information was collected as frequency of reading newspapers/magazines, frequency of listening to radio, frequency of watching television [9, 26, 27, 29], and frequency of internet use [26]. These access to information variables were categorised as 'not at all', 'less than once a week' and '≥ once a week' [10, 26, 27].

Statistical analysis

We performed analysis by first summarising the data using a frequency tabulation. Subsequently, we conducted descriptive statistics, disaggregating the NDHS 2018 data (for the overall Nigerian population) into rural and urban residences (Table 1) as in previous studies [26, 27, 29, 32–34]. To explore the relationship between CS and various explanatory factors, we initially employed the Chi-square ($\chi 2$) test. Significant variables identified from this test were then subjected to multivariable binary logistic regression analysis to determine their independent association with the outcome variable. We used the backward elimination method to consider potential interactions among the independent variables. We included variables in the next model if they showed a significant association with CS at the 5% significance level ($p<0.05$). Adjusted odds ratios (AOR) and their corresponding 95% Confidence Intervals (CI) were computed and reported. The multivariable binary logistic regression analysis was initially conducted on the entire Nigerian population (using the aggregated dataset) and then replicated for data segmented into rural and urban residences. Our analysis excluded missing data and was conducted with adjustments for the study design and sample weights. We utilised the complex sample function of the Statistical Package for Social Sciences (SPSS version 21) for these statistical procedures. Results were deemed statistically significant at the 5% level.

Results

Sample characteristics

Table 1 provides an overview of the participants' characteristics. In the overall Nigerian population, only 8.2% of the mothers had attained higher education, while almost half (46.5%) had received no formal education. One-third of the mothers were not engaged in paid employment, and 45% came from poor households. Additionally, most mothers (61.5%) were from rural areas. Most births were multiparous, and about 13.5% of children were small. Only 3.7% of births were multiple births. One in five mothers had the recommended eight or more ANC contacts. For 88.2% of mothers, permission to visit health facilities was not a major problem.

After disaggregating the overall data into rural and urban residences, we observed considerable variations in respondents' characteristics between the two groups. Urban women notably exhibit a more favourable profile (Table 1), revealing substantial rural-urban differences. In rural residences, for instance, higher education attainment was only three per cent, while the percentage was over five times higher (16.6%) in urban residences. Similarly, the percentage of women with no education was nearly three times higher in rural residence (61.8%) than in urban residence (22.1%) (Table 1). Furthermore, 64.8% of respondents from rural residences belonged to the poor wealth status compared to only 13.4% in urban residences (Table 1).

Prevalence of caesarean section in Nigeria

In terms of the prevalence of CS and rural-urban differences, 2.7% (95% CI: 2.4, 3.1%, $P<0.001$) of mothers reported giving birth through caesarean delivery in Nigeria (Fig. 1; Table 1). The proportion of CS in urban areas was 5.2% (95% CI: 4.5, 6.1%, $P<0.001$), while it was nearly four times lower in rural areas (1.2%; 95% CI: 1.0, 1.4%, $P<0.001$) (Fig. 1). Several independent variables were assessed for the unadjusted association with CS (Table 1). These factors remained significant even when the data was disaggregated by urban and rural areas (Table 1). The prevalence of CS reflects notable disparities across geographic (rural and urban, as well as region of residences (Figs. 1 and 2) and socioeconomic (maternal education levels and wealth index, Figs. 3 and 4) divides. In all residences, the prevalence of CS was substantially higher in private facilities, 11.8%, 13.6% and 7.5% in the overall, urban, and rural residences, respectively (Table 1). Also, respondents in the southern regions, those with higher levels of education and those in the rich wealth index category had higher CS prevalence in all residences but more in urban than rural settings (Table 1).

Factors associated with caesarean section in the overall Nigerian population

Table 2 presents the outcomes of our multivariable analysis. Several factors had a significant association with the odds of a CS in Nigeria, including maternal education level, rural-urban residences, wealth index, maternal age, antenatal contact, birth order, birth type, birth size, frequency of internet use, maternal religion, and permission to access healthcare services. Mothers with a higher education level had greater odds (AOR: 2.60,

Table 1 Sample characteristics and prevalence of cesarean delivery in Nigeria

Factors	Urban Nigeria			Rural Nigeria			Overall Nigeria		
	Weighted sample (%)[a]	Prevalence of CS		Weighted sample (%)[a]	Prevalence of CS		Weighted sample (%)[a]	Prevalence of CS	
		95% CI	*p*-values		95% CI	*p*-values		95% CI	*p*-values
Outcome variable									
Mode of delivery			< 0.001*			< 0.001*			< 0.001*
Caesarean section (CS)	687	5.2 (4.5–6.1)		244	1.2 (1.0–1.4)		930	2.7 (2.4–3.1)	
Vaginal delivery	12,409	94.8 (93.9–95.5)[#]		20,719	98.8 (88.6–99.0)[#]		33,127	97.3 (96.9–97.6)[#]	
Geographic/environmental factors									
Rural-urban residence									< 0.001*
Rural				20,962 (100.0)	1.2 (1.0–1.4)		20,962 (61.5)	1.2 (1.0–1.4)	
Urban	13,095 (100.0)	5.2 (4.5–6.1)					13,095 (38.5)	5.2 (4.5–6.1)	
Region of residence			< 0.001*			< 0.001*			< 0.001*
North-Central	1450 (11.1)	4.3 (3.2–5.8)		3167 (15.1)	1.9 (1.4–2.7)		4617 (13.6)	2.7 (2.2–3.3)	
North-East	1474 (11.3)	1.9 (1.2–3.0)		4716 (22.5)	0.6 (0.4–1.1)		6190 (18.2)	0.9 (0.2–1.3)	
North-West	3115 (23.8)	1.5 (1.0–2.2)		9442 (45.0)	0.4 (0.3–0.7)		12,557 (36.9)	0.7 (0.5–0.9)	
South-East	2428 (18.5)	7.0 (5.1–9.5)		919 (4.4)	3.2 (2.3–4.5)		3347 (9.8)	6.0 (4.5–7.8)	
South-South	1206 (9.2)	8.5 (5.3–13.3)		1753 (8.4)	2.8 (2.1–3.9)		2959 (8.7)	5.1 (3.7–7.2)	
South-West	3422 (26.1)	8.1 (6.4–10.2)		966 (4.6)	3.3 (1.8–6.1)		4388 (12.9)	7.0 (5.7–8.7)	
Socio-demographic factors									
Maternal education level			< 0.001*			< 0.001*			< 0.001*
Higher	2171 (16.6)	15.3 (12.8–18.1)		622 (3.0)	9.7 (6.9–13.4)		2793 (8.2)	14. 0 (12:0-16.4)	
Secondary	6019 (46.0)	4.8 (4.1–5.7)		4311 (20.6)	2.4 (1.9–3.0)		10,330 (30.3)	3.8 (3.4–4.4)	
Primary	2014 (15.4)	1.9 (1.3–2.8)		3073 (14.7)	1.0 (0.6–1.5)		5087 (14.9)	1.3 (1.0 -1.8)	
None	2891 (22.1)	0.8 (0.5–1.5)		12,957 (61.8)	0.4 (0.3–0.6)		15,847 (46.5)	0.5 (0.3–0.7)	
Maternal working status			0.091			< 0.001*			< 0.001*
Working	9561 (73.0)	5.6 (4.7–6.5)		13,441 (64.1)	1.5 (1.2–1.8)		23,003 (67.5)	3.2 (2.8–3.6)	
Not working	3534 (27.0)	4.4 (3.3–5.7)		7521 (35.9)	0.6 (0.4–0.9)		11,054 (32.5)	1.8 (1.4–2.3)	
Husband education level			< 0.001*			< 0.001*			< 0.001*
higher	3145 (25.9)	10.2 (8.2–12.5)		1561 (7.9)	4.8 (3.5–6.6)		4706 (14.7)	8.4 (7.0–10.1)	
Secondary	5414 (44.5)	4.5 (3.7–5.4)		5347 (27.0)	1.9 (1.5–2.4)		10,761 (33.7)	3.2 (2.7–3.7)	
Primary	1579 (13.0)	4.2 (3.0–5.8)		2942 (14.8)	0.9 (0.5–1.5)		4521 (14.1)	2.0 (1.5–2.7)	
None	2017 (16.6)	0.8 (0.4–1.4)		9974 (50.3)	0.3 (0.2–0.5)		11,991 (37.5)	0.4 (0.3–0.6)	
Husband working status			0.045**			0.427			0.018**
Not working	335 (2.7)	2.7 (1.3–5.3)		702 (3.5)	0.8 (0.3–2.1)		1037 (3.2)	1.4 (0.8–2.4)	

Table 1 (continued)

Factors	Urban Nigeria			Rural Nigeria			Overall Nigeria		
	Weighted sample (%)[a]	Prevalence of CS		Weighted sample (%)[a]	Prevalence of CS		Weighted sample (%)[a]	Prevalence of CS	
		95% CI	*p*-values		95% CI	*p*-values		95% CI	*p*-values
Working	11,933 (97.3)	5.4 (4.6–6.3)		19,424 (96.5)	1.2 (1.0–1.4)		31,357 (96.8)	2.8 (2.4–3.1)	
Wealth index			< 0.001*			< 0.001*			< 0.001*
Rich	8680 (66.3)	7.1 (6.0–8.3)		3015 (14.4)	4.1 (3.2–5.2)		11,695 (34.3)	6.3 (5.5–7.2)	
Middle	2665 (20.3)	2.0 (1.4–2.7)		4357 (20.8)	1.4 (1.1–1.9)		7022 (20.6)	1.6 (1.3–2.0)	
Poor	1750 (13.4)	1.1 (0.6–2.3)		13,591 (64.8)	0.4 (0.3–0.6)		15,341 (45.0)	0.5 (0.4–0.7)	
Decision on own health			< 0.001*			< 0.001*			< 0.001*
Respondent alone	1652 (13.4)	8.8 (6.5–11.7)		1351 (6.7)	1.9 (1.2–2.9)		3003 (9.2)	5.7 (4.4–7.3)	
Respondent and Husband	5038 (41.0)	6.8 (5.6–8.2)		4571 (22.6)	2.6 (2.1–3.3)		9609 (29.6)	4.8 (4.1–5.6)	
Husband alone/someone else	5603 (45.6)	2.9 (2.3–3.6)		14,269 (70.7)	0.6 (0.5–0.8)		19,871 (61.2)	1.3 (1.1–1.5)	
Maternal marital status			0.786			0.602			0.742
Never married	277 (2.1)	4.4 (2.5–7.3)		304 (1.4)	1.7 (0.7–4.1)		581 (1.7)	3.0 (1.9–4.6)	
Formerly married	526 (4.0)	4.9 (2.8–8.4)		467 (2.2)	1.2 (0.6–2.4)		993 (2.9)	3.1 (1.9–5.0)	
Currently married	12,292 (93.9)	5.3 (4.5–6.2)		20,191 (96.3)	1.2 (1.0–1.4)		32,484 (95.4)	2.7 (2.4–3.1)	
Maternal age (years)			< 0.001*			0.010**			< 0.001*
15–19	285 (2.2)	2.8 (1.2–6.2)		1169 (5.6)	1.4 (0.6–3.2)		1454 (4.3)	1.7 (0.9–3.1)	
20–24	2005 (15.3)	2.5 (1.7–3.5)		4661 (22.2)	0.8 (0.5–1.2)		6666 (19.6)	1.3 (1.0–1.7)	
25–29	3785 (28.9)	4.0 (3.1–5.3)		5766 (27.5)	0.8 (0.6–1.1)		9551 (28.0)	2.1 (1.6–2.6)	
30–34	3436 (26.2)	6.3 (4.8–8.2)		4329 (20.7)	1.5 (1.1–2.1)		7765 (22.8)	3.6 (2.9–4.5)	
35–39	2362 (18.0)	8.0 (6.5–9.9)		3054 (14.6)	1.5 (1.1–2.2)		5416 (15.9)	4.4 (3.6–5.3)	
40–44	883 (6.7)	5.6 (3.9–8.0)		1438 (6.9)	1.9 (1.2–2.9)		2321 (6.8)	3.3 (2.5–4.3)	
45–49	339 (2.6)	6.3 (3.3–11.6)		545 (2.6)	0.8 (0.3–2.0)		883 (2.6)	2.9 (1.7–5.1)	
Maternal religion			< 0.001*			< 0.001*			< 0.001*
Christianity	6243 (47.7)	8.4 (7.2–9.9)		5960 (28.4)	2.8 (2.3–3.5)		12,203 (35.8)	5.7 (5.0–6.5)	
Traditional/other	50 (0.4)	2.3 (0.6–8.0)		131 (0.6)	0 (0–0)		181 (0.5)	0.6 (0.2–2.6)	
Islam	6802 (51.9)	2.3 (1.8–2.9)		14,871 (70.9)	0.5 (0.4–0.7)		21,673 (63.6)	1.1 (0.9–1.3)	
Birth order			< 0.001*			< 0.001*			< 0.001*
1	2810 (21.5)	8.2 (6.8–10.0)		3775 (18.0)	1.9 (1.5–2.5)		6585 (19.3)	4.6 (4.0–5.4)	
2–3	4940 (37.7)	6.2 (5.1–7.5)		6513 (31.1)	1.3 (1.0–1.7)		11,453 (33.6)	3.4 (2.9–4.0)	
4 or more	5346 (40.8)	2.8 (2.2–3.4)		10,674 (50.9)	0.8 (0.6–1.1)		16,019 (47.0)	1.5 (1.2–1.7)	
Birth size			0.097			0.031**			0.011**
Large	4293 (33.4)	6.0 (5.0–7.2)		6940 (33.6)	1.5 (1.1–1.9)		11,233 (33.5)	3.2 (2.8–3.7)	
Average	6962 (54.1)	4.9 (4.0–5.9)		10,662 (51.6)	0.9 (0.7–1.2)		17,624 (52.6)	2.5 (2.1–2.9)	

Table 1 (continued)

Factors	Urban Nigeria			Rural Nigeria			Overall Nigeria		
	Weighted sample (%)[a]	Prevalence of CS		Weighted sample (%)[a]	Prevalence of CS		Weighted sample (%)[a]	Prevalence of CS	
		95% CI	*p*-values		95% CI	*p*-values		95% CI	*p*-values
Small	1605 (12.5)	4.9 (3.7–6.4)		3064 (14.8)	1.2 (0.8–1.9)		4669 (13.9)	2.5 (1.9–3.1)	
Birth interval (preceding)			0.795			0.262			0.407
< 24 months	2503 (24.4)	4.2 (3.0–5.9)		4322 (25.2)	0.8 (0.5–1.2)		6825 (24.9)	2.1 (1.6–2.7)	
24 or more months	7755 (75.6)	4.4 (3.8–5.1)		12,823 (74.8)	1.0 (0.8–1.3)		20,578 (75.1)	2.3 (2.0–2.6)	
Birth type			< 0.001*			< 0.001*			< 0.001*
Multiple	466 (3.6)	13.8 (9.4–19.9)		805 (3.8)	3.2 (1.9–5.3)		1271 (3.7)	7.1 (5.2–9.7)	
Single	12,629 (96.4)	4.9 (4.2–5.8)		20,157 (96.2)	1.1 (0.9–1.3)		32,786 (96.3)	2.6 (2.3–2.9)	
Ethnicity			< 0.001*			< 0.001*			< 0.001*
Hausa/Fulani	3986 (30.4)	1.7 (1.2–2.3)		11,748 (56.0)	0.4 (0.3–0.7)		15,735 (46.2)	0.7 (0.6–1.0)	
Yoruba	2973 (22.7)	5.1 (4.0–6.7)		759 (3.6)	4.7 (2.7–8.2)		3732 (11.0)	5.1 (4.0–6.4)	
Igbo	3061 (23.4)	9.7 (7.7–12.1)		1184 (5.6)	3.4 (2.5–4.5)		4246 (12.5)	7.9 (6.4–9.7)	
Others	3075 (23.5)	5.5 (4.3–7.0)		7270 (34.7)	1.6 (1.3–2.1)		10,345 (30.4)	2.8 (2.3–3.3)	
Health enabling factors									
Antenatal care (ANC) contacts			< 0.001*			< 0.001*			< 0.001*
ANC use (8 or more contacts)	2958 (35.3)	10.4 (8.8–12.3)		1355 (10.4)	4.6 (3.5–6.1)		4313 (20.1)	8.6 (7.4–10.0)	
ANC underuse (7 or less contacts)	5427 (64.7)	3.3 (2.7–3.9)		11,728 (89.6)	1.0 (0.8–1.3)		17,155 (79.9)	1.7 (1.5–2.0)	
Health insurance coverage			< 0.001*			0.053			< 0.001*
Yes	488 (3.7)	17.1 (12.4–23.1)		239 (1.1)	2.7 (1.1–6.5)		727 (2.1)	12.4 (8.9–16.9)	
No	12,607 (96.3)	4.8 (4.1–5.6)		20,723 (98.9)	1.1 (1.0–1.4)		33,331 (97.9)	2.5 (2.2–2.8)	
Place of delivery			< 0.001*			< 0.001*			< 0.001*
Private health facility	3074 (24.1)	13.6 (11.3–16.3)		1244 (6.0)	7.5 (5.7–9.7)		4318 (12.9)	11.8 (10.1–13.8)	
Public health facility	4893 (38.4)	5.5 (4.6–6.5)		4115 (19.8)	3.7 (3.0–4.5)		9008 (26.9)	4.7 (4.1–5.3)	
Home	4787 (37.5)	0 (0–0)		15,388 (74.2)	0 (0–0)		20,175 (60.2)	0 (0–0)	
Distance to health facility			0.374			< 0.001*			< 0.001*
Big problem	2205 (16.8)	4.7 (3.5–6.1)		7366 (35.1)	0.7 (0.5–1.0)		9572 (28.1)	1.6 (1.3–2.0)	
Not a big problem	10,890 (83.2)	5.4 (4.5–6.3)		13,596 (64.9)	1.4 (1.1–1.7)		24,486 (71.9)	3.2 (2.8–3.6)	
Permission to visit health facility			< 0.001*			0.002*			< 0.001*
Big problem	1024 (7.8)	2.2 (1.3–3.6)		2999 (14.3)	0.6 (0.3–0.9)		4022 (11.8)	1.0 (0.7–1.4)	

Table 1 (continued)

Factors	Urban Nigeria			Rural Nigeria			Overall Nigeria		
	Weighted sample (%)[a]	Prevalence of CS		Weighted sample (%)[a]	Prevalence of CS		Weighted sample (%)[a]	Prevalence of CS	
		95% CI	*p*-values		95% CI	*p*-values		95% CI	*p*-values
Not a big problem	12,072 (92.2)	5.5 (4.7–6.4)		17,964 (85.7)	1.3 (1.1–1.5)		30,035 (88.2)	3.0 (2.6–3.4)	
Getting money for health services			< 0.001*			0.004*			< 0.001*
Big problem	5044 (38.5)	3.9 (3.2–4.8)		11,526 (55.0)	0.9 (0.7–1.1)		16,570 (48.7)	1.8 (1.5–2.1)	
Not a big problem	8051 (61.5)	6.1 (5.1–7.3)		9436 (45.0)	1.5 (1.2–1.9)		17,487 (51.3)	3.6 (3.1–4.2)	
Need factor									
Desire for pregnancy			0.617			< 0.001*			< 0.001*
Then	11,417 (87.2)	5.1 (4.4–6.0)		19,180 (91.5)	1.0 (0.9–1.2)		30,597 (89.8)	2.6 (2.3–2.9)	
Later	1269 (9.7)	5.9 (3.9–8.7)		1328 (6.3)	2.5 (1.6–3.9)		2597 (7.6)	4.2 (3.1–5.6)	
No more	409 (3.1)	6.1 (3.9–9.3)		454 (2.2)	2.8 (1.6–5.0)		864 (2.5)	4.4 (3.1–6.2)	
Information access factors									
Frequency of reading newspaper/magazine			< 0.001*			< 0.001*			< 0.001*
Not at all	10,446 (79.8)	4.0 (3.3–4.8)		19,783 (94.4)	1.0 (0.8–1.2)		30,230 (88.8)	2.0 (1.8–2.3)	
< Once a week	1915 (14.6)	10:1 (8.1–12.6)		857 (4.1)	3.0 (1.8–4.9)		2773 (8.1)	7.9 (6.4–9.7)	
≥ Once a week	734 (5.6)	10.2 (7.1–14.4)		321 (1.5)	7.9 (4.8–12.8)		1055 (3.1)	9.5 (7.0–12.6)	
Frequency of listening to radio			0.001*			< 0.001*			< 0.001*
Not at all	4124 (31.5)	3.3 (2.5–4.4)		12,121 (57.8)	0.6 (0.5–0.8)		16,245 (47.7)	1.3 (1.1–1.6)	
< Once a week	3759 (28.7)	6.6 (5.2–8.4)		4451 (21.2)	1.7 (1.3–2.3)		8210 (24.1)	4.0 (3.2–4.8)	
≥ Once a week	5212 (39.8)	5.8 (4.7–7.1)		4390 (20.9)	2.0 (1.5–2.7)		9602 (28.2)	4.1 (3.4–4.8)	
Frequency of watching television			< 0.001*			< 0.001*			< 0.001*
Not at all	4094 (31.3)	1.6 (1.1–2.3)		15,434 (73.6)	0.6 (0.4–0.8)		19,528 (57.3)	0.8 (0.6–1.0)	
< Once a week	2944 (22.5)	4.8 (3.7–6.3)		2812 (13.4)	2.2 (1.6–3.1)		5755 (16.9)	3.6 (2.9–4.4)	
≥ Once a week	6057 (46.3)	7.9 (6.7–9.3)		2716 (13.0)	3.3 (2.6–4.4)		8774 (25.8)	6.5 (5.6–7.5)	
Frequency of Internet use			< 0.001*			< 0.001*			< 0.001*
Not at all	10,578 (80.8)	3.2 (2.7–3.7)		20,444 (97.5)	1.0 (0.8–1.1)		31,022 (91.1)	1.7 (1.5–1.9)	
< Once a week	413 (3.2)	7.7 (4.6–12.5)		105 (0.5)	6.9 (2.9–15.2)		518 (1.5)	7.5 (4.8–11.5)	
≥ Once a week	2104 (16.1)	15.1 (12.3–18.4)		413 (2.0)	10.1 (6.9–14.6)		2517 (7.4)	14.3 (11.8–17.1)	

[#]Prevalence of vaginal delivery, *CI* confidence interval, *Significant at < 1% level, ** Significant at < 5% level, [a] weighted sample size and percentages

95%CI: 1.51, 4.45) of a CS than those without education. Similarly, mothers living in urban areas had higher odds of having their childbirth through CS compared to their rural counterparts (AOR: 1.28, 95% CI: 1.01, 1.63). The odds and significance of a CS increased substantially in urban residences once the 'wealth index' was excluded from the model, suggesting wealth strongly influenced CS utilisation in Nigeria. Mothers from rich households

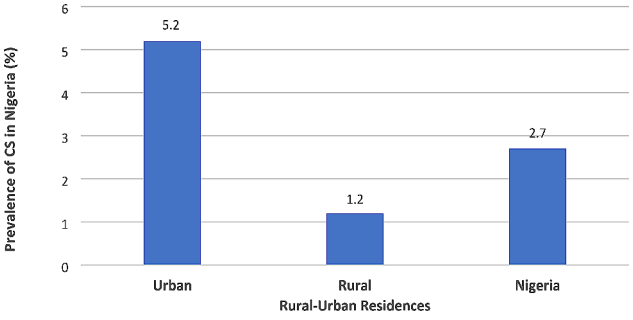

Fig. 1 CS prevalence across rural and urban residences in Nigeria

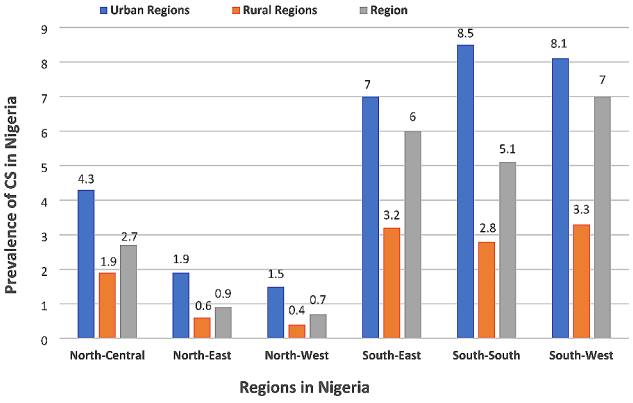

Fig. 2 CS prevalence by rural and urban residences across regions in Nigeria

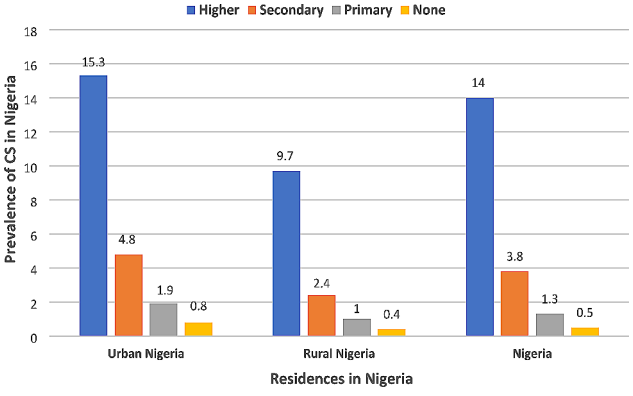

Fig. 3 CS prevalence by rural and urban residences across maternal education level

(AOR: 2.92, 95% CI: 1.74, 4.90) or middle wealth status (AOR: 1.97, 95% CI: 1.16, 3.33) had more likelihood of CS than their counterparts from poor households. Likewise, mothers aged 35–39 years (AOR: 2.55, 95% CI: 1.13, 5.75) and 40–44 years had higher odds (AOR: 3.11, 95% CI: 1.34, 7.25) of CS compared to mothers aged 15–19.

Mothers with eight or more antenatal contacts had higher odds of CS than those with seven or fewer contacts (AOR: 1.69, 95% CI: 1.36, 2.09). Additionally, compared to mothers with a birth order≥4, we found increased odds of CS among those with a birth order of

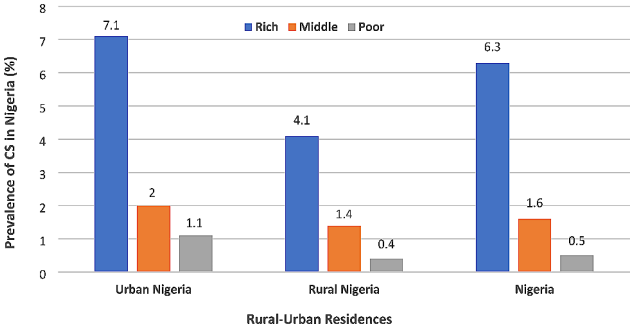

Fig. 4 CS prevalence by rural and urban residences across wealth index

one (AOR: 3.16, 95% CI: 2.23, 4.48) and those with a birth order of 2–3 (AOR: 1.98, 95% CI: 1.49, 2.62). Furthermore, multiple births (AOR: 3.17, 95% CI: 1.96, 5.13) and larger birth size (AOR: 1.38, 95% CI: 1.11, 1.71) increased the odds of a CS. Mothers who used the internet at least once a week (AOR: 1.70, 95% CI: 1.25, 2.30), those who identified as Christians (AOR: 1.76, 95% CI: 1.32, 2.34) and those with no difficulty in getting permission for healthcare services (AOR: 2.06, 95% CI: 1.31, 3.22) had higher odds of a CS.

Factors associated with CS in urban residences in Nigeria

Table 2 similarly presents factors associated with CS in urban Nigeria. Mothers with higher education (AOR: 2.54, 95% CI: 1.23, 5.26), those from rich wealth category (AOR: 2.70, 95% CI: 1.16, 6.29), and those aged 35–39 years (AOR: 3.36, 95% CI: 1.31, 8.64) or 40–44 years (AOR: 3.45, 95% CI: 1.29, 9.23) had increased odds of CS, compared to their respective counterparts. Similarly, mothers who recorded eight or more ANC sessions were more likely to have a CS (AOR: 1.78, 95% CI: 1.37, 2.32) than those with fewer ANC contacts. A birth order of one (AOR: 3.24, 95% CI: 2.17, 4.81) and 2–3 (AOR: 2.09, 95% CI: 1.50, 2.91) significantly increased the likelihood of CS when compared to a birth order of four or more. Mothers of multiple births (AOR: 3.96, 95% CI: 2.15, 7.31), those who identified as Christians (AOR: 1.73, 95% CI: 1.24, 2.42), who used the internet at least once a week (AOR: 1.72, 95% CI: 1.22, 2.43), or those for whom obtaining consent to access a healthcare facility posed no challenges (AOR: 1.94, 95% CI: 1.04, 3.61) had higher odds of a CS in urban Nigeria.

Factors associated with CS in rural residences in Nigeria

Table 2 presents factors associated with CS in rural Nigeria. These factors include a higher level of education for mothers (AOR: 2.53, 95%CI: 1.13, 5.68) and their husbands (AOR: 3.16, 95% CI: 1.43, 6.98), compared to no education, respectively. Mothers in the rich wealth index (compared to poor wealth category, AOR: 2.51, 95%CI: 1.22, 5.14) and those having ANC of at least eight times

Table 2 Factors associated with caesarean section in Nigeria and across urban and rural residences

Factors	Urban Nigeria			Rural Nigeria			Overall Nigeria		
	AOR	95%CI	*P*-value	AOR	95%CI	*P*-value	AOR	95%CI	*P*-value
Maternal education			< 0.001*			0.037**			< 0.001*
Primary	1.00	0.46–2.17	0.997	0.96	0.41–2.24	0.925	1.08	0.63–1.88	0.772
Secondary	1.61	0.79–3.32	0.193	1.38	0.64–3.00	0.409	1.57	0.93–2.67	0.092
Higher	2.54	1.23–5.26	0.012**	2.53	1.13–5.68	0.025**	2.60	1.51–4.45	0.001*
No education	1.00	Reference	-	1.00	Reference	-	1.00	Reference	-
Residence									0.042**
Urban							1.28	1.01–1.63	0.042**
Rural							1.00	Reference	-
Husband education level						0.018**			
Higher				3.16	1.43–6.98	0.004*			
Primary				2.01	0.74–5.42	0.169			
Secondary				1.94	0.91–4.14	0.085			
No education				1.00	Reference	-			
Wealth index			0.008*			0.037**			< 0.001*
Rich	2.70	1.16–6.29	0.021**	2.51	1.22–5.14	0.012**	2.92	1.74–4.90	< 0.001*
Middle	1.66	0.70–3.91	0.25	1.98	0.96–4.09	0.065	1.97	1.16–3.33	0.012**
Poor	1.00	Reference	-	1.00	Reference	-	1.00	Reference	-
Maternal age			< 0.001*			0.006*			0.002*
20–24	0.89	0.36–2.20	0.801	1.70	0.48–6.03	0.410	0.66	0.29–1.50	0.325
25–29	1.27	0.51–3.16	0.608	1.31	0.65–2.66	0.448	0.98	0.44–2.18	0.956
30–34	1.91	0.76–4.80	0.169	2.98	1.45–6.13	0.003*	1.56	0.70–3.47	0.274
35–39	3.36	1.31–8.64	0.012**	3.76	1.75–8.10	0.001*	2.55	1.13–5.75	0.024**
40–44	3.45	1.29–9.23	0.014**	4.97	1.96–12.64	0.001*	3.11	1.34–7.25	0.008*
45–49	7.81	2.78–21.96	< 0.001*	2.98	0.97–9.15	0.056	4.06	1.64–10.07	0.002*
15–19	1.00	Reference	-	1.00	[#]Reference	-	1.00	Reference	-
ANC contacts			< 0.001*			0.021**			< 0.001*
ANC use (8 or more contacts)	1.78	1.37–3.32	< 0.001*	1.54	1.07–2.21	0.021**	1.69	1.36–2.09	< 0.001*
ANC underuse (7 or less contacts)	1.00	Reference	-	1.00	Reference	-	1.00	Reference	-
Birth order			< 0.001*			0.004*			< 0.001*
1	3.24	2.17–4.81	< 0.001*	3.30	1.64–6.64	0.001*	3.16	2.23–4.48	< 0.001*
2–3	2.09	1.50–2.91	< 0.001*	1.96	1.12–3.44	0.019**	1.98	1.49–2.62	< 0.001*
≥ 4	1.00	Reference	-	1.00	Reference		1.00	Reference	-
Birth type			< 0.001*						< 0.001*
Multiple	3.96	2.15–7.31	< 0.001*				3.17	1.96–5.13	< 0.001*
Singe	1.00	Reference	-				1.00	Reference	-
Birth size						0.004*			0.01**
Large				1.96	1.31–2.92	0.001*	1.38	1.11–1.71	0.004*
Small				1.88	1.06–3.35	0.032**	1.33	0.98–1.80	0.068
Average				1.00	Reference	-	1.00	Reference	-
Frequency of using the Internet			0.008*						0.003*
< Once a week	1.12	0.59–2.12	0.198				1.07	0.61–1.86	0.814
≥ Once a week	1.72	1.22–2.43	0.002*				1.70	1.25–2.30	0.001*
Not at all	1.00	Reference	-				1.00	Reference	-
Maternal religion			0.006*						< 0.001*
Christianity	1.73	1.24–2.42	0.001*				1.76	1.32–2.34	< 0.001*
Traditionalist/others	1.43	0.46–4.41	0.537				0.82	0.24–2.80	0.755
Islam	1.00	Reference	-				1.00	Reference	-
Getting permission for healthcare			0.006*						0.002*
Not a big problem	1.94	1.04–3.61	0.006*				2.06	1.31–3.22	0.002*
Big problem	1.00	Reference	-				1.00	Reference	-
Desire for pregnancy						0.056			
No more				1.73	0.84–3.55	0.134			

Table 2 (continued)

Factors	Urban Nigeria			Rural Nigeria			Overall Nigeria		
	AOR	95%CI	*P*-value	AOR	95%CI	*P*-value	AOR	95%CI	*P*-value
Later				1.77	1.01–3.11	0.047**			
Then				1.00	Reference	-			
Decision on own health						0.03**			
Respondent alone				1.44	0.82–2.50	0.201			
Respondent and spouse				1.68	1.14–2.46	0.008*			
Spouse alone/someone else/others				1.00	Reference	-			

AOR adjusted odds ratio, *Significant at 1% level, **Significant at *5%* level, #Age 20–24 was chosen as the reference category in rural Nigeria to clarify the significance of the association of maternal age with CS odds. *Note* We reported only the significant factors in each of the residences. A factor may be significant in one residence but not in the other, explaining why some variables could have vacant spaces in one or more residences. To prevent over-fitting and or low statistical power, we included only factors significant at $P<0.05$ (in Table 1) in our multivariable modelling

Factors included in the multivariable model but not significant in urban residence: Regions of residence, Frequency of watching TV, Frequency of listening to radio, Frequency of reading newspapers, Husband education level, Getting money for treatment, Health insurance coverage, Husband's working status, Decision on own health

Factors included in the multivariable model but not significant in rural residence: Regions of residence, Frequency of watching TV, Frequency of listening to radio, Frequency of reading newspapers, Getting permission for medical help, Getting money for treatment, Distance to healthcare facility, Health insurance coverage, Maternal working status, Birth type, Frequency of internet use, Maternal religion

Factors included in the multivariable model but not significant in overall Nigeria: Regions of residence, Frequency of watching TV, Frequency of listening to radio, Frequency of reading newspapers, Getting money for treatment, Distance to healthcare facility, Health insurance coverage, Maternal working status, Husband's working status, Desire for pregnancy, Decision on own health

(compared to seven or fewer contacts, AOR:1.54, 95% CI: 1.07, 2.21) had increased odds of CS. Similarly, mothers aged 30–34 demonstrated nearly 3 times higher odds of CS (AOR: 2.98, 95% CI: 1.45, 6.13) compared to those aged 20–24. Similar trends were observed for older age groups, including mothers aged 35–39 years (AOR: 3.76, 95% CI: 1.75, 8.10) and 40–44 years (AOR: 4.97, 95% CI: 1.96, 12.64).

Compared to the birth order≥4, birth order of one (AOR: 3.30, 95% CI: 1.64, 6.64), and 2–3 (AOR: 1.96, 95% CI: 1.12, 3.44), respectively, were associated with increased odds of having a CS. Additionally, large birth size (AOR: 1.96, 95% CI: 1.31, 2.92) and small birth size (AOR: 1.88, 95% CI: 1.06, 3.35) increased the odds of a CS, compared to average birth size. In comparison to those who desired pregnancy at the time they conceived, mothers who had such desire later (potentially unplanned pregnancy) demonstrated higher odds of a CS (AOR: 1.77, 95% CI: 1.01, 3.11). Finally, mothers who jointly made decisions with their spouse on their health had increased odds of a CS (AOR: 1.68, 95% CI: 1.14, 2.46) compared to their counterparts for whom such decisions were made without their involvement.

Comparing factors associated with CS across rural and urban Nigeria

In rural and urban Nigeria, several common factors were associated with the odds of a CS. First is a higher maternal education level with comparable effect sizes (rural: AOR 2.53, 95% CI: 1.13, 5.68; urban: AOR 2.54, 95% CI: 1.23, 5.26). Secondly, mothers from wealthier households had elevated odds of a CS, regardless of whether they resided in rural or urban areas in Nigeria. Estimates of effect sizes are similarly comparable (rural: AOR 2.51, 95% CI: 1.22, 5.14; urban: AOR 2.70, 95% CI: 1.16, 6.29). Thirdly, in both settings, having optimal ANC contacts (≥8) increased the odds of a CS (rural: AOR 1.54, 95% CI: 1.07, 2.2; urban: AOR 1.78, 95% CI: 1.37, 2.32). Moreover, in both rural and urban contexts, older mothers, particularly those aged 30–44, were more likely to undergo a CS. Lastly, lower birth order was associated with increased CS odds in both rural and urban areas (rural: AOR 3.30 [birth order of one], AOR 1.96 [birth order of 2–3]; urban: AOR 3.24 [birth order of one], AOR 2.09 [birth order of 2–3]). Despite these shared factors, disparities exist between rural and urban Nigeria regarding factors associated with CS.

In rural Nigeria, birth size was a significant factor, with both larger and smaller birth sizes increasing the odds of CS compared to average-sized births. This factor did not exhibit a significant association in urban settings. The timing of 'desire for pregnancy' also revealed differences. In rural areas, mothers who desired pregnancy later (potentially unplanned pregnancy) had higher odds of a CS, whereas this factor was not significant in urban Nigeria. Spousal involvement in health decisions emerged as a noteworthy factor in rural Nigeria, where mothers who made joint healthcare decisions with their husbands had increased CS odds. Conversely, this factor did not show a significant association in urban Nigeria. While older maternal ages of 30–44 years were significantly associated with CS in both residences, maternal age of 45 years and above was associated with CS only in rural Nigeria. In rural Nigeria, mothers whose husbands had higher education levels demonstrated increased odds of a CS; this association was not observed in urban areas. Notably, several unique factors were associated with CS only in urban Nigeria, including multiple births, religious

affiliation (with mothers professing Christianity having higher odds), frequency of internet use, and the ease of obtaining permission to visit health facilities.

Discussion

We present a comprehensive exploration of CS prevalence and associated factors in Nigeria, focusing on rural-urban inequalities. Our analysis reveals an overall CS prevalence of 2.7% (95%CI: 2.4, 3.1, $P<0.001$), which is consistent with previous studies reporting CS utilisation in Nigeria [24, 25, 31] (i.e., results are within our estimated 95%CI). Compared to the 2.0% reported in 2008 [38] and the 2.1% reported in 2013 [9], the present finding indicates a marginal increase in CS use; nonetheless, our study supports an underutilisation, indicating unmet needs and emphasising the necessity for improved access to life-saving CS in Nigeria. Consistent with this position, the CS prevalence in our study is considerably lower than the pooled estimate for sub-Saharan Africa (6.04%)[31] and those of similar African countries, including Rwanda 15.6% (in 2019–2020) [39], Ghana (12.80% in 2014) [40], Liberia (5.48 in 2019–2020) [31], and Togo (7.0 in 2013–2014) [31]. Our estimated CS prevalence also differs from findings in healthcare facility-based studies, an example being a recent systematic review reporting a prevalence of 17.6% across Nigeria [22]. Institutional CS prevalence represents a proportion of caesarean births relative to the total number of deliveries at a healthcare facility, and this can vary widely (particularly, in tertiary health centres), not necessarily reflecting the population-level prevalence [9, 22]. The WHO's position that CS rates exceeding 10–15% have no additional benefits relates to population-based estimates [1, 6, 7].

We assessed the within-population differences in CS prevalence and associated factors across rural and urban residences in Nigeria. To our knowledge, this is the first study to provide this critical insight into CS utilisation in Nigeria. We notably uncovered a substantial gap between rural and urban areas, with rural respondents having a nearly fourfold lower CS prevalence (1.2%) than their urban counterparts (5.2%). CS prevalence similarly differs between rural and urban Nigeria across geographic, educational, and socioeconomic factors. The significant gap in CS utilisation suggests access challenges in rural Nigeria, aligning with social inequities due to geographic and economic disparities [41]. This observation gains further support across regions in the country. For instance, CS prevalence was generally higher in the southern compared to the northern regions. Even in rural areas, CS prevalence in the southern regions exceeded that of any northern region, be it urban, rural, or overall, except urban North-Central. These significant rural-urban and regional variations likely mirror Nigeria's healthcare facility distribution. The WHO recommends a minimum of five emergency obstetric care facilities per 500,000 people, with at least one capable of CEmOC, evenly spread across all subpopulations [42]. There is no convincing evidence to suggest this level of facility and service coverage, particularly in rural areas in Nigeria [43–46]. Contrariwise, inadequate or sparsely distributed CEmoC facilities and expertise are commonly reported [43–47], and citing facilities (or services) is primarily influenced by donor funding and political pressure rather than data-driven needs assessments [46].

In all residences, higher maternal education was strongly associated with increased CS odds, echoing previous evidence of maternal education's centrality to healthcare services utilisation [9, 24, 26, 27]. Urban residency also demonstrated a significant association with higher odds of CS (overall population), similar to findings in Nigeria [9, 25], Ghana [40], Burundi [48] and several countries in sub-Saharan Africa [31], potentially reflecting the 'urban advantage' in access to better health infrastructure and services [27, 29, 31]. Furthermore, mothers from rich households had elevated CS odds across overall, rural, and urban settings in Nigeria, reflecting socioeconomic disparities in CS access in Nigeria [49]. By excluding the 'wealth index' from our adjusted model, we observed a substantial increase in the disparity of CS odds between rural and urban residences, indicating socioeconomic inequalities indeed play a pivotal role in CS utilisation in Nigeria. Thus, addressing socioeconomic inequalities represents a notable intervention implicated in our study.

The finding of increased CS odds among mothers aged ≥35 in all residences suggests age-related complications or maternal preferences in this demographic. The link of optimal ANC with increased CS odds also cuts across all residences in Nigeria, possibly signifying the heightened medical surveillance that ANC services promise [27]. Optimal ANC may expose pregnant women to health information and potentially contribute to debunking myths about CS. Lastly, primiparous mothers and those with a birth order of 2–3 had elevated CS odds, suggesting higher childbirth risks necessitating surgical delivery among first-time mothers or those with fewer prior pregnancies. Current findings align with the NDHS 2013 results [9], except for 'husband education' and 'health insurance coverage,' which did not retain significance in the overall and urban residences in the present study.

Factors associated with CS in urban areas include multiple births, Christianity, frequency of internet use, and ease of obtaining permission for healthcare services. These factors may be explained by urban advantages such as healthcare infrastructure, access to information, employment opportunities, cultural or religious diversity, technology, social amenities, and autonomy or likely

support systems for health decision-making. The finding that internet access is associated with CS in urban residences is particularly interesting, given its potential to contribute to the socioeconomic well-being of the population [50, 51]. Internet access is a fundamental human right [50, 51], and the United Nations supports its unrestricted access [51]. Further recognising its potential, Internet connectivity and digital literacy have been termed the "super social determinants of health" because of their capacity to influence other social determinants of health [52, 53]. However, the proportion of mothers using the internet is low, and extremely so in rural Nigeria (<3%), indicating poor access, a likely reason the factor was not significant in rural areas. Improved internet access can facilitate information accessibility, telemedicine, online prenatal education, networking, socialising, and virtual meetings [52–54]. These enhancements can benefit timely access to resources, cost-saving, informed decision-making, and more effective healthcare service utilisation [52–54], including CS, as indicated in the present study.

In rural Nigeria, the likelihood of a CS was uniquely associated with disproportionate birth size (large or small), a recognised indication of CS [3]. This finding agrees with similar observations in 28 countries in Sub-Saharan Africa [31] and echoes results from the NDHS 2013 analysis conducted on the broader Nigerian population [9]. Limited resources and expertise in managing complicated deliveries in rural areas compared to urban settings may explain this association. Other factors such as unplanned pregnancy and spousal involvement in healthcare decision-making increased CS odds exclusively in rural residences. The results regarding unplanned pregnancies might signal limited knowledge or access to family planning services in rural areas—a crucial entry point for targeted interventions.

On the other hand, collaborative healthcare decision-making that harnesses the autonomy of mothers and incorporates spouses' inputs may be a vital contributor to utilising life-saving CS (and perhaps other healthcare services) in the context of rural Nigeria. Furthermore, mothers whose husbands attained higher education demonstrated increased odds of CS in rural areas, supporting the influence of education on healthcare decision-making. Identifying this factor in rural residences may underscore the considerable gap in husbands' higher educational attainments between rural (7.9%) and urban (25.9%) residences. Providing educational opportunities for rural mothers and their husbands can improve CS utilisation in rural Nigeria. Furthermore, higher spousal education attainment, especially in rural areas, may indicate a higher socioeconomic status, contributing to greater access to healthcare resources and services, including CS.

Implications and recommendations

Current findings have far-reaching implications for CS utilisation in Nigeria. Firstly, addressing the rural-urban disparities requires immediate attention through targeted interventions. These interventions may focus on enhancing the availability and accessibility of CS facilities and services, engaging community and religious leaders to promote acceptance, combating misinformation, utilising culturally and religiously sensitive behaviour change communication approaches, promoting optimal ANC utilisation, raising awareness about the life-saving benefits of CS, and improving the expertise of healthcare providers. The recommendation for awareness of CS is critical, given previous evidence indicating that mothers are averse to the procedure [19], likely due to misconceptions and traditional or even religious beliefs in Nigeria.

Secondly, the link between higher maternal education and increased CS prevalence brings to the fore the importance of prioritising formal education for girls in Nigeria. This premise gains further significance given the relatively low levels of higher educational attainment in the country (8.2%), especially among rural mothers (3.0%). The result implicating 'husband's education' in rural residences further supports the need for educational interventions in these regions. Providing an enabling environment for rural dwellers to achieve their educational potential can foster socioeconomic empowerment, poverty reduction, gender equality, informed decision-making ability and improved health-seeking behaviours. Specific strategies should include implementing targeted educational campaigns to increase awareness about the benefits of education in rural communities and providing scholarships, tuition fee waivers, or financial incentives for girls' education. Advocating for government policies that allocate more resources to build and maintain schools in rural areas, training and supporting teachers specifically for rural schools, ensuring access to educational materials, and integrating culturally relevant curriculum content are additional actionable steps. Collaborating with local educational institutions, community leaders, and non-governmental organisations can also foster the establishment of programs that provide accessible and culturally sensitive educational opportunities for girls and women.

Thirdly, with 'wealth index' as a significant predictor of CS in all residences, socioeconomic barriers to healthcare utilisation persist in Nigeria. Interestingly, health insurance did not demonstrate significance as a CS predictor in any location (multivariable analyses); hence, merely subsidising costs or eliminating user fees may not necessarily boost CS utilisation. This position aligns with the findings of a study on user fee exemption in Nigeria, which revealed lower CS rates among low-income women, notwithstanding the availability of free maternal

healthcare services [21]. Thus, a comprehensive intervention strategy that addresses systemic issues such as socioeconomic inequalities and creates job opportunities could be more effective [41]. Specific strategies can focus on supporting agriculture, small businesses, and entrepreneurship in rural areas through programs that provide microloans, subsidies, and technical training to empower rural communities socioeconomically. Enhancing access to quality education and vocational training is also crucial for improving employability. This recommendation can be achieved through initiatives such as provision of scholarships and the establishment of vocational centres. Furthermore, investing in rural healthcare infrastructure by building well-equipped facilities staffed with trained professionals and implementing mobile health clinics and telemedicine services can bridge gaps in healthcare access.

Notably, our research revealed that religion significantly predicts CS in urban and overall Nigerian populations, which may contribute to the lack of significance of health insurance. Religious beliefs can strongly influence healthcare decisions, creating barriers for women due to accepted norms, religious or cultural practices. This observation may also explain the result of a study [41] that indicated low-income women underutilised CS, notwithstanding free maternal healthcare services. Hence, addressing cultural and religious factors, such as engaging community and religious leaders to promote CS acceptance, is crucial. By understanding and respecting religious or cultural perspectives, raising awareness, and training healthcare providers in culturally sensitive care, policymakers can promote equitable access to CS and maternal healthcare services.

Lastly, the association between internet use and CS in urban areas suggests the potential effectiveness of digital health campaigns and online platforms for telemedicine, health awareness or education. Efforts to provide equitable access to the Internet may, thus, contribute to bridging CS (and other maternal healthcare services [26]) utilisation inequalities, across rural and urban Nigeria. While providing equal access to the Internet for urban and rural areas in Nigeria presents challenges, it is a crucial step towards reducing inequalities and improving healthcare outcomes. Encouraging partnerships between the government and the private sector to invest in Internet connectivity in rural areas can contribute to achieving this goal. Also, governments can subsidise broadband installation costs and incentivise telecommunication companies to expand their services in rural areas. Establishing community Wi-Fi programs, and providing Internet access in central locations such as schools, healthcare, and community centres can also enhance accessibility. Additionally, conducting digital literacy training programs will ensure that rural populations can effectively utilise Internet services for health information, education, and other vital services.

Strengths and limitations

This study has several notable strengths that enhance the credibility and relevance of its findings. We used recent, nationally representative datasets with high response rates and a rigorous rural-urban data disaggregation approach. Accordingly, our findings are generalisable, providing valuable insights into the prevalence of CS and the associated factors across geographic divides in Nigeria. With a large sample size, data disaggregation does not undermine the study's generalisability. The data utilised in our study maintains a low rate of missing information. We implemented complex sample statistics during data analysis, enhancing our estimates' representativeness, accuracy, and unbiasedness. Importantly, this study is Nigeria's first nationally representative endeavour to comprehensively investigate the prevalence of CS and its associated factors with data disaggregated for rural and urban contexts.

However, it is crucial to consider the limitations of this study when interpreting its results. Firstly, the study's cross-sectional design restricts its capacity to establish causal relationships between the outcome and predictor variables. Secondly, the dataset we analysed relies on self-reported information collected retrospectively, making it susceptible to potential biases associated with social desirability and information recall. Furthermore, due to a significant proportion of missing data for body mass index, the study did not include obesity among the factors analysed. Notably, the WHO recommends using the Robson classification for CS within and between healthcare facilities; hence, it was not applied in this population-based study. Lastly, our study could not stratify CS into emergency or elective categories due to data constraints.

Conclusion

This study provides new insights into the use of CS and the associated factors in Nigeria, focusing on the inequalities between rural and urban areas. Our findings revealed approximately four times higher prevalence and increased odds of CS in urban compared to rural Nigeria. The prevalence of CS was also disproportionately lower among respondents in northern regions and those in the low socioeconomic stratum, highlighting geographic and socioeconomic inequalities in access to this life-saving obstetric care services in Nigeria. Predictors of CS utilisation showed varying degrees of significance in rural and urban residences. While some factors were consistent across both settings, such as maternal education, wealth status, maternal age, and ANC contacts, others displayed notable differences. In rural areas, abnormal

birth size, unplanned pregnancy, spousal involvement in health decisions, older maternal age>45 years, and husbands' higher education levels increased the odds of CS. In contrast, multiple births, Christianity, frequency of internet use, and ease of getting permission to visit healthcare facilities increased the odds of CS in urban areas. Our study highlights the imperatives of addressing inequalities in CS access, particularly in rural areas and the northern regions. Targeted interventions are needed for mothers adherent to Islam or Traditional/other religions (in urban areas), uneducated mothers (in all residences), and socioeconomically disadvantaged mothers (in all residences). Bridging socioeconomic inequalities between rural and urban areas (e.g., by supporting rural residents in agriculture, small businesses, and entrepreneurship) is crucial. Also, providing well-equipped facilities across geographic divides, facilitating equitable access to the Internet (e.g., through public-private partnership and community Wi-Fi), and encouraging optimal ANC use are other practical steps towards addressing inequitable utilisation of life-saving CS in Nigeria.

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Author contributions
EOA and VK conceived and designed this study. EOA carried out statistical analysis, AAP extracted data and populated Tables, and EOA, VK and MIA contributed to interpreting the results. EOA, WA, VO, AAP, RO, MIA, AA, and VK contributed to writing various sections of the first manuscript draft. All authors reviewed the manuscript for intellectual content and approved the final copy for submission.

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Data availability
Access to the data underlying this study is freely granted through online requests on the DHS's website at www.dhsprogram.com.

Declarations

Ethics approval and consent to participate
We utilised publicly accessible, de-identified datasets from the Demographic and Health Survey program. The survey received ethical approval from the ICF Institutional Review Board in the USA, and the National Ethics Board in Nigeria. Mothers provided informed consent both for themselves and on behalf of their children [10]. Given this research only involved a secondary analysis of completely anonymised data, there was no need for additional ethical clearance. Authors received approved access to utilise the data.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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