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Caesarean section rate in Nigeria between 2013 and 2018 by obstetric risk and socio-economic status

Sofia Berglundh[1], Lenka Benova[2,3], Gladys Olisaekee[4] and Claudia Hanson[1,3]

1 *Department of Global Public Health, Karolinska Institutet, Stockholm, Sweden*
2 *Institute of Tropical Medicine, Antwerp, Belgium*
3 *London School of Hygiene and Tropical Medicine, London, UK*
4 *The Palladium Group, Abuja, Nigeria*

Abstract

OBJECTIVES Caesarean section (CS) can be life-saving for both mother and child, but in Nigeria the CS rate remains low, at 2.7% of births. We aimed to estimate the rate of CS and early neonatal mortality in Nigeria according to obstetric risk and socio-economic background and to identify factors associated with CS.

METHODS We used the 2018 Nigeria Demographic and Health Survey, encompassing 33 924 live births within the last 5 years, to estimate the CS rate and early neonatal mortality rate (ENMR) by obstetric risk group, informed by the Robson classification. The CS rate and ENMR were assessed within each Robson group and stratified by socio-economic background. Logistic regression analyses were used to explore determinants of CS.

RESULTS Almost three-quarters (72.4%) of all births were to multiparous women, with a singleton baby of normal birthweight, thus a low-risk group similar to Robson 3, and with a CS rate of 1.0%. CS rates in the two high-risk groups (multiple pregnancy and preterm/low birthweight) were low, 7.1% (95% CI: 5.2–9.7) and 1.8 % (95% CI: 1.4–2.4), respectively. The ENMR was particularly high for multiple pregnancy (175 per 1000 live births; 95% CI: 131–230). Greater number of antenatal visits, unwanted pregnancy, multiple pregnancy, household wealth, maternal education, Christians/Others versus Muslims and referral during childbirth were positively associated with CS.

CONCLUSION Inequitable access to CS is not limited to socio-economic determinants, but also related to obstetric risk factors, calling for increased efforts to improve access to CS for high-risk pregnancies.

keywords Caesarean section, early neonatal mortality, Nigeria, socio-economic inequalities, obstetric risk, Robson classification

Sustainable Development Goals: Good Health and Well-Being, Reduced Inequalities

Introduction

Caesarean sections (CS) can be life-saving for mother and child during childbirth. However, the procedure is associated with complications [1] and should be performed based on medical indications [2]. Large variations in CS rates exist globally, ranging from 0.6% (South Sudan), indicating lack of access to this live-saving intervention, to 58.1% (Dominican Republic) where overuse is likely [3]. The smallest increase in CS rate during the last decades (1990–2014) was found in sub-Saharan Africa (from 2.3 to 3.5%) [4].

The optimal CS rate to save lives is debated but levels between 9% and 16% have been suggested in previous studies [5, 6]. To enhance the monitoring of CS use, the application of the Robson classification is recommended by WHO [7, 8]. This classification groups births into 10 totally inclusive and mutually exclusive groups based on a few commonly documented obstetric parameters (e.g. single/multiple pregnancy, term/preterm) for easy comparisons [8]. Few studies using this approach have been published from low-income countries (LIC) [9, 10].

According to the latest Nigeria DHS, the maternal mortality ratio is still high at 512 per 100 000 live births (95% confidence interval (CI): 447–578) [11]. Further, the prevalence of stillbirths is estimated at 39.6/1000 births, and 32% of those stillbirths could be associated with asphyxia [12]. A study showed that infants born by CS in Nigeria were roughly three times more likely to die than those born vaginally [13], indicating that the intervention might be used too late. Other factors associated with increased risk of adverse neonatal outcome during labour in Nigeria include referral status, parity, gestational age [12], male gender and rural residence [13].

The percentage of facility-based births estimated by the 2018 DHS was 39%; 26% of births took place in the public sector and 13% in a private health facility. The percentage of women reporting receiving any ANC was 67% and women receiving four or more visits was 57% [11]. Further, access to Emergency Obstetric Care (EmOC) in Nigeria is insufficient [14] and financial and geographical access barriers prevail [15, 16]. Cultural beliefs and negative attitudes towards CS are other possible explanations for a delay in care-seeking behaviour and low CS rate [17, 18]. As a result, the population CS rate remains low at 2.7% [11] and between 11 and 49% in facilities [19–22], with positive associations between likelihood of CS and urban residence [23], wealth and higher education level [24, 25]. Extremely low CS rates of 0.4% are found among the poorest women [24].

While the evidence of the effect of socio-economic status and place of residence on CS rates in Nigeria is well established, little is known about CS rates in relation to obstetric needs. A few facility-based studies have shown increased odds of having a CS for women with overweight, previous CS [21] and obstructed labour [22]. Only one population-based study has investigated the association between obstetric factors and CS in Nigeria using the 2013 Demographic and Health Survey (DHS) data, showing a positive association between CS and maternal age, large birth size, multiple pregnancy, primiparity, health insurance coverage, antenatal care (ANC) and maternal obesity [26].

To improve the evidence on the intersection of socio-economic inequalities and obstetric risk factors in Nigeria, we aimed to estimate the rate of CS and early neonatal mortality rate (ENMR) by applying an innovative approach with newly collected DHS variables, which allowed the concurrent analysis of obstetric risk (based on the Robson classification) and socio-economic factors.

Methods

We used the 2018 Nigeria DHS to obtain information on obstetric factors, socio-economic background, CS rate and ENMR [27]. DHS are cross-sectional, nationally representative household surveys, typically conducted in 5-year intervals. Data on maternal health and care-seeking are based on self-reports of women in reproductive age (15–49 years) within sampled households. Standardised questionnaires are used for data collection by trained enumerators. The surveys were conducted in Hausa, Yoruba, Igbo and English, which are the 4 main languages in Nigeria, and the questionnaires were pre-tested for comprehensibility.

The Nigeria DHS used two-stage sampling; after stratification of rural/urban setting, 1400 clusters were selected from the enumeration areas, and from each cluster, 30 households were randomly chosen. All women of child-bearing age were interviewed in each sampled household, yielding a total size of 41 821 women, corresponding to a response rate of 99% [11]. All live births to these women within five years prior to the survey were considered in this study (Figure 1).

Outcomes and explanatory variables

We adapted the *Conceptual framework for factors affecting Infant Mortality*, to guide our analysis [28, 29] (Figure S1). Our main outcomes were self-reported CS and early neonatal mortality (death at age <7 days) for all live births. Women who gave birth at a healthcare facility were asked 'Was (name) delivered by caesarean section, that is, did they cut your belly open to take the baby out?'. The reason for CS was clarified by 'What was the reason for taking the decision to have the CS?' [11].

We categorised births into 'modified Robson groups' using parity (nulliparous; 0 previous live birth before index pregnancy, or multiparous;>=1 previous live birth before index pregnancy), singleton/multiple pregnancy (twins or triplets categorised as multiple), full-term or preterm birth using birthweight as a proxy, breech position and whether the CS was planned or emergency. Usually, information regarding spontaneous onset of labour vs. induction is considered when assessing Robson group, as is previous CS. However, this information was not collected by the DHS. The original and modified Robson groups are presented in Table 1. Data about whether the CS was planned were used to create Robson groups 2 and 4. Information about breech position ($n = 150$) was only available in case of CS, since it was a follow-up question about the reason why CS was performed. The two most common Robson groups 1 and 3 are considered low-risk groups with rates typically below 10 %, while CS rates among groups 5 and 8 are usually fundamentally higher with rates up to 60–70% and for group 10 around 33–37% [30].

Of all live births, 98.95% were reported as full-term (born in pregnancy month 9 or 10) based on the contraceptive calendar data. Such high proportion of full-term births is improbable compared to global estimates of preterm births [31]. Therefore, the baby's birthweight was used as a proxy measurement when creating the modified

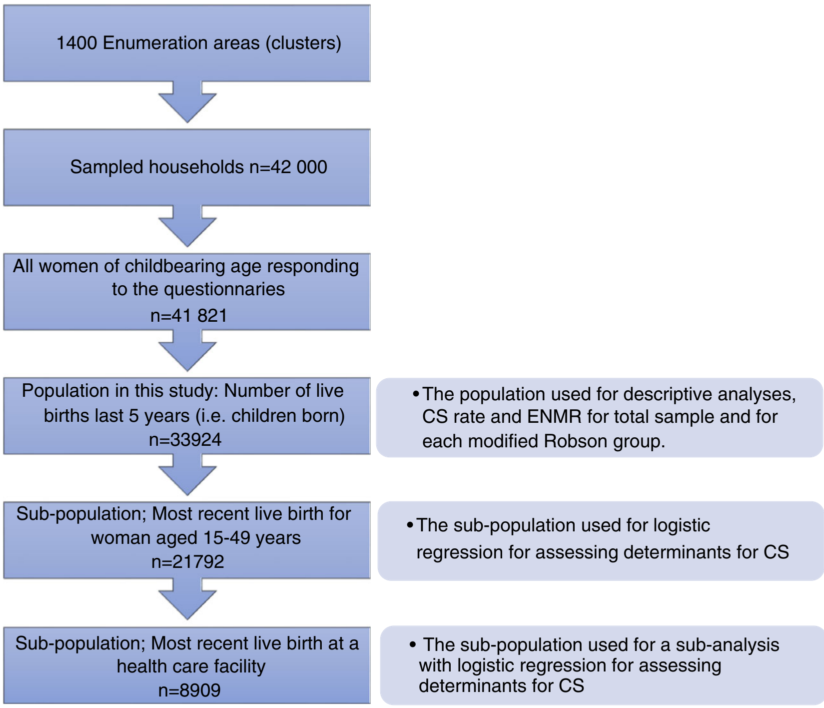

Figure 1 Flow chart of the study population. CS, caesarean section; ENMR, early neonatal mortality rate. [Colour figure can be viewed at wileyonlinelibrary.com]

Robson groups [32, 33]. The variable 'birthweight' was generated by combing two variables, since few of the infants had their actual weight recorded at birth. For babies with a recorded birthweight (22.8%), we categorised those weighing <2500 g as preterm/low birthweight. Babies with a missing birthweight were categorised based on mother's recall of baby's size (very small, small, average, larger than average). 'Very small' and 'small' were considered preterm/low birthweight, while 'average' or 'larger than average' were categorised as normal birthweight (full-term).

When exploring determinants for CS, we considered the following: within-country region, household wealth (quintiles), residence (urban/rural), religion (Islam; Christianity/Other), ethnicity (1. Hausa, Fulani, Kanuri/Beriberi; 2. Igbo, Ijaw/Izon, Ibibio, Ekoi; 3. Yoruba, Igala, Tiv; and 4. Other) [34], highest level of maternal education (no education; incomplete primary/completed primary; incomplete secondary/completed secondary; higher), maternal age group at the time of the birth (<20; 20–24.9; 25–29.9; 30–34.9; >35), marital status at the time of survey (married/cohabiting or not), wantedness of pregnancy (wanted at the time or unwanted/mistimed), sex of the baby (male; female), birthweight ('very small/small', 'average' or 'larger than average'), type of pregnancy (singleton; multiple), parity at last live birth (0, 1–3, 4+), place of birth (public primary, public hospital, private facilities), referral during childbirth (yes/no), and number of antenatal visits (none, 1–3, 4–7, 8+). The household wealth index score was calculated using principal component analysis on the basis of household assets and household characteristics. The standardised score with a mean of 0 was used to create equally sized quintiles of households. The wealth score and quintiles were provided in the DHS dataset [35, 36].

Missing data

There were 514 cases (1.5%) with missing birthweight (neither recorded birthweight nor mother's report of birth size). These observations were excluded from the modified Robson analyses. For the other determinants, there were no cases with missing data.

Statistical analyses

We estimated the percentage (95% CI) of live births by CS and ENMR (per 1000 live births). Further, the relative size of each modified Robson group and the corresponding CS rate and ENMR were calculated. Thereafter, the CS rates

Table 1 Original and modified Robson groups

	Original Robson group		Modified Robson group
1	Nulliparous, singleton, cephalic, >37 weeks' gestational age, in spontaneous labour	1	Nulliparous, singleton, registered birthweight >2500 g or estimated weight by mother as 'average size' or 'larger than average size'
2	Nulliparous, singleton, cephalic, >37 weeks' gestational age, induced labour or CS before labour	2	Nulliparous, singleton, registered birthweight >2500 g or estimated weight by mother as 'average size' or 'larger than average size'. Planned CS.
3	Multiparous (excluding previous caesarean section), singleton, cephalic, >37 weeks' gestation, in spontaneous labour	3	Multiparous, singleton, registered birthweight >2500g or estimated weight by mother as 'average size' or 'larger than average size'
4	Multiparous without a previous uterine scar, with singleton, cephalic pregnancy, >37 weeks' of gestation, induced or CS before labour	4	Multiparous, singleton, registered birthweight >2500 g or estimated weight by mother as 'average size' or 'larger than average size'. Planned CS.
5	Previous caesarean section, singleton, cephalic, >37 weeks' gestation	-	Information not available
6	All nulliparous with a single breech	6	Nulliparous and multiparous with single breech position
7	All multiparous with a single breech (including CS)	-	Combined in group 6
8	All multiple pregnancies (including previous CS)	8	All multiple pregnancies
9	All women with a single pregnancy in transverse or oblique lie (including those with previous CS)	-	Information not available
10	All singleton, cephalic, <37 weeks' gestation pregnancies (including previous caesarean section)	10	All babies categorised as small in size or with a birthweight <2500 g

CS, caesarean section.

were estimated for each modified Robson group, stratified by socio-economic background (education, wealth, residence, place of birth). When comparing CS rates between different socio-economic factors within the Robson groups, only Robson 1, 3, 8 and 10 were kept, since groups 2, 4 and 6 all had a CS rate of 100%.

Logistic regression analyses were used to explore determinants for CS. First, each independent variable was examined in bivariate analysis and variables significantly associated ($P < 0.05$) with CS were retained in multivariable analysis. When assessing the determinants for CS, only the woman's most recent live birth in the recall period was included. The rationale for this was to reduce the risk of recall bias [26] and because some variables were only available for most recent birth as well as to align with previous studies on CS [4, 37]. Referral status during childbirth was assessed in a multivariable sub-analysis, restricting the population to most recent births at a healthcare facility. The svyset command in Stata was used to account for sampling design (sample weights, clustering and stratification). All analyses were performed in Stata version 16.

Ethical considerations

The DHS surveys were approved by ICF Institutional Review Board (IRB) and by national IRB. Informed consent was obtained by each participant [38]. This secondary data analysis of anonymised data was exempt from ethical review at Karolinska Institutet.

Results

Characteristics of the study population

We included 33 924 live births (referred to as births) in the five-year period before the survey to describe CS rates and ENMR according to socio-economic background and modified Robson groups. When exploring determinants for CS, only the most recent live birth was included (n = 21 792) (Figure 1). Referral status during childbirth was assessed in a sub-sample of facility births (n = 8909).

Descriptive characteristics of the population (Table 2) show that 46.4% of the babies were born to mothers with no formal education, with a majority (61.5%) living in a rural setting (Table 2). Almost 40% of the births were among women who had given birth to four or more children before their index pregnancy. Most births occurred at home (60.6%), while around 13% of the births occurred in private health facilities. The overall CS rate was 2.7% (95% CI: 2.4–3.1) and varied across regions with the lowest rate in North-West (0.7%, 95% CI: 0.5–0.9) and highest in South-West (7.0%, 95% CI: 5.7–8.7).

Table 2 Sample characteristics, Caesarean section and Early Neonatal Mortality rates among all live births in the 2018 Nigeria DHS

	Total			Caesarean section rate			Early neonatal mortality rate		
Factor	*N*	%	95% CI	*N*	%	95% CI	*N*	Per 1000 live births	95% CI
Total number of live births†	33 924			879	2.7	(2.4–3.1)	1091	34	(31–37)
Community factors									
Region									
North-Central	5875	13.5	(12.5–14.6)	195	2.7	(2.2–3.3)	188	34	(28–41)
North-West	10 305	36.7	(34.7–38.8)	66	0.7	(0.5–0.9)	360	39	(32–46)
North-East	7211	18.2	(16.9–19.6)	74	0.9	(0.7–1.3)	251	33	(27–40)
South-East	3798	10.0	(9.2–11.0)	202	6.0	(4.5–7.8)	100	27	(21–34)
South-West	3533	12.9	(11.7–14.2)	218	7.0	(5.7–8.7)	115	33	(26–41)
South-South	3202	8.7	(7.9–9.5)	124	5.1	(3.7–7.2)	77	25	(19–34)
Residence									
Urban	11 699	38.5	(36.7–40.4)	601	5.2	(4.5–6.1)	359	32	(28–36)
Rural	22 225	61.5	(59.6–63.3)	278	1.2	(1.0–1.4)	732	35	(31–40)
Number of ANC visits‡									
All	21 792								
0	5365	24.4	(22.8–26.0)	18	0.3	(0.2–0.6)	126	23	(19–28)
1–3	4120	18.8	(18.0–19.7)	63	1.7	(1.2–2.4)	84	25	(18–35)
4–7	8210	36.9	(35.7–38.2)	254	2.9	(2.5–3.3)	189	22	(19–26)
8+	4097	19.9	(18.9–21.0)	312	8.6	(7.4–10.0)	104	25	(20–31)
Socio-economic factors									
Household Wealth									
Poorest	8066	22.2	(20.5–23.9)	29	0.3	(0.2–0.6)	265	33	(28–38)
Poor	7743	22.8	(21.2–24.4)	59	0.7	(0.5–1.0)	244	34	(27–42)
Middle	7171	20.6	(19.2–22.1)	127	1.6	(1.3–2.0)	253	41	(31–54)
Richer	6166	18.3	(17.0–19.6)	205	3.1	(2.6–3.8)	187	32	(26–38)
Richest	4778	16.2	(14.9–17.6)	459	9.9	(8.4–11.6)	142	30	(24–37)
Highest level of maternal education									
No formal	15 391	46.4	(44.5–48.2)	74	0.5	(0.3–0.7)	502	35	(30–39)
Incomplete/complete primary	5274	14.9	(14.0–15.8)	81	1.3	(1.0–1.8)	174	37	(26–52)
Incomplete/complete secondary	10 623	30.5	(29.1–31.8)	390	3.8	(3.3–4.4)	332	32	(28–37)
Higher	2636	8.2	(7.5–9.1)	334	14.0	(12.0–16.4)	83	32	(24–43)
Ethnicity									
Igbo, Ijaw/Izon, Ibibio, Ekoi	5900	15.7	(14.6–16.9)	334	7.3	(6.0–8.8)	151	28	(23–34)
Hausa, Fulani, Kanuri/Beriberi	15 062	48.8	(46.6–51.0)	121	0.7	(0.6–1.0)	530	36	(32–4.)
Yoruba, Igala, Tiv	4291	14.0	(12.7–15.4)	197	4.6	(3.7–5.7)	130	31	(25–38)
Others	8671	21.5	(20.0–23.2)	227	2.8	(2.3–3.4)	280	36	(27–47)
Religion									
Christian & other	13 512	36.52	(34.7–38.4)	646	5.6	(4.9–6.5)	382	31	(25–37)
Islam	20 412	63.48	(61.6–65.3)	233	1.1	(0.9–1.3)	709	36	(32–40)
Maternal factors									
Marital status									
Married/cohabiting	32 226	95.4	(95.0–95.7)	53	2.7	(2.4–3.1)	48	30	(21–43)
Neither	1698	4.641	(4.3–5.0)	826	3.1	(2.2–4.3)	1043	34	(31–38)
Mother's age at last live birth									
<20	4573	13.7	(13.0–14.4)	50	1.0	(0.7–1.5)	208	47	(40–56)
20–24.9	8840	25.9	(25.3–26.6)	150	1.6	(1.3–2.1)	241	31	(23–41)
25–29.9	8856	26.4	(25.7–27.1)	237	3.0	(2.4–3.6)	247	29	(24–34)
30–34.9	6503	19.1	(18.4–19.7)	265	4.3	(3.6–5.1)	221	34	(29–40)
>35	5152	15.0	(14.4–15.6)	177	3.8	(3.1–4.5)	174	36	(30–43)
Wantedness of pregnancy									
Wanted at the time	30 355	89.8	(89.2–90.4)	744	2.6	(2.3–2.9)	979	34	(31–38)
Unwanted/mistimed	3569	10.2	(9.6–10.8)	135	4.2	(3.3–5.4)	112	32	(25–40)

Table 2 (*Continued*)

	Total			Caesarean section rate			Early neonatal mortality rate		
Factor	*N*	%	95% CI	*N*	%	95% CI	*N*	Per 1000 live births	95% CI
Infant factor									
Sex of the baby									
Female	16 667	49.1	(48.4–49.7)	407	2.6	(2.3–3.0)	480	32	(27–37)
Male	17 257	51.0	(50.3–51.6)	472	2.8	(2.5–3.3)	611	36	(32–40)
Type of pregnancy									
Singleton	32 661	96.3	(95.9–96.6)	781	2.6	(2.3–2.9)	909	28	(26–31)
Multi-pregnancy	1263	3.7	(3.4–4.1)	98	7.1	(5.2–9.7)	182	175	(131–230)
Birthweight§									
Very small/ smaller than average	4880	14.7	(13.7–15.7)	130	2.6	(2.1–3.2)	266	62	(51–76)
Normal	20 139	60.58	(59.5–61.6)	647	3.5	(3.0–4.0)	505	26	(23–29)
Larger than average	8391	24.49	(23.5–25.6)	88	0.9	(0.7–1.2)	263	30	(26–34)
Missing	514	1.5	(1.3–1.8)	14	3.2	(1.7–5.8)	57	130	(93–178)
Parity at last live birth									
0	3753	11.1	(10.6 –11.6)	185	5.2	(4.4–6.2)	84	25	(19–32)
1–3	16 816	49.5	(48.5–50.5)	525	3.4	(3.0–4.0)	519	32	(29–36)
4+	13 355	39.4	(38.4 –40.4)	169	1.1	(0.9–1.4)	488	39	(34–45)
Childbirth care factors									
Place of childbirth									
Public primary	4934	13.2	(12.4 –14.1)	55	1.0	(0.8–1.4)	147	31	(26–38)
Public hospital	4431	13.1	(12.3–14.0)	385	8.3	(7.2–9.6)	193	46	(35–61)
Private facility	4123	13.0	(12.1–14.0)	439	11.8	(10.1–13.8)	144	40	(32–50)
Home and other	20 436	60.6	(59.0–62.2)	NA	-	-	607	30	(27–34)
Referral¶									
All	8909								
Yes	164	1.9	(1.6–2.2).	79	50.5	(41.1–59.9)	12	56	(31–101)
No	8745	98.1	(97.7–98.4)	568	6.9	(6.2–7.8)	218	27	(23–32)

CI, confidence interval; ANC, antenatal care.
†Information regarding mode of childbirth was missing for 146 cases (0.4%). Of these, 142 women delivered in private health care, where the birth could have been either vaginal or by CS and therefore these cases were excluded from the analyses.
‡Number of ANC visits were assessed for the most recent live birth only, *n* = 21 792.
§Birthweight measured in g in cases of child being weighed at birth (22.8%), in all other cases from maternal report (75.7%).
¶Referral was assessed within a subset of the women who reported childbirth at a facility (public or private), *n* = 8909.

The national ENMR was 34/1000 live births (95% CI: 31–37). The ENMR was nearly twofold higher for babies born by CS (60/1000 live births, 95% CI: 41–87) compared to vaginal births (33/1000 live births, 95% CI: 30–37). Among women who were referred during childbirth, 50.5% had a CS and the ENMR was higher in this group (56/1000 live births, 95% CI: 31–101) compared to non-referred (27/1000 live births, 95% CI: 23–32).

Caesarean section and early neonatal mortality rates by modified Robson groups

The distribution of CS rates and ENMR according to modified Robson group is shown in Table 3. Modified Robson 3 (multipara, singleton, normal birthweight) was the most common obstetric group with 72.4% of all births and a low CS rate (1.0%, 95% CI: 0.8–1.2). However, due to its large size, this group contributed to 26.2% of the total number of CS births. The other low-risk group, modified Robson 1 (nullipara, singleton, normal birthweight) accounted for 9.1% of all births, contributed to 10.4% of all CS and had the lowest ENMR (21/1000 live births, 95% CI: 16–28). The modified Robson 4 (multipara, planned CS) was small (0.6% of all births) but a large contributor to the total number of CS (23.2%).

The two high-risk groups – modified Robson 8 (multiple pregnancy) and Robson 10 (preterm/low birthweight) – had CS rates of 7.1% (95% CI: 5.2–9.7) and 1.8% (95% CI: 1.4–2.4), respectively. The ENMRs in these

Table 3 Caesarean section and Early Neonatal Mortality rate by modified Robson group, all live births in the 2018 Nigeria DHS

	Modified Robson group	N	Relative size of obstetric population % (95% CI)	n of CS	CS rate % (95% CI)	Relative contribution to total number of CS % (95% CI)	n of Early Neonatal mortality	Early Neonatal Mortality, per 1000 live births (95% CI)
1	Nulliparous, singleton, normal birth size	3009	9.1 (8.6–9.5)	87	3.2 (2.5–4.1)	10.7 (8.5–13.3)	59	21 (16–28)
2	Nulliparous, singleton, normal birth size. CS before labour started	36	0.1 (0.1–0.2)	36	100	5.0 (3.2–7.9)	1	141 (21–553)
3	Multiparous, singleton, normal birth size	24 335	72.4 (71.4–73.3)	210	1.0 (0.8–1.2)	26.2 (22.4–30.3)	598	25 (22–27)
4	Multiparous, singleton, normal birth size. CS before labour started	185	0.6 (0.5–0.8)	185	100	23.2 (19.8–26.9)	9	36 (13–97)
6	Nulliparous and multiparous with single breech position	150	0.4 (0.3–0.5)	150	100	15.7 (12.8 –19.1)	6	32 (14–73)
8	All multiple pregnancies	1263	3.8 (3.5–4.1)	98	7.1 (5.2–9.7)	10.1 (7.4–13.6)	182	175 (131–230)
10	All singleton babies with low birthweight/ preterm	4445	13.6 (12.7 –14.5)	81	1.8 (1.4–2.4)	9.2 (7.0–11.9)	187	44 (35–55)
	Total	33 423		847	2.7 (2.4–3.0)		1042	33 (30–36)

CS, caesarean section; CI, confidence interval.

groups were high, 175/1000 live births (95% CI: 131–230) in modified Robson 8 and 44/1000 live births (95% CI: 35–55) in Robson 10.

Caesarean section rates in each modified Robson group by socio-economic factors

We observed large disparities in CS rate by household wealth quintile (Figure 2). In modified Robson 8 (multiple pregnancy), the rate ranged from 0.8% (95% CI: 0.2–3.2) in the poorest quintile to 19.7% (95% CI: 12.5–29.7) in the richest. A similar pattern was seen for maternal education; for example, in modified Robson 1, women with no education had a rate of 0.2% (95% CI: 0.0–0.6) compared to 11.2% (95% CI: 7.9–15.7) among women with the highest education level. In modified Robson 8, the CS rate was 30.7% (95% CI: 21.3–42.2) among births in private health facilities and 9.2% (95% CI: 5.5–14.9) in public hospitals.

Determinants associated with caesarean section

When assessing the determinants for CS, the sample was restricted to the most recent live birth including 21 792 women–baby pairs (Table 4). Women with the highest level of education had an adjusted odds ratio (aOR) of a CS birth of 2.47 (95% CI: 1.49–4.08) compared to women with no formal education. The three richer wealth quintiles were positively associated with CS; the richest quintile compared to the poorest had an aOR of 4.66 (95% CI: 2.28–9.51).

Women identifying as Christian/Other religion had 1.5 times higher adjusted odds of CS than Muslim women. Number of ANC visits, especially if more frequent (8+), was strongly associated with CS (aOR 5.71, 95% CI: 3.14–10.39).

Among maternal factors, age was a predictor of CS with 4.61 higher adjusted odds (95% CI: 2.51–8.46) for CS for women age >35 years vs. those <20. Unwanted pregnancy also increased the likelihood for CS, whereas marital status was not associated with CS. Women with multiple pregnancy had 2.55 (95% CI: 1.57–4.15) higher adjusted odds of a CS than those with singletons.

In a sub-analysis, referral during childbirth and place of birth were added to the multivariable analyses. Referral increased the odds for having a CS (aOR 11.97, 95% CI: 7.98–17.94) as did giving birth in a private health clinic (aOR 6.98, 95% CI: 4.83–10.08) compared to public primary options. Many of the other predictors, that is wealth, education and ANC visits lost statistical significance when place of childbirth and referral status were added.

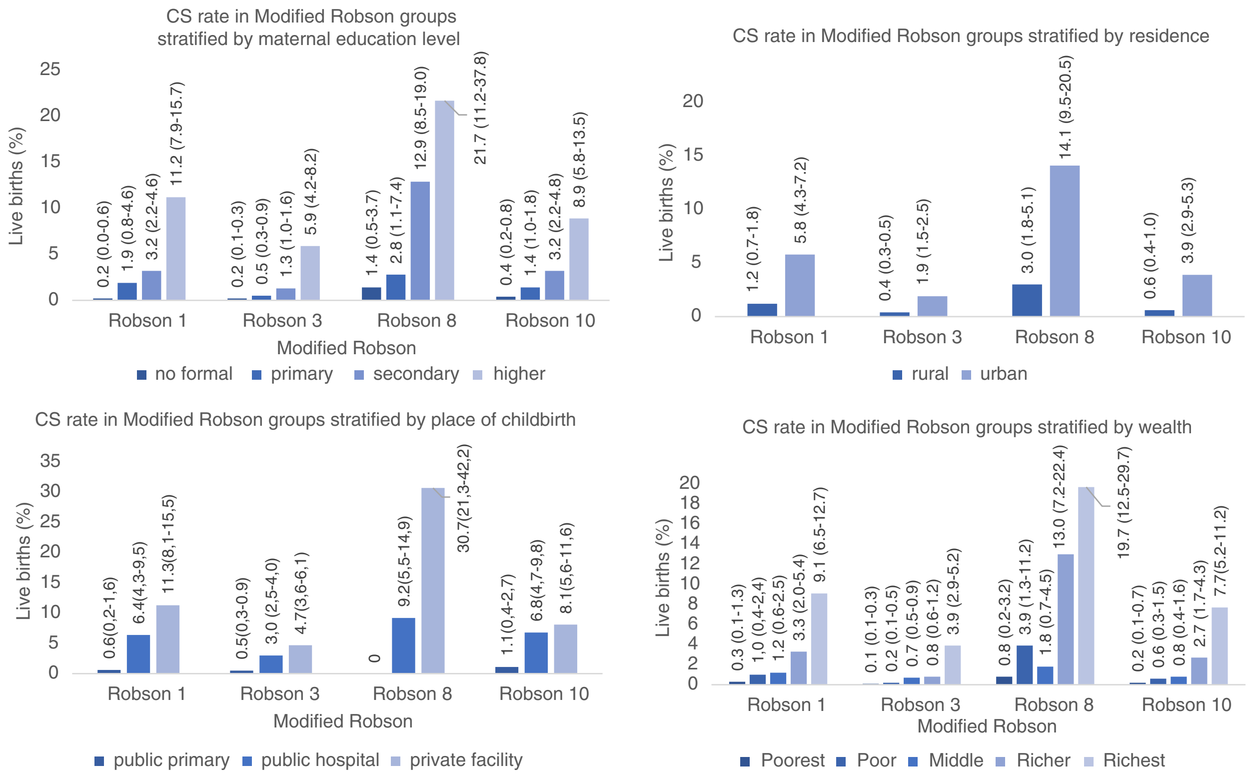

Figure 2 CS rate (95 % CI) in modified Robson groups 1, 3, 8, and 10 stratified by maternal education, residence, place of birth and wealth. CS, caesarean section; CI, confidence interval. [Colour figure can be viewed at wileyonlinelibrary.com]

Discussion

To improve the evidence of inequity of access to CS in case of obstetric complications in Nigeria, we applied a modified Robson classification to DHS data, while also integrating socio-economic aspects. Thus, our analysis sheds light on social disparities in health by intersecting social inequalities and obstetric risk factors. We indicated suboptimal CS rates within all the modified Robson groups, ranging from 1.0% (modified Robson 3) to 7.1% (modified Robson 8). In the two high-risk groups multiple pregnancy and preterm/low birthweight, the rates were worryingly low and with corresponding high ENMRs. Higher number of ANC visits, multiple pregnancy, wealth, education, religious affiliation and increasing maternal age were positively associated with CS. Finally, referral during childbirth was strongly associated with CS and the referred group had a high ENMR.

Globally, CS births are increasing in all regions, but levels remain low in sub-Saharan Africa [3]. In this study, the underuse of CS was especially apparent for the modified Robson 8 (multiple pregnancy), with a national average rate of 7.1%. Higher rates for multiple pregnancies were found among women who had the highest education (21.7%), greater wealth (19.7%) and with childbirth in private facilities (30.7%). A study of eight countries in Southern and Eastern Africa showed rates between 9 and 36% [39] while in high-income countries CS rates are often above 60% for multiple pregnancies [30]. Further, multiple pregnancies had an unacceptably high ENMR (175/1000 live births) in this study. Our results are in line with a previous study from Nigeria indicating 6 and 2.54 times higher odds of a low Apgar score and of neonatal death, respectively, when compared to singleton pregnancies [40].

The other obstetric risk group, modified Robson 10 (preterm/low birthweight), was the second largest group (13.6% of all births). The CS rates, with an average of 1.8% and as low as 0.2% among the poorest women, are far beneath previous, yet facility-based, findings for this Robson group with rates around 33–37% [30, 41]. Further, as shown by Ezeh at al., a large number of early neonatal deaths can be attributed to low birthweight in Nigeria [42]. Thus, this is an obstetric group with a particular need of extra precaution during childbirth.

Table 4 Determinants for Caesarean section for A) most recent live birth (n = 21 792) and B) most recent birth at a healthcare facility (n = 8909)

	Unadjusted OR	95 % CI	*P*-value	Adjusted OR A) most recent live birth	95 % CI	*P*-value	Adjusted OR B) most recent live birth at healthcare facility	95 % CI	*P*-value
Community factors									
Region									
North-Central	Ref			Ref			Ref		
North-West	0.29	0.20–0.44	<0.001	0.56	0.34–0.92	0.022	0.81	0.47–1.38	0.438
North-East	0.41	0.27–0.62	<0.001	0.90	0.58–1.38	0.618	1.28	0.81–2.02	0.290
South-East	2.19	1.51–3.17	<0.001	0.52	0.32–0.85	0.009	0.58	0.36–0.94	0.027
South-West	2.68	1.94–3.69	<0.001	1.00	0.68–1.47	0.997	1.19	0.82–1.72	0.353
South-South	1.94	1.31–2.87	0.001	0.60	0.38–0.94	0.025	0.88	0.57–1.35	0.554
Residence									
Rural	Ref			Ref			Ref		
Urban	4.37	3.45–5.54	<0.001	1.23	0.96–1.57	0.106	1.00	0.77–1.29	0.998
Number of ANC visits									
0	Ref			Ref			Ref		
1–3	5.10	2.76–9.43	<0.001	2.91	1.56–5.46	0.001	0.65	0.33–1.28	0.213
4–7	8.68	5.07–14.87	<0.001	3.73	2.08–6.68	<0.001	0.72	0.39–1.33	0.287
8+	27.58	16.01–47.50	<0.001	5.71	3.14–10.39	<0.001	1.03	0.55–1.91	0.933
Socio-economic factors									
Household Wealth									
Poorest	Ref			Ref			Ref		
Poor	2.40	1.12–5.18	0.025	1.71	0.81–3.60	0.160	1.20	0.58–2.48	0.622
Middle	5.97	3.01–11.86	<0.001	2.59	1.25–5.36	0.010	1.36	0.674–2.74	0.392
Richer	11.18	5.71–21.90	<0.001	3.04	1.49–6.17	0.002	1.33	0.68–2.62	0.407
Richest	35.23	18.17–68.29	<0.001	4.66	2.28–9.51	<0.001	1.93	0.97–3.85	0.061
Highest level of maternal education									
No formal	Ref			Ref			Ref		
Incomplete/complete primary	2.54	1.60–4.04	<0.001	0.94	0.55–1.61	0.825	0.75	0.44–1.26	0.277
Incomplete/complete secondary	6.86	4.67–10.08	<0.001	1.28	0.77–2.13	0.336	0.86	0.52–1.42	0.565
Higher	25.72	17.49–37.82	<0.001	2.47	1.49–4.08	<0.001	1.39	0.84–2.29	0.199
Ethnicity									
Hausa, Fulani, Kanuri/Beriberi	Ref			Ref			Ref		
Igbo, Ijaw/Izon, Ibibio, Ekoi	8.95	6.39–12.55	<0.001	1.21	0.70–2.09	0.495	1.12	0.62–1.97	0.726
Yoruba, Igala, Tiv	5.68	4.01–8.03	<0.001	0.48	0.29–0.80	0.005	0.46	0.28–0.77	0.003
Other	3.19	2.27–4.47	<0.001	0.71	0.44–1.14	0.153	0.67	0.41–1.08	0.103
Religion									
Islam	Ref			Ref			Ref		
Christian and Other	4.75	3.76–5.98	<0.001	1.50	1.05–2.15	0.025	1.28	0.90–1.82	0.164
Maternal factors									
Marital status									
Married/cohabitant	Ref								
Neither	1.07	0.76–1.50	0.693						

Table 4 (*Continued*)

	Unadjusted OR	95 % CI	*P*-value	Adjusted OR A) most recent live birth	95 % CI	*P*-value	Adjusted OR B) most recent live birth at healthcare facility	95 % CI	*P*-value
Mother's age at last live birth									
<20	Ref			Ref			Ref		
20–24.9	1.40	0.82–2.40	0.215	1.14	0.64–2.04	0.654	1.06	0.58–1.93	0.848
25–29.9	2.52	1.49–4.28	0.001	1.91	1.06–3.43	0.030	1.81	0.99–3.29	0.052
30–34.9	3.92	2.35–6.55	<0.001	3.14	1.73–5.71	<0.001	2.87	1.55–5.33	0.001
>35	3.44	2.08–5.68	<0.001	4.61	2.51–8.46	<0.001	3.97	2.09–7.53	<0.001
Wantedness of pregnancy									
Wanted at the time	Ref			Ref			Ref		
Unwanted/mistimed	1.66	1.27–2.18	<0.001	1.43	1.06–1.93	0.020	1.37	1.00–1.87	0.048
Infant factors									
Sex of the baby									
Male	Ref								
Female	0.97	0.81–1.18	0.779						
Type of pregnancy									
Single	Ref			Ref			Ref		
Multiple	2.64	1.73–4.01	<0.001	2.55	1.57–4.15	<0.001	1.98	1.23–3.18	0.005
Birthweight†									
Very small/small	Ref			Ref			Ref		
Average	1.39	1.05–1.85	0.023	0.89	0.67–1.18	0.406	0.94	0.70–1.27	0.699
Larger than average	0.35	0.24–0.51	<0.001	0.62	0.42–0.92	0.017	0.88	0.58–1.31	0.517
Parity at last live birth									
0	Ref			Ref			Ref		
1–3	0.71	0.58–0.87	0.001	0.53	0.41–0.68	<0.001	0.60	0.46–0.79	<0.001
4+	0.26	0.20–0.35	<0.001	0.25	0.17–0.37	<0.001	0.30	0.20–0.439	<0.001
Childbirths care factors									
Place of childbirth									
Public primary	Ref						Ref		
Public hospital	7.08	4.83–10.37	<0.001				5.70	3.83–8.48	<0.001
Private	10.83	7.48–15.67	<0.001				6.98	4.83–10.08	<0.001
Referral during childbirth‡									
No	Ref						Ref		
Yes	13.71	9.26–20.31	<0.001				11.97	7.98–17.94	<0.001

Determinants for caesarean section assessed by logistic regression for A) most recent live birth (n = 21 792) and **B)** for a subset of the women giving birth at a healthcare facility (n = 8909). *P*-value of Wald test.
OR, odds ratio; CI, confidence interval; ANC, antenatal care
†Birthweight measured in g in cases of child being weighed at birth (22.8%), in all other cases from maternal report (75.7%).
‡Childbirth care factors were only assessed for women giving birth at a health facility (n = 8909).

There was no apparent overuse of CS at a population level in Nigeria in this study. However, the procedure is unevenly distributed. Large disparities were seen within the wealth quintiles, with the poorest women having a CS rate (0.3%) far below the suggested minimum of 9% to maintain safety for women and child [6]. This uneven distribution of CS across wealth groups has been established before in Nigeria [24] and other LIC [37] and these inequalities highlight the need for removing financial barriers to CS.

Lastly, the modified Robson 4 (multipara, planned CS) was small (0.6% of the obstetric groups) but contributed to a large proportion of all CS (23.2%). Even though the indications for the planned CS were unknown, studies have shown that planned CS is largely driven by previous CS [20, 21], thus a large part may belong to the Robson group 5, which we were unable to construct. Repeated CS may become an increasingly important factor to consider in Nigeria, despite the low total rates, not least because of the high fertility rate.

Referral during labour substantially increased the odds for CS. Referral could be a proxy for complications such as obstructed labour and antenatal haemorrhage, explaining the high CS rate in this group (50.5%). The very high ENMR in this group can be interpreted as the interventions being done too late to save the baby's life, as others propose [13]. A timely CS performed with good quality of care can be life-saving for the neonate by reducing the risk of asphyxia during labour. However, while the general recommendation that a CS rate of 9–16% to save neonatal lives apply on a population level [5], these rates are not sufficient for risk pregnancies such a preterm/low birthweight or multiple pregnancies due to higher risk of complications such as bleeding, asphyxia and cord prolapse. This is clearly shown in our results where Robson groups 8 and 10 had unacceptable high ENMR, thus stresses the need of more attention during labour and readiness for CS for these high-risk groups in particular.

After adding referral and place of childbirth to the analysis, only unwantedness of pregnancy, older maternal age and multiple pregnancy remained positively associated with CS. This could be explained by the reduction in population size (from 21 792 to 8909 births) or that some of the predictors, that is number of ANC visits [43] and education, being closely interlinked with giving birth at a health facility, affecting the statistical associations [44].

Implications and future research

Our study indicates that inequitable access to CS is exacerbated in relation to obstetric risk factors. Still, our study also confirms the known socio-economic and financial barriers to access. We note that health insurance coverage in this population was low at 3% [11]. Improving universal health coverage, thus, remains essential. Removing user fees – as done in Benin and Mali – remains a potentially effective measure to improve accessibility of CS [45], albeit transport cost may continue to be a major barrier. This was confirmed by a study investigating the user fee exemption in some regions in Nigeria, showing lower CS rates for women with low income despite free maternal health care [46]. Thus, increased availability of EMOC in rural areas is also needed.

The inequity identified in relation to obstetric risks demands new thinking and programming. Better risk detection during ANC through, for example, ultrasound to detect multiple pregnancies and for accurately estimating gestational age, intensified counselling of danger signs and early effective referral could address these inequities. Finally, ANC could also provide a platform for encouraging childbirth in a healthcare facility, especially in case of multiple pregnancy. We believe that the opportunity of reducing socio-economic barriers through ANC by focusing on those most in need is given too little attention [47].

Moreover, we believe that our approach to apply the Robson classification to population-level data provided important new knowledge. While there are limitations, these modified Robson groups could be useful for continuous monitoring of CS rates stratified by regions, facilities or socio-economic groups to evaluate equity in access. Further research comparing trends over time in relation to the Robson groups would be useful for examining the drivers of underuse and possible, future overuse of CS in Nigeria and other LIC settings. It would be useful to collect some basic obstetric factors in the DHS, for example previous history of CS, to improve the evaluation of CS rates on a population-based level. However, more medical aspects like comorbidities and complications have limited validity in such surveys, particularly specificity [48].

Strengths and limitations

The DHS includes a large sample size and has a high participation rate (99%). The questionnaires are well tested and with a low number of missing data. The DHS is population-based and includes all states in the sampling processes, which makes the results generalisable to the whole country. This study is the first of its kind to assess CS and ENMR in Nigeria within modified Robson groups, stratified by socio-economic factors.

The data were collected with a five-year recall period; thus, recall bias cannot be ruled out. However, some questions were restricted to only to the most recent birth, for example regarding ANC. Moreover, for some of the data, the accuracy might be substandard; that is, birthweight where the perceived birth size reported by the mother was used for the majority of the cases.

We missed some variables to categorise births by the Robson classification, such as previous CS and induction of labour. However, the majority of women with a previous CS are most likely found in modified Robson 4, multipara with planned CS, as discussed above. Further, information about breech position was obtained by asking about the reason for CS and it is possible that the women were not correctly informed by the provider or did not remember. Moreover, data regarding breech position among vaginal births were not available; thus, proportional CS rate of adverse foetal position could not be calculated. In this study, the relative group size with breech position was 0.4%; ten-fold lower than the expected rate around 3–4% [30], indicating that most of the children with breech position were probably delivered vaginally. Overall, self-reported data on indication for CS might not be as accurate as hospital-derived data, potentially resulting in over- and/or underreporting of some obstetric factors. Additionally, this DHS did not capture mode of birth for stillbirths and since stillbirths can be due to intrapartum complications, some cases of perinatal mortality are not captured [12].

Conclusion

The severe underuse of CS, especially for multiple and preterm births among socio-economically disadvantaged women, emphasises insufficient access to health care in Nigeria. Our analysis highlights the importance of disaggregating data to indicate underserved groups, in order to plan strategies targeted at-risk pregnancies to improve neonatal outcome. We suggest that women with multiple pregnancy or with a high risk of preterm/low birthweight would benefit from specific attention already during ANC. The referral system also needs to be strengthened and striving towards UHC is important to assure access to CS for the most underprivileged women.

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Data availability statement

The data set used for this study is available at the Demographic and Health Surveys repository; https://dhsprogram.com

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Figure S1. "Adapted conceptual framework for factors affecting Infant Mortality", originally developed by Mosley and Chen and further developed by Lamichhane *et al.*

Corresponding Author Claudia Hanson, Department of Global Public Health, Karolinska Institutet, K9 Global folkhälsa, GH Stålsby Lundborg Hanson, 171 77 Stockholm, Sweden. E-mail: claudia.hanson@ki.se