Rural–urban disparities in caesarean deliveries in sub-Saharan Africa: a multivariate non-linear decomposition modelling of Demographic and Health Survey data

Bright Opoku Ahinkorah1, Richard Gyan Aboagye2, Abdul-Aziz Seidu3,4, Joshua Okyere5*, Aliu Mohammed6, Vijay Kumar Chattu7,8, Eugene Budu5, Faustina Adoboi9 and Sanni Yaya10,11

Abstract

Introduction: Globally, the rate of caesarean deliveries increased from approximately 16.0 million in 2000 to 29.7 million in 2015. In this study, we decomposed the rural–urban disparities in caesarean deliveries in sub-Saharan Africa.

Methods: Data for the study were extracted from the most recent Demographic and Health Surveys of twenty-eight countries in sub-Saharan Africa. We included 160,502 women who had delivered in health facilities within the five years preceding the survey. A multivariate non-linear decomposition model was employed to decompose the rural–urban disparities in caesarean deliveries. The results were presented using coefficients and percentages.

Results: The pooled prevalence of caesarean deliveries in the 28 countries considered in the study was 6.04% (95% CI = 5.21–6.88). Caesarean deliveries' prevalence was highest in Namibia (16.05%; 95% CI = 14.06–18.04) and lowest in Chad (1.32%; 95% CI = 0.91–1.73). For rural–urban disparities in caesarean delivery, the pooled prevalence of caesarean delivery was higher in urban areas (10.37%; 95% CI = 8.99–11.75) than rural areas (3.78%; 95% CI = 3.17–4.39) across the 28 countries. Approximately 81% of the rural–urban disparities in caesarean deliveries were attributable to the differences in child and maternal characteristics. Hence, if the child and maternal characteristics were levelled, more than half of the rural–urban inequality in caesarean deliveries would be reduced. Wealth index (39.2%), antenatal care attendance (13.4%), parity (12.8%), mother’s educational level (3.5%), and health insurance subscription (3.1%) explained approximately 72% of the rural–urban disparities in caesarean deliveries.

Conclusion: This study shows significant rural–urban disparities in caesarean deliveries, with the disparities being attributable to the differences in child and maternal characteristics: wealth index, parity, antenatal care attendance, mother’s educational level, and health insurance subscription. Policymakers in the included countries could focus and work on improving the socioeconomic status of rural-dwelling women as well as encouraging antenatal care attendance, women’s education, health insurance subscription, and family planning, particularly in rural areas.

Keywords: Caesarean deliveries, Women, Decomposition analysis, Sub-Saharan Africa, Global health

*Correspondence: joshuaokyere54@gmail.com
1 Department of Population and Health, University of Cape Coast, Cape Coast, Ghana
Full list of author information is available at the end of the article

Introduction

Despite the huge global interventions to reduce maternal mortality, it remains a major public health problem in many low- and middle-income countries (LMICs)
Caesarean delivery is a surgical procedure that involves delivering one or more babies from a woman’s uterus [5]. It is one of the most important interventions for saving the lives of mothers and their foetuses during difficult labour [6]. The procedure is usually recommended when a vaginal delivery is likely to endanger the lives of the mother or foetus, such as during prolonged labour, foetal asphyxia [7], abnormal foetal presentation, antepartum haemorrhage and eclampsia [8]. Globally, the rate of caesarean deliveries has increased significantly from approximately 16.0 million (12.1% of all births) in the year 2000 to 29.7 million (21.1% of all births) in 2015 [8]. The increase in caesarean deliveries has largely been attributed to the growing rate of childbirths occurring at healthcare facilities due to improved access and the increasing trend of maternal requests for caesarean deliveries [6, 9–11]. The increasing trend of maternal requests for caesarean deliveries has become a global concern due to its exposure of women to short and long-term risk for maternal health complications [11, 12].

Meanwhile, there are wide disparities in the use of caesarean deliveries between and within countries. For instance, a recent global survey revealed that the prevalence of caesarean delivery varies from 0.6% in South Sudan to 58.1% in the Dominican Republic [8]. In SSA, approximately 3.0% of all births in Western and Central Africa and 4.6% in Eastern and Southern Africa occur through caesarean delivery [8]. Thus, despite the enormous increase in caesarean deliveries worldwide [12, 13], most countries in SSA still have caesarean delivery rates of less than 10% of total births in the population [9], which is lower than the WHO’s recommended 10–15% required for a reduction in both maternal and perinatal mortality [13]. The WHO suggests that a caesarean delivery rate of less than 10% indicates inadequate access to medically required caesarean deliveries [13], which increases the risk for maternal mortality.

Aside from the limited access to caesarean deliveries in SSA, there are vast within-country disparities in the use of caesarean deliveries, largely due to socio-economic and demographic inequalities [1, 9]. Factors such as maternal age, education, wealth, parity, number of antenatal care visits, religion, ethnicity, health insurance coverage, employment status, reproductive history, and place of residence contribute significantly to the use of caesarean deliveries in SSA [1, 13, 14]. In Nigeria, for example, higher odds for caesarean delivery were observed among women with a higher number of antenatal care visits, higher educational attainment, multiple pregnancies, higher household wealth, and among Christians [14]. In Burundi, higher rates of caesarean deliveries were observed among wealthy women, those with higher educational levels, and those living in urban areas [10].

Meanwhile, one of the major predictors for within-country differences in caesarean deliveries in SSA is the rural–urban differences in population characteristics [4, 15, 16]. Generally, higher rates of caesarean deliveries are recorded in urban areas and lower rates in rural areas [5]. In Burundi, higher rates of caesarean deliveries among urban dwellers is largely due to the higher socioeconomic status of women living in urban areas compared to those in rural areas [5, 15–17]. This is because women in rural communities are mostly poor and thus the least likely to receive adequate healthcare, including access to caesarean deliveries [2].

Although previous studies have investigated rural–urban differences in the use of caesarean deliveries in SSA [3, 4, 10, 14], most of these studies were conducted at the individual country level. Thus, there are limited multi-country analyses of rural–urban disparities in the use of caesarean deliveries in SSA. Having a comprehensive multi-country level data on the rural–urban differences in the use of caesarean deliveries could help in designing and implementing strategies that can improve access to medically required caesarean deliveries and perhaps contribute to achieving the Sustainable Development Goal (SDG) target 3.1 (i.e., achieving global maternal mortality ratio target of less than 70 per 100,000 live births by 2030). In this study, we decomposed the rural–urban disparities in caesarean deliveries in SSA.

Methods

Data source and study design
Data for the study were extracted from the most recent Demographic and Health Surveys (DHS) of twenty-eight countries in SSA. We pooled the data from the women’s recode files in each of the 28 countries. The DHS is a comparatively nationally representative survey conducted in over 85 low-and-middle-income countries worldwide [18]. DHS employed a descriptive cross-sectional design. Respondents for the survey were recruited using a two-stage cluster sampling method. Detailed sampling technique has been highlighted in the literature...
Standardized structured questionnaires were used to collect data from the respondents on health indicators, including place and mode of delivery. We included a total of 160,502 women who had delivered in a health facility within the five years preceding the survey (Table 1). Only women with complete cases on the variables of interest in this study were included in the analyses. The dataset used is freely available at https://dhsprogram.com/data/available-datasets.cfm. This manuscript was drafted with reference to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement guidelines [20].

Variables

Outcome variable

Caesarean delivery was the outcome variable in this study. With this variable, the women were asked the question, “Was (NAME) delivered by caesarean, that is, did they cut your belly open to take the baby out?” The response options were “yes” and “no”. In the analysis, the response categories were recoded as “0 = no” and “1 = yes”. Studies that used the DHS dataset employed similar coding [1, 21].

Equity stratifier

Place of residence was the equity stratifier by which the disparity in caesarean delivery was measured. Previous studies have shown that place of residence plays a key role in caesarean delivery [5, 22, 23].

Explanatory variables

The main explanatory variable was place of residence. The responses for this were “rural” and “urban”.

Covariates

The covariates considered in this study were selected based on their association with caesarean delivery from literature [1, 24–26] and their availability in the DHS dataset. The variables consisted of sex of the child, size of child at birth, twin status, mother’s age, educational level, current working status, marital status, religion, antenatal care attendance, national health insurance subscription, parity, partner’s educational level, person who usually decides on respondent’s health care, person who usually decides on large household purchases, person who usually decides on visits to family or relatives, sex of household head, frequency of reading newspaper or magazine, frequency of watching television, frequency of listening to the radio, and wealth index. The categories of each of the variables are shown in Table 2.

Table 1  Description of the study sample

| Countries | Year of survey | Weighted N | Weighted % |
|-----------|----------------|------------|------------|
| 1. Angola  | 2015–16        | 5463       | 3.40       |
| 2. Burkina Faso | 2010    | 10,046     | 6.26       |
| 3. Benin   | 2018          | 7,721      | 4.81       |
| 4. Burundi | 2016–17       | 7,487      | 4.89       |
| 5. DR Congo| 2013–14       | 8,876      | 5.53       |
| 6. Congo   | 2011–12       | 4,205      | 2.62       |
| 7. Cote d’Ivoire | 2011–12 | 3,982      | 2.48       |
| 8. Cameroon | 2018          | 5,045      | 3.14       |
| 9. Ethiopia| 2016          | 7,066      | 4.40       |
| 10. Gabon  | 2012          | 2,187      | 1.36       |
| 11. Ghana  | 2014          | 3,400      | 2.12       |
| 12. Gambia | 2019–20       | 4,437      | 2.76       |
| 13. Guinea | 2018          | 4,858      | 3.03       |
| 14. Kenya  | 2014          | 5,487      | 3.42       |
| 15. Comoros| 2012          | 1,471      | 0.92       |
| 16. Liberia| 2019–20       | 2,452      | 1.53       |
| 17. Lesotho| 2014          | 1,975      | 1.23       |
| 18. Mali   | 2018          | 5,776      | 3.60       |
| 19. Malawi | 2015–16       | 10,995     | 6.85       |
| 20. Nigeria| 2018          | 19,850     | 12.37      |
| 21. Namibia| 2013          | 1,303      | 0.81       |
| 22. Sierra Leone | 2019 | 5,108      | 3.18       |
| 23. Senegal| 2010–11       | 6,343      | 3.95       |
| 24. Chad   | 2014–15       | 3,028      | 1.89       |
| 25. Togo   | 2013–14       | 4,270      | 2.66       |
| 26. Uganda | 2016          | 7,921      | 4.94       |
| 27. Zambia | 2018          | 5,212      | 3.25       |
| 28. Zimbabwe| 2015          | 4,178      | 2.60       |
| All countries | 2010–2020 | 160,502    | 100.00     |

Statistical analyses

Data for the study were analysed using Stata version 16. First, forest plots were used to show the prevalence of caesarean deliveries across the 28 countries and by the place of residence. Next, the distribution of caesarean section delivery across all the covariates was examined using chi-square test. The results were further disaggregated by place of residence. Third, multivariable binary logistic regression analysis was carried out to explore the predictors of caesarean deliveries. In the final analysis, a multivariate non-linear decomposition analysis [27] was employed to decompose the rural–urban disparities in caesarean deliveries. A multivariate decomposition analysis is used commonly in social research to quantify the contributions to group differences in average predictions from multivariate models. The technique uses the output from regression models to partition the components of a group difference in a statistic, such as a mean or proportion, into a component attributable to compositional differences between groups (that is, differences in characteristics or endowments) and a component attributable
Table 2  Bivariable analysis of caesarean deliveries among women in sub-Saharan Africa

| Variables                              | Weighted N | Weighted % | Caesarean delivery | p-value |
|----------------------------------------|------------|------------|--------------------|---------|
|                                        |            |            | No (%)  | Yes (%) |            |         |
| Sex of child                           |            |            | 94.5    | 5.5     | <0.001   |         |
| Male                                   | 81,490     | 50.8       | 94.5    | 5.5     |          |         |
| Female                                 | 79,012     | 49.2       | 95.1    | 4.9     |          |         |
| Mother's self-reported size of child at birth |            |            | 93.9    | 6.1     | <0.001   |         |
| Large                                  | 58,258     | 36.3       | 93.9    | 6.1     |          |         |
| Average                                | 77,329     | 48.2       | 95.6    | 4.4     |          |         |
| Smaller                                | 24,915     | 15.5       | 94.3    | 5.7     |          |         |
| Twin status                            |            |            | 95.0    | 5.0     | <0.001   |         |
| Single birth                           | 157,123    | 97.9       | 95.0    | 5.0     |          |         |
| Multiple birth                         | 3379       | 2.1        | 86.7    | 13.3    |          |         |
| Mother's age (years)                   |            |            | 96.3    | 3.7     | <0.001   |         |
| 15–19                                  | 9123       | 5.7        | 96.3    | 3.7     |          |         |
| 20–24                                  | 33,680     | 21.0       | 95.7    | 4.3     |          |         |
| 25–29                                  | 42,581     | 26.5       | 94.7    | 5.3     |          |         |
| 30–34                                  | 34,240     | 21.3       | 94.3    | 5.7     |          |         |
| 35–39                                  | 24,821     | 15.5       | 93.6    | 6.4     |          |         |
| 40–44                                  | 12,066     | 7.5        | 94.8    | 5.2     |          |         |
| 45–49                                  | 3991       | 2.5        | 95.2    | 4.8     |          |         |
| Maternal educational level             |            |            | 97.5    | 2.5     | <0.001   |         |
| No education                           | 66,121     | 41.2       | 97.5    | 2.5     |          |         |
| Primary                                | 48,691     | 30.3       | 95.3    | 4.7     |          |         |
| Secondary                              | 39,356     | 24.5       | 92.0    | 8.0     |          |         |
| Higher                                 | 6334       | 4.0        | 79.6    | 20.4    |          |         |
| Current working status                 |            |            | 95.1    | 4.9     | 0.006    |         |
| No                                     | 54,764     | 34.1       | 95.1    | 4.9     |          |         |
| Yes                                    | 105,738    | 65.9       | 94.6    | 5.4     |          |         |
| Antenatal care attendance              |            |            | 99.2    | 0.8     | <0.001   |         |
| None                                   | 16,808     | 10.5       | 99.2    | 0.8     |          |         |
| 1–3                                    | 52,552     | 32.7       | 96.5    | 3.5     |          |         |
| 4 or more                              | 91,142     | 56.8       | 93.0    | 7.0     |          |         |
| Marital status                         |            |            | 95.0    | 5.0     | <0.001   |         |
| Married                                | 131,261    | 81.8       | 95.0    | 5.0     |          |         |
| Cohabiting                             | 29,241     | 18.2       | 94.0    | 6.0     |          |         |
| Religion                               |            |            | 95.8    | 4.2     | <0.001   |         |
| No religion/others                     | 4077       | 2.5        | 95.8    | 4.2     |          |         |
| Christianity                           | 92,235     | 57.5       | 93.4    | 6.6     |          |         |
| Islamic                                | 61,090     | 38.1       | 96.6    | 3.4     |          |         |
| African Traditional                    | 3100       | 1.9        | 97.2    | 2.8     |          |         |
| National health insurance subscription |            |            | 95.4    | 4.6     | <0.001   |         |
| No                                     | 150,021    | 93.5       | 95.4    | 4.6     |          |         |
| Yes                                    | 10,481     | 6.5        | 86.2    | 13.8    |          |         |
| Parity                                 |            |            | 91.7    | 8.3     | <0.001   |         |
| 1 birth                                | 27,226     | 17.0       | 91.7    | 8.3     |          |         |
| 2 births                               | 30,009     | 18.7       | 93.5    | 6.5     |          |         |
| 3 births                               | 26,928     | 16.8       | 94.4    | 5.6     |          |         |
| Four or more births                    | 76,339     | 47.6       | 96.5    | 3.5     |          |         |
Ahinkorah et al. BMC Pregnancy and Childbirth (2022) 22:709

Table 2 (continued)

| Variables                                        | Weighted N | Weighted % | Caesarean delivery |
|--------------------------------------------------|------------|------------|---------------------|
|                                                  |            |            | No (%)   | Yes (%) | p-value |
| Partnership's educational level                  |            |            |           |         |         |
| No education                                     | 56,473     | 35.2       | 97.6     | 2.4     | <0.001  |
| Primary                                          | 41,801     | 26.0       | 95.6     | 4.4     |         |
| Secondary                                        | 49,354     | 30.8       | 93.1     | 6.9     |         |
| Higher                                           | 12,874     | 7.0        | 86.1     | 13.9    |         |
| Person who usually decides on respondent's health care |            |            |           |         | <0.001  |
| Respondent alone                                 | 24,604     | 15.3       | 93.1     | 6.9     |         |
| Respondent and partner                           | 59,270     | 36.9       | 93.8     | 6.2     |         |
| Partner alone                                    | 75,566     | 47.1       | 96.1     | 3.9     |         |
| Someone else or other                            | 1062       | 0.7        | 95.9     | 4.1     |         |
| Person who usually decides on large household purchases |            |            |           |         | <0.001  |
| Respondent alone                                 | 19,161     | 11.9       | 93.4     | 6.6     |         |
| Respondent and partner                           | 63,762     | 39.7       | 93.7     | 6.3     |         |
| Partner alone                                    | 75,799     | 47.2       | 96.0     | 4.0     |         |
| Someone else or other                            | 1780       | 1.1        | 96.3     | 3.7     |         |
| Person who usually decides on visits to family or relatives |            |            |           |         | <0.001  |
| Respondent alone                                 | 30,451     | 19.0       | 94.2     | 5.8     |         |
| Respondent and partner                           | 70,363     | 43.8       | 93.9     | 6.1     |         |
| Partner alone                                    | 58,428     | 36.4       | 96.1     | 3.9     |         |
| Someone else or other                            | 1260       | 0.8        | 95.7     | 4.3     |         |
| Sex of household head                            |            |            |           |         | <0.001  |
| Male                                             | 138,375    | 86.2       | 95.0     | 5.0     |         |
| Female                                           | 22,127     | 13.8       | 93.4     | 6.6     |         |
| Frequency of watching television                 |            |            |           |         | <0.001  |
| Not at all                                       | 99,640     | 62.1       | 96.7     | 3.3     |         |
| Less than once a week                            | 18,782     | 11.7       | 94.1     | 5.9     |         |
| At least once a week                             | 42,080     | 26.2       | 90.5     | 9.5     |         |
| Frequency of listening to radio                  |            |            |           |         | <0.001  |
| Not at all                                       | 71,690     | 44.7       | 93.4     | 6.6     |         |
| Less than once a week                            | 30,858     | 19.2       | 94.3     | 5.7     |         |
| At least once a week                             | 57,954     | 36.1       | 93.0     | 7.0     |         |
| Frequency of reading newspaper/magazine          |            |            |           |         | <0.001  |
| Not at all                                       | 138,833    | 86.5       | 95.8     | 4.2     |         |
| Less than once a week                            | 12,235     | 7.6        | 90.0     | 10.0    |         |
| At least once a week                             | 9434       | 5.9        | 86.4     | 13.6    |         |
| Wealth index                                     |            |            |           |         | <0.001  |
| Poorest                                          | 34,832     | 21.7       | 98.1     | 1.9     |         |
| Poorer                                           | 34,395     | 21.4       | 97.3     | 2.7     |         |
| Middle                                           | 32,276     | 20.1       | 96.1     | 3.9     |         |
| Richer                                           | 30,944     | 19.3       | 93.8     | 6.2     |         |
| Richest                                          | 28,055     | 17.5       | 87.3     | 12.7    |         |

*p-values are obtained from chi-square test

to differences in the effects of characteristics [27]. This technique was used to assess the variations in caesarean deliveries between rural and urban women and identify how much each of the covariates contributes to the variation. We applied the sample weights to obtain unbiased estimates according to the DHS guidelines. Also, the Stata survey command 'svy' was used to adjust for the complex sampling structure of the data in the chi-square and regression analyses. The variance inflation factor (VIF) was used to check for the presence of multicollinearity...
and there was no evidence of multicollinearity (mean VIF = 2.02, maximum = 4.51, minimum = 1.01).

**Ethical consideration**

In this study, ethical clearance was not sought due to the public availability of the DHS dataset. The datasets were obtained from the Monitoring and Evaluation to Assess and Use Results Demographic and Health Survey (MEASURE DHS) after registration and approval were given for its usage. All the ethical guidelines concerning the use of secondary datasets in the publication were strictly adhered to. Detailed information about the DHS data usage and ethical standards are available at [http://goo.gl/ny8T6X](http://goo.gl/ny8T6X).

**Results**

**Prevalence of caesarean deliveries among women in sub-Saharan Africa**

The pooled prevalence of caesarean deliveries in the 28 countries considered in the study was 6.04% (95% CI = 5.21–6.88). Caesarean delivery was highest in Namibia (16.05%; 95% CI = 14.06–18.04) and lowest in Chad (1.32%; 95% CI = 0.91–1.73) (Fig. 1). For the rural-urban disparities in caesarean section, the pooled prevalence of caesarean delivery was higher in urban areas (10.37%; 95% CI = 8.99–11.75) than rural areas (3.78%; 95% CI = 3.17–4.39), and this observation was evident in all 28 countries (Figs. 2 and 3).

**Bivariable results of caesarean delivery among women in sub-Saharan Africa**

Table 2 presents the bivariable results of caesarean delivery among women in SSA. Majority of the women had male children (50.8%), 48.2% had children who were average size at childbirth, and 97.9% had single birth children (Table 2). The modal age was 25–29 (26.5%), and the modal maternal level of education was no formal education (41.2%). Most of the women were working (65.9%), had four or more antenatal care visits (56.8%), were married (81.8%), Christians (57.5%), and were not covered by health insurance (93.5%). The modal parity was four or more births (47.6%), and modal partner educational level was no formal education (35.2%). Approximately 47.1% and 47.2% of the respondents’ partners decided alone on their healthcare and household purchases and 43.8% decided on visits to family or relatives with their partners.

| Country (Year of survey) | Prevalence (95% CI) | Weight % |
|-------------------------|---------------------|-----------|
| Angola (2015-2016)      | 4.50 (3.95, 5.05)   | 3.63      |
| Burkina Faso (2010)     | 2.28 (1.97, 2.55)   | 3.67      |
| Benin (2018)            | 5.59 (5.08, 6.10)   | 3.64      |
| Burundi (2016-2017)     | 5.85 (5.33, 6.37)   | 3.64      |
| Congo DR (2013-2014)    | 5.43 (4.96, 5.90)   | 3.65      |
| Congo (2011-2012)       | 6.03 (5.31, 6.75)   | 3.59      |
| Cote d’Ivoire (2011-2012)| 2.87 (2.35, 3.39) | 3.64      |
| Cameroon (2018)         | 3.65 (3.13, 4.17)   | 3.64      |
| Ethiopia (2016)         | 2.31 (1.96, 2.66)   | 3.67      |
| Gabon (2012)            | 11.19 (9.87, 12.51) | 3.38      |
| Ghana (2014)            | 13.95 (12.49, 14.70) | 3.45    |
| Gambia (2016-2020)      | 4.05 (3.47, 4.63)   | 3.63      |
| Guinea (2016)           | 2.96 (2.48, 3.44)   | 3.65      |
| Kenya (2014)            | 8.94 (8.19, 9.69)   | 3.58      |
| Comoros (2012)          | 10.70 (9.12, 12.28) | 3.26      |
| Liberia (2019-2020)     | 5.48 (4.58, 6.38)   | 3.54      |
| Lesotho (2014)          | 10.44 (9.09, 11.79) | 3.37      |
| Mali (2018)             | 3.10 (2.65, 3.55)   | 3.65      |
| Malawi (2015-2016)      | 6.39 (5.85, 6.75)   | 3.65      |
| Nigeria (2018)          | 3.14 (2.90, 3.38)   | 3.68      |
| Namibia (2013)          | 16.05 (14.06, 18.04) | 3.05     |
| Sierra Leone (2019)     | 4.19 (3.64, 4.74)   | 3.63      |
| Senegal (2010-2011)     | 6.51 (5.90, 7.12)   | 3.62      |
| Chad (2014-2015)        | 1.32 (0.91, 1.73)   | 3.66      |
| Togo (2013-2014)        | 7.00 (6.23, 7.77)   | 3.58      |
| Uganda (2016)           | 7.16 (6.59, 7.73)   | 3.63      |
| Zambia (2018)           | 5.63 (5.00, 6.26)   | 3.62      |
| Zimbabwe (2015)         | 6.37 (5.63, 7.11)   | 3.59      |
| Overall (I-squared = 98.6%, p = 0.000) | 6.04 (5.21, 6.86) | 100.00   |

NOTE: Weights are from random effects analysis.

Fig. 1 Forest plot showing the prevalence of caesarean deliveries in sub-Saharan Africa.
(43.8%). Most of the respondents lived in male-headed households (86.2%), never watched television (62.1%), and never read newspaper/magazine (86.5%). The modal category for the frequency of listening to the radio was not at all (44.7%) and the modal wealth category was the poorest (21.7%). Statistically significant differences in caesarean delivery were observed across all the characteristics of the women (Table 2). Similar results were found across urban and rural areas. However, mother’s age showed no statistically significant difference in caesarean section in rural areas (Table 3).

### Rural–urban disparities in factors associated with caesarean delivery among women in sub-Saharan Africa

Overall, approximately 81% of the rural–urban disparities in caesarean section were attributable to the differences in child and maternal characteristics (Table 4). Hence, if the child and maternal characteristics were levelled, more than half of the rural–urban inequality in the caesarean section would be reduced. Among the child and maternal characteristics, wealth index (39.2%), antenatal care attendance (13.4%), parity (12.8%), educational level (3.5%), and health insurance coverage (3.1%) explained approximately 72% of the rural–urban disparities in caesarean section (Table 4). The likelihood of caesarean section increased with wealth index in both urban ([aOR = 2.83; 95% CI = 2.11–3.80] and rural areas [aOR = 2.58; 95% CI = 2.17–3.07]). However, the odds were slightly higher in urban areas. The likelihood of caesarean delivery decreased with increasing parity in both rural [aOR = 0.25; 95% CI = 0.21–0.29], and urban areas [aOR = 0.29; 95% CI = 0.25–0.34]. Compared to women who had no antenatal care, those who had four or more antenatal care visits were more likely to deliver through caesarean delivery, with higher odds in rural areas [aOR = 4.49; 95% CI = 3.42–5.89] compared to urban areas [aOR = 2.71; 95% CI = 1.80–4.11]. Women with a higher level of education were more likely to deliver through caesarean delivery than those with no formal education in both rural and urban areas. However, the odds were significant among women with higher education in rural areas only [aOR = 1.42; 95% CI = 1.15–1.76]. Women covered by health insurance were more likely to deliver through caesarean delivery than those

![Fig. 2 Forest plot showing the prevalence of caesarean deliveries in rural sub-Saharan Africa](image-url)
who were not covered by health insurance in rural and urban areas. However, the odds were higher in rural areas \( \text{aOR} = 1.65; 95\% \text{ CI} = 1.41–1.94 \) when compared to those in urban areas \( \text{aOR} = 1.56; 95\% \text{ CI} = 1.39–1.75 \) (Table 5).

**Discussion**

The current study sought to decompose the rural–urban differences in the use of caesarean deliveries in SSA. Generally, a prevalence of < 9% is considered low prevalence of caesarean deliveries [28]. We found an overall prevalence of 6.04%, which corroborates previous studies that have showed that countries in SSA have a low prevalence (6%) of caesarean deliveries [29, 30]. The observed low prevalence of caesarean deliveries in SSA reflects Miller et al’s "too little, too late" [31], which links low prevalence of caesarean deliveries to lower rates of institutional deliveries and deficiencies in resources and evidence-based care. We found the highest prevalence in Namibia, whereas Chad reported the lowest prevalence of caesarean deliveries. It is important to note that Namibia’s prevalence (16.05%) is a little above the accepted interval (5–15%) by the WHO [1].

Our findings indicate rural–urban disparities in caesarean deliveries among women in the 28 countries included in the study, with urban areas reporting a higher prevalence of caesarean deliveries. The result supports previous studies that have reported that urban areas have a disproportionately higher prevalence of caesarean deliveries than rural areas [10, 32]. This could be due to the comparative advantage urban residences have over rural areas regarding access to obstetric care [33]. Nonetheless, we found that over two-thirds of the rural–urban disparities in caesarean deliveries were attributable to the differences in child and maternal characteristics, including wealth index, parity, antenatal care attendance, educational level, and health insurance coverage.

We found differences in the prevalence of caesarean deliveries attributable to the wealth index, which aligns with the findings of a related study in Ethiopia [32]. Rural areas are usually disadvantaged in access to obstetric care, with the nearest health facilities being miles away from such communities [33]. This means that poorer women in rural areas would find it difficult to afford transportation to access facility birthing, let alone utilize caesarean section. Although there is the

### Table 5: Prevalence of Caesarean Deliveries by Country

| Country (Year of survey) | Prevalence (95% CI) | Weight % |
|-------------------------|---------------------|----------|
| Angola (2015-2016)      | 6.21 (5.57, 6.85)   | 3.61     |
| Burundi (2017)          | 7.05 (6.55, 7.56)   | 3.62     |
| Benin (2016)            | 8.88 (8.25, 9.51)   | 3.61     |
| Burundi (2016-2017)     | 19.16 (18.29, 20.03)| 3.58     |
| Congo DR (2013-2014)    | 7.65 (7.09, 8.41)   | 3.61     |
| Congo (2011-2012)       | 7.72 (6.91, 8.53)   | 3.59     |
| Cote d'Ivoire (2011-2012)| 5.72 (5.00, 6.44)   | 3.60     |
| Cameroon (2018)         | 6.18 (5.52, 6.84)   | 3.61     |
| Ethiopia (2016)         | 12.02 (11.26, 12.78)| 3.60     |
| Gabon (2012)            | 11.74 (10.39, 13.09)| 3.51     |
| Ghana (2014)            | 20.51 (19.15, 21.87)| 3.51     |
| Gambia (2019-2020)      | 5.29 (4.63, 5.95)   | 3.61     |
| Guinea (2018)           | 7.17 (6.44, 7.90)   | 3.60     |
| Kenya (2014)            | 13.69 (12.78, 14.60)| 3.58     |
| Comoros (2012)          | 13.88 (12.11, 15.65)| 3.43     |
| Liberia (2019-2020)     | 8.68 (7.69, 9.67)   | 3.57     |
| Lesotho (2014)          | 13.91 (12.38, 15.44)| 3.48     |
| Mali (2018)             | 6.21 (5.59, 6.83)   | 3.61     |
| Malawi (2015-2016)      | 12.27 (11.66, 12.86)| 3.61     |
| Nigeria (2018)          | 5.89 (5.56, 6.22)   | 3.63     |
| Namibia (2013)          | 23.75 (21.44, 26.06)| 3.30     |
| Sierra Leone (2019)     | 7.13 (6.42, 7.84)   | 3.60     |
| Senegal (2010-2011)     | 12.01 (11.21, 12.81)| 3.59     |
| Chad (2014-2015)        | 3.45 (2.80, 4.10)   | 3.61     |
| Togo (2013-2014)        | 12.68 (11.68, 13.68)| 3.57     |
| Uganda (2016)           | 13.60 (12.65, 14.53)| 3.60     |
| Zambia (2018)           | 9.54 (8.74, 10.34)  | 3.59     |
| Zimbabwe (2015)         | 12.01 (11.02, 13.00)| 3.57     |
| Overall (\(i^2 = 99\%\), \(p = 0.000\)) | 10.37 (9.89, 10.86) | 100.00 |

*Fig. 3 Forest plot showing the prevalence of caesarean deliveries in urban sub-Saharan Africa*
Table 3  Bivariable analysis of caesarean deliveries among women in sub-Saharan Africa segregated by place of residence

| Variables                        | Rural (n = 111,450) |              | Urban (n = 63,150) |              |
|----------------------------------|---------------------|--------------|--------------------|--------------|
|                                  | Weighted Caesarean  | p-value      | Weighted Caesarean  | p-value      |
|                                  | N (%) No (%) Yes (%)|              | N (%) No (%) Yes (%)|              |
| **Sex of child**                 |                     |              |                    |              |
| Male                             | 56,724 (50.9)       | 96.6 3.4     | 24,782 (50.5)      | 90.2 9.8     |
| Female                           | 54,726 (49.1)       | 96.9 3.1     | 24,270 (49.5)      | 91.5 8.5     |
| **Mother’s self-reported size of child at birth** | <0.001 |              | <0.001 |              |
| Large                            | 39,275 (35.2)       | 96.1 3.9     | 18,854 (38.5)      | 89.9 10.1    |
| Average                          | 54,056 (48.5)       | 97.2 2.8     | 23,312 (47.5)      | 92.1 7.9     |
| Smaller                          | 18,119 (16.3)       | 96.6 3.4     | 6886 (14.0)        | 89.0 11.0    |
| **Twin status**                  |                     | <0.001       | <0.001             |              |
| Single birth                     | 109,197 (98.0)      | 96.8 3.2     | 47,936 (97.7)      | 91.1 8.9     |
| Multiple birth                   | 2253 (2.0)          | 91.0 9.0     | 1116 (2.3)         | 78.9 21.1    |
| **Mother’s age (years)**         | 0.348               | <0.001       |                    |              |
| 15–19                            | 7087 (6.4)          | 96.9 3.3     | 2118 (4.3)         | 94.7 5.3     |
| 20–24                            | 24,306 (21.8)       | 96.6 3.4     | 9475 (19.3)        | 93.8 6.2     |
| 25–29                            | 28,364 (25.5)       | 97.2 2.8     | 14,085 (28.7)      | 91.1 8.9     |
| 30–34                            | 22,715 (20.4)       | 96.8 3.2     | 11,409 (23.2)      | 89.9 10.1    |
| 35–39                            | 16,965 (15.2)       | 96.7 3.3     | 7827 (16.0)        | 87.7 12.3    |
| 40–44                            | 8852 (7.9)          | 97.0 3.0     | 3266 (6.7)         | 89.6 10.4    |
| 45–49                            | 3161 (2.8)          | 97.3 2.7     | 872 (1.8)          | 88.7 11.3    |
| **Maternal educational level**   | <0.001              | <0.001       |                    |              |
| No education                     | 55,710 (50.0)       | 98.1 1.9     | 11,484 (23.4)      | 94.8 5.2     |
| Primary                          | 37,289 (33.5)       | 96.2 3.8     | 11,784 (24.0)      | 92.7 7.3     |
| Secondary                        | 17,181 (15.4)       | 94.2 5.8     | 21,063 (43.0)      | 90.5 9.5     |
| Higher                           | 1270 (1.1)          | 85.7 14.3    | 4721 (9.6)         | 78.1 21.9    |
| **Antenatal care attendance**    | 0.049               | <0.001       |                    |              |
| None                             | 36,844 (33.1)       | 96.9 3.1     | 17,790 (36.3)      | 91.7 8.3     |
| 1–3                              | 74,606 (66.9)       | 96.6 3.4     | 31,262 (63.7)      | 90.3 9.7     |
| 4 or more                        | <0.001              | <0.001       |                    |              |
| None                             | 15,135 (13.6)       | 99.4 0.6     | 2052 (4.2)         | 97.6 2.4     |
| 1–3                              | 41,502 (37.2)       | 97.3 2.7     | 11,599 (23.6)      | 93.9 6.1     |
| 4 or more                        | 54,813 (49.2)       | 95.5 4.5     | 35,401 (72.2)      | 89.4 10.6    |
| **Marital status**               | <0.001              | 0.013        |                    |              |
| Married                          | 94,604 (87.9)       | 96.9 3.1     | 37,035 (75.5)      | 90.6 9.4     |
| Cohabiting                       | 16,846 (15.1)       | 95.8 4.2     | 12,017 (24.5)      | 91.7 8.3     |
| **Religion**                     | <0.001              | <0.001       |                    |              |
| No religion/others               | 3154 (2.8)          | 97.6 2.4     | 958 (1.9)          | 90.6 9.4     |
| Christianity                     | 62,105 (55.7)       | 95.7 4.3     | 29,917 (61.0)      | 89.2 10.8    |
| Islamic                          | 43,351 (38.9)       | 98.1 1.9     | 17,841 (36.4)      | 93.5 6.5     |
| African Traditional              | 2840 (2.6)          | 97.6 2.4     | 335 (0.7)          | 94.0 6.0     |
| **National health insurance subscription** | <0.001 |              | <0.001 |              |
| No                               | 106,265 (95.3)      | 97.0 3.0     | 43,985 (89.7)      | 92.0 8.0     |
| Yes                              | 5185 (4.7)          | 91.7 8.3     | 5067 (10.3)        | 81.1 18.9    |
| **Parity**                       | <0.001              | <0.001       |                    |              |
| 1 birth                          | 17,146 (15.4)       | 94.6 5.4     | 9888 (20.2)        | 87.3 12.7    |
| 2 births                         | 18,743 (16.8)       | 96.0 4.0     | 11,037 (22.5)      | 89.8 10.2    |
| 3 births                         | 17,528 (15.7)       | 96.5 3.5     | 9272 (18.9)        | 91.0 9.0     |
| Four or more births              | 58,033 (52.1)       | 97.7 2.3     | 18,856 (38.4)      | 93.2 6.8     |
user fee exemption policy in most SSA countries including Ghana and Nigeria, evidence suggests that there are substantial inequalities in access to caesarean deliveries with women in lower wealth index having significantly lower likelihood to have a by caesarean deliveries [34]. The observed result also corroborates the findings from our multivariable regression analyses that showed a significant association between wealth index and the odds

| Variables                                      | Rural (n = 111,450) | Urban (n = 63,150) |
|------------------------------------------------|---------------------|--------------------|
|                                                | Weighted Caesarean section | Weighted Caesarean section |
|                                                | N (%) No (%) Yes (%) p-value | N (%) No (%) Yes (%) p-value |
| Partner educational level                     |                     |                    |
| No education                                   | 47,759 (42.8) 98.2 1.8 <0.001 | 9650 (19.7) 95.3 4.7 <0.001 |
| Primary                                        | 33,889 (30.4) 96.5 3.5 | 8445 (17.2) 92.3 7.7 |
| Secondary                                      | 26,015 (23.3) 95.2 4.8 | 22,435 (45.7) 90.9 9.1 |
| Higher                                         | 3788 (3.4) 91.0 9.0 | 8522 (17.4) 84.2 15.8 |
| Person who usually decides on respondent's health care |                     |                    |
| Respondent alone                               | 15,587 (14.0) 95.6 4.4 <0.001 | 8854 (18.1) 89.2 10.8 |
| Respondent and partner                         | 40,273 (36.1) 96.1 3.9 | 18,900 (38.5) 89.4 10.6 |
| Partner alone                                  | 54,782 (49.2) 97.5 2.5 | 21,037 (42.9) 92.8 7.2 |
| Someone else or other                          | 808 (0.7) 96.7 3.3 | 262 (0.5) 93.7 6.3 |
| Person who usually decides on large household purchases |             |                    |
| Respondent alone                               | 11,481 (10.3) 96.3 3.7 <0.001 | 7480 (15.2) 89.4 10.6 |
| Respondent and partner                         | 42,660 (38.3) 95.9 4.1 | 20,925 (42.7) 89.6 10.4 |
| Partner alone                                  | 56,132 (50.4) 97.5 2.5 | 20,051 (40.9) 92.5 7.5 |
| Someone else or other                          | 1177 (1.1) 96.6 3.4 | 596 (1.2) 95.7 4.3 |
| Person who usually decides on visits to family or relatives |             |                    |
| Respondent alone                               | 19,536 (17.5) 96.8 3.2 <0.001 | 10,739 (21.9) 90.0 10.0 |
| Respondent and partner                         | 47,848 (42.9) 96.1 3.9 | 22,404 (45.7) 89.8 10.2 |
| Partner alone                                  | 43,137 (38.7) 97.5 2.5 | 15,572 (31.7) 92.8 7.2 |
| Someone else or other                          | 929 (0.8) 95.7 4.3 | 337 (0.7) 95.7 4.3 |
| Sex of household head                          |                     |                    |
| Male                                           | 96,892 (86.9) 96.9 3.1 | 41,572 (84.8) 91.1 8.9 |
| Female                                         | 14,558 (13.1) 95.7 4.3 | 7480 (15.2) 89.4 10.6 |
| Frequency of watching television               |                     |                    |
| Not at all                                     | 87,263 (78.3) 97.2 2.8 <0.001 | 14,357 (29.3) 94.2 5.8 |
| Less than once a week                           | 11,554 (10.4) 96.2 3.8 | 7066 (14.4) 91.1 8.9 |
| At least once a week                            | 12,633 (11.3) 94.0 6.0 | 27,629 (56.3) 89.0 11.0 |
| Frequency of listening radio                   |                     |                    |
| Not at all                                     | 56,268 (50.5) 97.5 2.5 <0.001 | 16,132 (32.9) 92.9 7.1 |
| Less than once a week                           | 20,216 (18.1) 96.6 3.4 | 10,510 (21.4) 90.5 9.5 |
| At least once a week                            | 34,966 (31.4) 95.6 4.4 | 22,410 (45.7) 89.5 10.5 |
| Frequency of reading newspaper/magazine         |                     |                    |
| Not at all                                     | 102,913 (92.3) 97.0 3.0 <0.001 | 36,633 (74.7) 92.6 7.4 |
| Less than once a week                           | 5627 (5.1) 94.0 6.0 | 6294 (12.8) 86.9 13.1 |
| At least once a week                            | 2910 (2.6) 91.0 9.0 | 6125 (12.5) 84.5 15.5 |
| Wealth index                                    |                     |                    |
| Poorest                                        | 33,991 (30.5) 98.1 1.9 <0.001 | 1915 (3.9) 97.1 2.9 |
| Poorer                                         | 31,730 (28.5) 97.4 2.6 | 3524 (7.2) 95.9 4.1 |
| Middle                                         | 24,982 (22.4) 96.4 3.6 | 7575 (15.5) 95.0 5.0 |
| Richer                                         | 15,568 (14.0) 94.9 5.1 | 14,728 (30.0) 92.8 7.2 |
| Richest                                        | 5179 (4.6) 90.3 9.7 | 21,310 (43.4) 86.6 13.4 |

*p-values are obtained from chi-square test
### Table 4 Multivariate decomposition analysis of factors associated with caesarean section deliveries inequality between rural and urban residence

| Variable                                      | Difference due to Characteristics (E) | Difference due to Coefficients (C) |
|------------------------------------------------|--------------------------------------|-----------------------------------|
| % Total explained disparity                   | 0.04483*** 81.12                     | 0.01043*** 18.88                  |
| Sex of child                                  |                                      |                                   |
| Male                                          | -0.00000*** -0.00                   | 0.00010 0.18                      |
| Female                                        | 0.00000*** -0.00                     | -0.00010 -0.18                    |
| Mother’s self-reported size of child at birth |                                      |                                   |
| Large                                         | 0.00010** 0.19                       | -0.00098** -1.77                  |
| Average                                       | 0.00003*** 0.06                      | -0.00023 -0.41                    |
| Smaller                                       | -0.00019*** -0.35                    | 0.00052** 0.94                    |
| Twin status                                   |                                      |                                   |
| Single birth                                  | 0.00004*** 0.08                      | 0.00141 2.55                      |
| Multiple birth                                | 0.00004*** 0.08                      | -0.00003 -0.05                    |
| Mother’s age (years)                          |                                      |                                   |
| 15–19                                         | 0.00085*** 1.54                      | -0.00019 -0.34                    |
| 20–24                                         | 0.00082*** 1.49                      | -0.00165*** -2.98                 |
| 25–29                                         | -0.00059*** -1.07                    | -0.00114** -2.06                  |
| 30–34                                         | 0.00009 0.16                        | -0.00035 -0.64                    |
| 35–39                                         | 0.00009*** 0.16                      | 0.00052** 0.94                    |
| 40–44                                         | -0.00048*** -0.86                    | 0.00033 0.59                      |
| 45–49                                         | -0.00048*** -0.87                    | 0.00028* 0.50                     |
| Maternal educational level                    |                                      |                                   |
| No education                                  | 0.00186*** 3.37                      | 0.00028 0.51                      |
| Primary                                       | 0.00009 0.16                        | -0.00036 -0.65                    |
| Secondary                                     | -0.00105*** -1.89                    | -0.00014 -0.26                    |
| Higher                                        | 0.00112*** 1.85                      | 0.00002 0.03                      |
| Current working status                        |                                      |                                   |
| No                                            | 0.00001 0.03                         | -0.00037 -0.66                    |
| Yes                                           | 0.00001 0.03                         | 0.00073 1.33                      |
| Antenatal care attendance                     |                                      |                                   |
| None                                          | 0.00353*** 6.39                      | 0.00088* 1.59                     |
| 1–3                                           | -0.00131*** -2.37                    | -0.00097 -1.76                    |
| 4 or more                                     | 0.00521*** 9.42                      | -0.00187* -3.39                   |
| Marital status                                |                                      |                                   |
| Married                                       | -0.00015* -0.28                      | 0.00207** 3.75                    |
| Cohabiting                                    | -0.00015* -0.28                      | -0.00046** -0.73                  |
| Religion                                      |                                      |                                   |
| No religion/others                            | -0.00013* -0.23                      | 0.00012 0.22                      |
| Christianity                                  | 0.00020 0.37                         | -0.00032 -0.57                    |
| Islamic                                       | 0.00009* 0.16                        | 0.00035 0.63                      |
| African Traditional                           | 0.00015 0.26                        | -0.00012 -0.21                    |
| National health insurance subscription        |                                      |                                   |
| No                                            | 0.00086*** 1.56                      | 0.00049 0.88                      |
| Yes                                           | 0.00086*** 1.56                      | -0.00002 -0.04                    |
| Parity                                        |                                      |                                   |
| 1 birth                                       | 0.00186*** 3.36                      | -0.00014 -0.26                    |
| 2 births                                      | 0.00056*** 1.02                      | 0.00006 0.12                      |
| 3 births                                      | -0.00035*** -0.64                    | -0.00019 -0.34                    |
| Four or more births                           | 0.00502*** 9.08                      | 0.00093 1.68                      |

### Table 4 (continued)

| Variable                                      | Difference due to Characteristics (E) | Difference due to Coefficients (C) |
|------------------------------------------------|--------------------------------------|-----------------------------------|
| Partner educational level                     |                                      |                                   |
| No education                                  | 0.00167** 3.02                       | 0.00043 0.77                      |
| Primary                                       | -0.00051* -0.92                      | 0.00036 0.66                      |
| Secondary                                     | -0.00034 -0.62                       | -0.00041 -0.74                    |
| Higher                                        | 0.00065* 1.17                        | -0.00002 -0.04                    |
| Person who usually decides on respondent’s health care |                                      |                                   |
| Respondent alone                              | -0.00014 -0.25                      | -0.00067 -1.20                    |
| Respondent and partner                        | -0.00004 -0.08                      | -0.00023 -0.41                    |
| Partner alone                                 | 0.00057 1.04                        | -0.00078 -1.41                    |
| Someone else or other                         | -0.00003 -0.05                      | 0.00005 0.09                      |
| Person who usually decides on large household purchases |                                      |                                   |
| Respondent alone                              | 0.00027 0.48                        | 0.00045 0.81                      |
| Respondent and partner                        | 0.00028 0.50                        | 0.00053 0.95                      |
| Partner alone                                 | -0.00036 -0.64                      | 0.00166 3.00                      |
| Someone else or other                         | -0.00000 -0.00                      | -0.00010 -0.19                    |
| Person who usually decides on visits to family or relatives |                                      |                                   |
| Respondent alone                              | 0.00034* 0.61                       | 0.00155** 2.80                    |
| Respondent and partner                        | 0.00034 0.62                        | 0.00200 3.61                      |
| Partner alone                                 | -0.00042 -0.75                      | 0.00115 2.07                      |
| Someone else or other                         | 0.00004 0.06                        | -0.00014* -0.26                   |
| Sex of household head                         |                                      |                                   |
| Male                                          | 0.00001 0.02                        | 0.00098 1.77                      |
| Female                                        | 0.00001 0.02                        | -0.00015 -0.27                    |
| Frequency of watching television              |                                      |                                   |
| Not at all                                    | 0.00088 1.60                        | -0.00038 -0.69                    |
| Less than once a week                         | 0.00011 0.19                        | 0.00028* 0.52                     |
| At least once a week                          | -0.00016 -0.28                      | -0.00027* -0.49                   |
| Frequency of listening radio                  |                                      |                                   |
| Not at all                                    | 0.00036 0.65                        | 0.00088 1.59                      |
| Less than once a week                         | 0.00003 0.05                        | 0.00003 0.05                      |
| At least once a week                          | 0.00017 0.32                        | -0.00059* -1.06                   |
| Frequency of reading newspaper/magazine        |                                      |                                   |
| Not at all                                    | 0.00062* 1.12                       | -0.00011 -0.21                    |
| Less than once a week                         | 0.00005 0.08                        | 0.00005 0.09                      |
| At least once a week                          | 0.00028 0.50                        | -0.00002 -0.04                    |
| Wealth index                                  |                                      |                                   |
| Poorest                                       | 0.00630*** 11.40                     | 0.00039 0.71                      |
| Poorer                                        | 0.00234** 4.23                      | 0.00036 0.65                      |
| Middle                                        | 0.00027 0.48                        | -0.00039 -0.71                    |
| Richer                                        | 0.00147*** 2.66                      | -0.00013 -0.23                    |
| Richest                                       | 0.01127*** 20.38                     | 0.00002 0.03                      |

*p < 0.05, **p < 0.01, ***p < 0.001
Table 5  Multivariable regression analysis of factors associated with caesarean deliveries among women in sub-Saharan Africa

| Variables                                      | Pooled AOR [95% CI] | Rural AOR [95% CI] | Urban AOR [95% CI] |
|------------------------------------------------|---------------------|--------------------|--------------------|
| Sex of child                                   |                     |                    |                    |
| Male                                           | 1 [1.00,1.00]       | 1 [1.00,1.00]      | 1 [1.00,1.00]      |
| Female                                         | 0.87*** [0.82,0.92]  | 0.89** [0.82,0.97] | 0.85*** [0.78,0.93]|
| Twin status                                    |                     |                    |                    |
| Single birth                                   | 1 [1.00,1.00]       | 1 [1.00,1.00]      | 1 [1.00,1.00]      |
| Multiple birth                                 | 3.74*** [3.23,4.34]  | 4.06*** [3.36,4.92] | 3.52*** [2.83,4.39]|
| Mother's self-reported size of child at birth  |                     |                    |                    |
| Large                                          | 1 [1.00,1.00]       | 1 [1.00,1.00]      | 1 [1.00,1.00]      |
| Average                                        | 0.71*** [0.67,0.76]  | 0.68*** [0.62,0.75] | 0.74*** [0.67,0.81]|
| Smaller                                        | 1.01 [0.92,1.10]     | 0.86* [0.76,0.99]  | 1.15* [1.01,1.31]  |
| Mother's age (years)                           |                     |                    |                    |
| 15–19                                          | 1 [1.00,1.00]       | 1 [1.00,1.00]      | 1 [1.00,1.00]      |
| 20–24                                          | 1.18* [1.01,1.37]    | 1.25* [1.04,1.51]  | 1.13* [0.87,1.47]  |
| 25–29                                          | 1.73*** [1.47,2.02]  | 1.67*** [1.37,2.04] | 1.90*** [1.46,2.46]|
| 30–34                                          | 2.35*** [1.98,2.79]  | 2.26*** [1.80,2.84] | 2.61*** [1.99,3.42]|
| 35–39                                          | 3.48*** [2.91,4.16]  | 2.84*** [2.24,3.61] | 4.22*** [3.19,5.59]|
| 40–44                                          | 4.34*** [2.81,4.19]  | 3.00*** [2.30,3.91] | 4.03*** [2.95,5.50]|
| 45–49                                          | 4.17*** [3.22,5.40]  | 3.11*** [2.21,4.36] | 5.99*** [4.01,8.93]|
| Maternal educational level                     |                     |                    |                    |
| No education                                   | 1 [1.00,1.00]       | 1 [1.00,1.00]      | 1 [1.00,1.00]      |
| Primary                                        | 1.18*** [1.07,1.31]  | 1.22*** [1.07,1.39] | 1.04 [0.89,1.22]   |
| Secondary                                      | 1.11 [0.99,1.25]     | 1.17 [1.00,1.37]    | 0.97 [0.82,1.15]   |
| Higher                                         | 1.53*** [1.30,1.79]  | 1.31 [0.99,1.74]    | 1.41* [1.15,1.74]  |
| Current working status                         |                     |                    |                    |
| No                                             | 1 [1.00,1.00]       | 1 [1.00,1.00]      | 1 [1.00,1.00]      |
| Yes                                            | 0.97 [0.91,1.04]     | 0.95 [0.86,1.04]    | 0.98 [0.89,1.09]   |
| Antenatal care attendance                      |                     |                    |                    |
| None                                           | 1 [1.00,1.00]       | 1 [1.00,1.00]      | 1 [1.00,1.00]      |
| 1–3                                           | 2.95*** [2.34,3.72]  | 3.33*** [2.54,4.37] | 2.07*** [1.37,3.12]|
| 4 or more                                      | 3.97*** [3.14,5.02]  | 4.49*** [3.42,5.89] | 2.71*** [1.80,4.11]|
| Marital status                                 |                     |                    |                    |
| Married                                        | 1 [1.00,1.00]       | 1 [1.00,1.00]      | 1 [1.00,1.00]      |
| Cohabiting                                     | 1.03 [0.95,1.12]     | 1.15* [1.02,1.30]  | 0.93 [0.83,1.05]   |
| Religion                                       |                     |                    |                    |
| No religion/others                             | 1 [1.00,1.00]       | 1 [1.00,1.00]      | 1 [1.00,1.00]      |
| Christianity                                   | 1.03 [0.84,1.25]     | 1.18 [0.91,1.53]    | 0.90 [0.68,1.20]   |
| Islamic                                        | 0.79* [0.65,0.98]    | 0.85 [0.65,1.13]    | 0.68* [0.51,0.93]  |
| African Traditional                            | 1.01 [0.74,1.37]     | 1.20 [0.83,1.74]    | 0.88 [0.48,1.59]   |
| Parity                                         |                     |                    |                    |
| 1 birth                                        | 1 [1.00,1.00]       | 1 [1.00,1.00]      | 1 [1.00,1.00]      |
| 2 births                                       | 0.62*** [0.56,0.68]  | 0.61*** [0.54,0.70] | 0.61*** [0.54,0.69]|
| 3 births                                       | 0.45*** [0.40,0.50]  | 0.45*** [0.39,0.52] | 0.43*** [0.37,0.51]|
| Four or more births                            | 0.27*** [0.24,0.30]  | 0.25*** [0.21,0.29] | 0.29*** [0.25,0.34]|
| National health insurance subscription          |                     |                    |                    |
| No                                             | 1 [1.00,1.00]       | 1 [1.00,1.00]      | 1 [1.00,1.00]      |
| Yes                                            | 1.58*** [1.44,1.73]  | 1.65*** [1.41,1.94] | 1.56*** [1.39,1.75]|
| Partner educational level                      |                     |                    |                    |
| No education                                   | 1 [1.00,1.00]       | 1 [1.00,1.00]      | 1 [1.00,1.00]      |
| Primary                                        | 1.26*** [1.14,1.41]  | 1.20** [1.05,1.37]  | 1.30*** [1.09,1.54]|
Ahinkorah et al. BMC Pregnancy and Childbirth (2022) 22:709

of caesarean deliveries in both the urban and rural settings, with greater odds being reported in urban areas. This implies that enhancing the socio-economic status of women in rural areas to attend antenatal care attendance and seek facility birthing may help close the rural–urban gap in caesarean deliveries.

Consistent with the findings of a related study by Lisonkova et al. [35], rural–urban disparities in the prevalence of caesarean deliveries were attributable to the differences in parity of women. Additionally, our regression analyses also revealed that the odds of caesarean deliveries significantly declined with increasing parity in both rural and urban settings. However, the odds were much lower in rural areas as opposed to those in urban areas. Our result is supported by a related study from Ghana [36] that reported significantly lower odds of

Table 5 (continued)

| Variables                                      | Pooled AOR [95% CI] | Rural AOR [95% CI] | Urban AOR [95% CI] |
|------------------------------------------------|---------------------|---------------------|--------------------|
| Secondary                                      | 1.22*** [1.09,1.36] | 1.21** [1.05,1.39]  | 1.14 [0.97,1.33]   |
| Higher                                         | 1.28*** [1.12,1.47] | 1.42*** [1.15,1.76] | 1.17 [0.98,1.41]   |
| Person who usually decides on respondent’s health care |                     |                     |                    |
| Respondent alone                               | 1 [1.00,1.00]       | 1 [1.00,1.00]       | 1 [1.00,1.00]      |
| Respondent and partner                         | 0.97 [0.88,1.07]    | 0.83** [0.73,0.95]  | 1.08 [0.94,1.24]   |
| Partner alone                                  | 0.89 [0.80,0.98]    | 0.80*** [0.70,0.92] | 0.95 [0.81,1.10]   |
| Someone else or other                          | 0.95 [0.62,1.44]    | 0.70 [0.42,1.17]    | 1.19 [0.58,2.43]   |
| Person who usually decides on large household purchases |                     |                     |                    |
|Respondent alone                               | 1 [1.00,1.00]       | 1 [1.00,1.00]       | 1 [1.00,1.00]      |
|Respondent and partner                         | 0.94 [0.84,1.04]    | 1.06 [0.91,1.25]    | 0.88 [0.76,1.01]   |
|Partner alone                                   | 0.93 [0.83,1.04]    | 0.98 [0.84,1.14]    | 0.92 [0.79,1.07]   |
|Someone else or other                          | 0.70 [0.49,1.40]    | 0.96 [0.59,1.55]    | 0.52 [0.30,0.91]   |
| Person who usually decides on visits to family or relatives |                     |                     |                    |
| Respondent alone                               | 1 [1.00,1.00]       | 1 [1.00,1.00]       | 1 [1.00,1.00]      |
|Respondent and partner                         | 1.02 [0.92,1.12]    | 1.12 [0.98,1.28]    | 0.96 [0.84,1.09]   |
|Partner alone                                   | 1.01 [0.91,1.12]    | 1.08 [0.94,1.23]    | 0.97 [0.83,1.13]   |
|Someone else or other                          | 1.09 [0.74,1.61]    | 1.61*** [1.03,2.52] | 0.58 [0.27,1.26]   |
| Sex of household head                         |                     |                     |                    |
|Male                                           | 1 [1.00,1.00]       | 1 [1.00,1.00]       | 1 [1.00,1.00]      |
|Female                                         | 1.11 [1.02,1.20]    | 1.07 [0.96,1.20]    | 1.12 [0.99,1.27]   |
| Frequency of watching television               |                     |                     |                    |
| Not at all                                     | 1 [1.00,1.00]       | 1 [1.00,1.00]       | 1 [1.00,1.00]      |
|Less than once a week                           | 1.09 [0.98,1.21]    | 1.03 [0.89,1.18]    | 1.05 [0.90,1.24]   |
|At least once a week                            | 1.13*** [1.03,1.24] | 1.14*** [1.00,1.30] | 1.05 [0.93,1.20]   |
| Frequency of listening radio                   |                     |                     |                    |
| Not at all                                     | 1 [1.00,1.00]       | 1 [1.00,1.00]       | 1 [1.00,1.00]      |
|Less than once a week                           | 1.07 [0.98,1.17]    | 1.06 [0.94,1.20]    | 1.07 [0.94,1.22]   |
|At least once a week                            | 1.09** [1.01,1.18]  | 1.16*** [1.04,1.29] | 1.05 [0.94,1.17]   |
| Frequency of reading newspaper/magazine        |                     |                     |                    |
| Not at all                                     | 1 [1.00,1.00]       | 1 [1.00,1.00]       | 1 [1.00,1.00]      |
|Less than once a week                           | 1.10 [0.99,1.21]    | 1.00 [0.85,1.17]    | 1.15*** [1.02,1.30]|
|At least once a week                            | 1.21*** [1.08,1.35] | 1.28*** [1.06,1.55] | 1.23*** [1.07,1.41]|
| Wealth index                                   |                     |                     |                    |
|Poorest                                        | 1 [1.00,1.00]       | 1 [1.00,1.00]       | 1 [1.00,1.00]      |
|Poorer                                         | 1.23*** [1.10,1.38] | 1.17*** [1.05,1.34] | 1.33 [0.94,1.88]   |
|Middle                                         | 1.55*** [1.39,1.74] | 1.48*** [1.31,1.68] | 1.53*** [1.12,2.08]|
|Richer                                         | 2.07*** [1.84,2.33] | 1.85*** [1.61,2.13] | 2.02*** [1.50,2.72]|
| Richest                                       | 2.97*** [2.62,3.36] | 2.58*** [2.17,3.07] | 2.83*** [2.11,3.80]|

Exponentiated coefficients; 95% confidence intervals in brackets; * p < 0.05, ** p < 0.01, *** p < 0.001; AOR Adjusted Odds Ratio, CI Confidence Interval; 1 [1.00,1.00] = Reference category
birth by caesarean deliveries among multiparous women in both rural and urban settings as compared to uniparous women. Evidence shows that once women start birthing, subsequent deliveries become less risky until they reach the point of grand-multipara (i.e., their fifth delivery) [37]. This phenomenon could possibly explain why the likelihood of caesarean deliveries reduced significantly with increasing parity in both rural and urban settings. Nevertheless, the relatively lower odds of delivering by caesarean deliveries in rural areas as opposed to those in the urban areas is an indication of “too little, too late” as opined by Miller et al. [31]. That is, a situation where women who are in need of caesarean deliveries are unable to access it or that they get access to caesarean deliveries late, probably because of the distance to healthcare facilities, and problem with paying for the cost.

Antenatal care emerged an important maternal characteristic that explained the differences in rural–urban disparities in caesarean deliveries. Greater odds of birth by caesarean deliveries were reported among women who had 4 or more antenatal care visits in both rural and urban residences, with much higher likelihoods in rural settings than urban-dwelling women. The results are in agreement with a study from Nigeria [33] that reported two times greater odds of delivering by caesarean deliveries among women with 4+ antenatal care visits. This observation may be explained from the perspective that 4+ antenatal care visits offer the opportunity for healthcare providers to detect pregnancy complications and identify women who may need to deliver by caesarean deliveries [38]. Also, it serves as a conduit to create awareness of caesarean deliveries and facilitate women's capacity to make an informed decision to undergo elective caesarean section [33, 39]. It is also possible that women with more than 4 antenatal care visits may also have a higher propensity to seek care and to adhere to healthcare providers’ recommendations. Therefore, it implies that interventions aimed at improving caesarean deliveries utilisation would have to encourage women in rural areas to attend antenatal care to help close the rural–urban gap in caesarean deliveries.

We also found that educational attainment explains the rural–urban differences in caesarean deliveries deliveries. Generally, higher educational attainment is associated with better socio-economic status, higher knowledge about healthcare services and greater autonomy of healthcare decision-making [33]. Hence, similar dynamics play out in birthing by caesarean deliveries. Additionally, this finding confirms our result that women with higher level of education was more likely to deliver through caesarean deliveries than those with no formal education in rural and urban areas. However, we found that the odds were relatively higher in rural areas than those in urban areas. There is consensus in the literature that rural-dwelling women are often disproportionately disadvantaged in terms of higher levels of education and health-seeking [40]. Therefore, improving the educational level of women in rural areas provides an avenue for women who require caesarean delivery to have access to it.

The likelihood of delivering by caesarean deliveries was significantly higher among women covered by health insurance in rural and urban areas; however, the odds were higher among rural-dwelling women. Available evidence indicates that poor socio-economic status is a significant barrier to the utilisation of caesarean deliveries by women who need it; thus, demonstrating a scenario of “too little, too late” [31]. As such, health insurance coverage offsets this barrier by significantly limiting out-of-pocket payment, promoting greater appeal and odds of utilising caesarean deliveries [33]. Our study further revealed that rural women covered by health insurance have the same caesarean deliveries rates than urban women not covered by health insurance (8%). Moreover, urban women covered by health insurance present very high caesarean deliveries rates (19%). Thus, reflecting a situation of “too much, too soon”. That is, a situation where there are more caesarean deliveries than needed.

Strength and limitations
The national representativeness of the DHS data ensures that our findings can be generalized to women in the 28 included countries. Nevertheless, our study has some limitations that should be considered when interpreting the findings. The DHS does not include women who got caesarean deliveries with stillbirth in the samples, and therefore, the prevalence of caesarean deliveries as reported in this study may not be the true reflection of the reality. Also, the DHS is based on the cross-sectional design and thus, we were able to also establish association but not causal inferences. Finally, the differences in surveys years for the various countries could affect comparisons of estimates across countries. Another limitation is that, we excluded all births that occurred outside the healthcare facilities. Therefore, any interpretation of our findings note that our analysis is facility-based rather than population based.

Conclusion
We found significantly low prevalence of caesarean deliveries among the 28 SSA countries. Findings from this study suggest significant rural–urban disparities with respect to caesarean deliveries, with the disparities being attributable to the differences in maternal and child characteristics: wealth index, parity, antenatal care attendance, educational level, and health insurance...
coverage. Therefore, policymakers in the included countries could focus and work on improving the socio-economic status of rural-dwelling women as well as encouraging antenatal care attendance, women’s education, health insurance coverage, and family planning, particularly in rural areas.

Abbreviations
ANC: Antenatal care; CS: Caesarean section; DHS: Demographic and Health Survey; LMICs: Low-income and Middle-income Countries; SDG: Sustainable Development Goal; SSA: Sub-Saharan Africa; STROBE: Strengthening the Reporting of Observational Studies in Epidemiology.

Acknowledgements
We acknowledge MEASURE DHS for providing the data.

Authors’ contributions
BOA: Conceptualization, Analysis, Methodology, Writing – Original draft, Writing – Review & Editing; RGA: Analysis, Methodology, Writing – Original draft, Writing – Review & Editing; AS: Data curation, Methodology, Writing – Original draft, Writing – Review & Editing; JO: Data curation, Writing – Original draft, Writing – Review & Editing; AM: Data curation, Methodology, Writing – Original draft, Writing – Review & Editing; VKC: Writing – Original draft, Writing – Review & Editing; FA: Methodology, Writing – Original draft, Writing – Review & Editing; SY: Supervision, Validation, Writing – Original draft, Writing – Review & Editing; LMICs: Low-income and Middle-income Countries; SDG: Sustainable Development Goal; SSA: Sub-Saharan Africa; STROBE: Strengthening the Reporting of Observational Studies in Epidemiology.

Funding
We received no funding for this study.

Availability of data and materials
The data for this study can be accessed on https://dhsprogram.com/data/available-datasets.cfm.

Declarations
Ethics approval and consent to participate
In this study, ethical clearance was not sought due to the public availability of the DHS dataset. The datasets were obtained from the MEASUREDHS after registration and approval were given for its usage. All the ethical guidelines concerning the use of secondary datasets in the publication were strictly adhered to. All methods were performed in accordance with the Declaration of Helsinki.

Consent for publication
No consent was needed for this study, as the author did not use any details, images or videos related to individual participants. In addition, data used are available in the public domain. Detailed information about the DHS data usage and ethical standards are available at http://goo.gl/ny8T6X.

Competing interests
The author declares no competing interest.

Author details
1 School of Public Health, Faculty of Health, University of Technology Sydney, Sydney, Australia. 2 Department of Family and Community Health, Fred N. Bink School of Public Health, University of Health and Allied Sciences, Hohoe, Ghana. 3 College of Public Health, Medical and Veterinary Sciences, James Cook University, Townsville, Queensland, Australia. 4 Centre For Gender and Advocacy, Takoradi Technical University, PO Box 256, Takoradi, Ghana. 5 Department of Population and Health, University of Cape Coast, Cape Coast, Ghana. 6 Department of Health, Physical Education and Recreation, University of Cape Coast, Cape Coast, Ghana. 7 Department of Community Medicine, Faculty of Medicine, Datta Meghe Institute of Medical Sciences, Wardha, Maharashtra 442107, India. 8 Department of Transdisciplinary Research, Saveetha Medical College and Hospitals, SIMATS, Saveetha University, TN, Chennai 600077, India. 9 Cape Coast Nursing and Midwifery Training College, Cape Coast, Ghana. 10 School of International Development and Global Studies, University of Ottawa, Ottawa, Canada. 11 The George Institute for Global Health, Imperial College London, London, UK.

Received: 15 November 2021 Accepted: 22 August 2022
Published online: 17 September 2022

References
1. Yaya S, Uthman OA, Amouzou A, et al. Disparities in caesarean section prevalence and determinants across sub-Saharan Africa countries. Glob Health Res Policy. 2018;3(1):1–9.
2. World Health Organization. Maternal mortality: evidence brief. World Health Organization, 2019. p. 1–4. Available at: https://apps.who.int/iris/bitstream/handle/10665/329886/WHO-RHR-19.20-eng.pdf.
3. Nilsson C, Østbye T, Daltveit AK, et al. Trends in and socio-demographic factors associated with caesarean section at a Tanzanian referral hospital, 2000 to 2013. Int J Equity Health. 2014;13(1):1–1.
4. Yaya S, Bishwajit G, Shah V. Wealth, education and urban–rural inequality and maternal healthcare service usage in Malawi. BMJ Global Health. 2016;1(2):e000085.
5. Kang L, Gu H, Ye S, et al. Rural–urban disparities in caesarean section rates in minority areas in China: evidence from electronic health records. Int J Med Res. 2020;48(2):03006051987996.
6. Betrán AP, Ye J, Moller AB, et al. The increasing trend in caesarean section rates: global, regional and national estimates: 1990–2014. PLoS One. 2016;11(2):e0148343.
7. da Silva CP, Bittár MH, Stjernholm YV. Indications for increase in caesarean delivery. Reprod Health. 2019;16(1):1–6.
8. Boerma T, Ronmans C, Melesse DY, et al. Global epidemiology of use of and disparities in caesarean sections. Lancet. 2018;392(10155):1341–8.
9. Cavallaro FL, Cresswell JA, França GV, et al. Trends in caesarean delivery by country and wealth quintile: cross-sectional surveys in southern Asia and sub-Saharan Africa. Bull World Health Organ. 2013;91(9):914–22.
10. Yaya S, Zegeye B, Idriess-Wheeler D, et al. Inequalities in caesarean section in Burundi: evidence from the Burundian demographic and health surveys (2010–2016). BMC Health Serv Res. 2020;20(1):1–8.
11. Mu W, Huang YH, Chaumont A, et al. Breast feeding after caesarean delivery on maternal request: protocol of a systematic review and meta-analysis. BMJ Open. 2020;10(8):e028309.
12. Betran AP, Temmerman M, Kingdon C, et al. Interventions to reduce unnecessary caesarean sections in healthy women and babies. Lancet. 2018;392(10155):1358–68.
13. Ye J, Zhang J, Nikolajczyk R, et al. Association between rates of caesarean section and maternal and neonatal mortality in the 21st century: a world-wide population-based ecological study with longitudinal data. BJOG. 2016;123(5):745–53.
14. Berglundh S, Benova L, Olssaekee G, Hanson C. Caesarean section rate in Nigeria between 2013 and 2018 by obstetric risk and socio-economic status. Trop Med Int Health. 2021;26(7):775–88.
15. de Loenzen M, Schantz C, Luu BN, et al. Magnitude and correlates of caesarean section in urban and rural areas: a multivariate study in Vietnam. PLoS One. 2019;14(7):e0213179.
16. Khan MN, Islam MM, Shariff AA, et al. Socio-demographic predictors and average annual rates of caesarean section in Bangladesh between 2004 and 2014. PLoS One. 2017;12(5):e0177579.
17. Hasan MM, Ahmed S, Soares Magalhaes RJ, et al. Temporal trends in between and within-country inequalities in caesarean delivery in low-and middle-income countries: a Bayesian analysis. BJOG. 2021;128(12):1928–37.
18. Corsi DJ, Neuman M, Finlay JE, et al. Demographic and health surveys: a profile. Int J Epidemiol. 2012;41(6):1602–13.
19. Aliaga A, Rulin R. Cluster optimal sample size for demographic and health surveys. ICOTS. 2006;7:2–7.
20. Von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Bull World Health Organ. 2007;85:867–72.
21. Seidu AA, Hagan JE, Agbemavi W, et al. Not just numbers: beyond counting caesarean deliveries to understanding their determinants in Ghana using a population based cross-sectional study. BMC Pregnancy Childbirth. 2020;20(1):1.

22. Dankwah E, Kinyochuk S, Zeng W, et al. Socioeconomic inequalities in the use of caesarean section delivery in Ghana: a cross-sectional study using nationally representative data. Int J Equity Health. 2019;18(1):1–1.

23. Shen M, Wu Y, Xiang X. Hukou-based rural–urban disparities in maternal health service utilization and delivery modes in two Chinese cities in Guangdong Province. Int J Equity Health. 2021;20(1):1.

24. Al-Rawashdeh I, Kharboush I, Al-Kubaisy W. Disparities in cesarean section among women in Jordan: analysis of the 2017–2018 Jordan Population and Family Health Survey (JPFHS) data. J Matern Fetal Neonatal. 2021;15:1–9.

25. Banchani E, Tenkorang EY. Risk factors for Caesarean sections in Ghana: evidence from the Ghana Maternal Health Survey. J Biosoc Sci. 2020;12:1–8.

26. Peltzer K, Pengpid S. Prevalence and associated factors of Caesarean Section deliveries among child-bearing women in Iraq: results of the 2018 multiple indicator cluster survey. Gend Behav. 2019;17(4):14541–6.

27. Powers DA, Yoshioka H, Yun MS. mvdmcomp: Multivariate decomposition for nonlinear response models. Stand Genomic Sci. 2011;11(4):556–76.

28. Betran AP, Torloni MR, Zhang J, et al. What is the optimal rate of caesarean section at population level? A systematic review of ecologic studies. Reprod health. 2015;12(1):1.

29. Benova L, Macleod D, Footman K, et al. Role of the private sector in childbirth care: cross-sectional survey evidence from 57 low- and middle-income countries using demographic and health surveys. Trop Med Int Health. 2015;20(12):1657–73.

30. Vogel JP, Betrán AP, Vindevoghel N, et al. Use of the Robson classification to assess caesarean section trends in 21 countries: a secondary analysis of two WHO multicountry surveys. Lancet Glob Health. 2015;3(5):e260–70.

31. Miller S, Abarde E, Chambal M, et al. Beyond too little, too late and too much, too soon: a pathway towards evidence-based, respectful maternity care worldwide. Lancet. 2016;388(10056):2176–92.

32. Shibre G, Idiss-Wheeler O, Bishwajit G, et al. Observed trends in the magnitude of socioeconomic and area-based inequalities in use of caesarean section in Ethiopia: a cross-sectional study. BMC Public Health. 2020;20(1):1–2.

33. Adeyemo EA, Atema V, Khanal V, et al. Cesarean delivery in Nigeria: prevalence and associated factors—a population-based cross-sectional study. BMJ Open. 2019;9(6):e027273.

34. Ajayi A. Socioeconomic inequalities in access to birth by caesarean section in the context of user fee exemption for maternal health services in southwest and north central Nigeria. Int Health. 2021;13(6):598–605.

35. Lisonkova S, Sheps SB, Janssen PA, et al. Effect of older maternal age on birth outcomes in twin pregnancies: a population-based study. J Perinatol. 2011;31(2):85–91.

36. Manjaje AK, Amu A, Akpakli DE, et al. Socioeconomic and demographic factors associated with caesarean section delivery in Southern Ghana: evidence from INDEPTH Network member site. BMC Pregnancy Childbirth. 2018;18(1):1–9.

37. Mgaya AH, Massawe SN, Kidanto HL, et al. Grand multiparity: is it still a risk in pregnancy? BMC Pregnancy Childbirth. 2013;13(1):1–8.

38. Adeyemo EA, Atema V, Khanal V, et al. Prevalence and factors associated with underutilization of antenatal care services in Nigeria: a comparative study of rural and urban residences based on the 2013 Nigeria demographic and health survey. PLoS One. 2018;13(3):e0197324.

39. Chigbu CO, Iloabachie GC. The burden of caesarean section refusal in a developing country setting. BJOG Bjog-Int J Obstet Gy. 2007;114(10):1261–5.

40. Hung P, Henning-Smith CE, Casey MM, et al. Access to obstetric services in rural counties still declining, with 9 percent losing services, 2004–14. Health Aff. 2017;36(9):1663–71.

Publisher’s Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.