Prevalence and Factors Associated With Caesarean Section in Rwanda: a Trend Analysis of Rwanda Demographic and Health Survey 2000 to 2019-20

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Research Article

Keywords: Rwanda, caesarean section, women, maternal health, maternal mortality, Eastern Africa

Posted Date: October 28th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-996942/v1>

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Abstract

Background: Caesarean section (CS) is an important medical intervention for reducing the risk of poor perinatal outcomes. However, CS trends in sub-Saharan Africa (SSA) continue to increase yet maternal and neonatal mortality and morbidity remain high. Rwanda, like many other countries in SSA, has shown an increasing trend in the use of CS. This study assessed the trends and factors associated with CS delivery in Rwanda over the past two decades.

Methods: We used nationally representative child datasets from the Rwanda Demographic and Health Survey 2000 to 2019-20. All births in the preceding three years to the survey were assessed for the mode of delivery. The participants' characteristics, trends and the prevalence of CS were analysed using frequencies and percentages. Unadjusted and adjusted logistic regression analyses were used to assess the factors associated with population and hospital-based CS in Rwanda for each of the surveys.

Results: The population-based rate of CS in Rwanda significantly increased from 2.2% (95% CI 1.8–2.6) in 2000 to 15.6% (95% CI 13.9–16.5) in 2019-20. Despite increasing in all health facilities over time, there was an almost four-fold difference in the rate of CS between private (60.6%) and public health facilities (15.4%) in 2019-20. The rates and odds of CS were disproportionately high among women of high socioeconomic groups, those who resided in Kigali city, had multiple pregnancies, and attended at least four antenatal care visits while the odds of CS were significantly lower among multiparous women and those who had female babies.

Conclusion: Over the past two decades, the rate of CS use in Rwanda increased significantly at health facility and population level with high regional and socio-economic disparities. There is a need to examine the disparities in CS trends and developing tailored policy guidelines to ensure proper use of CS in Rwanda.

Background

The burden for maternal and neonatal mortality remains disproportionately high in many low- and middle-income countries (LMICs) [1, 2]. About 99% of all global maternal deaths occurred in LMICs between 1990 and 2010 with an estimated two-thirds occurring in sub-Saharan Africa (SSA) [1, 2]. Despite the high maternal deaths in SSA, Rwanda recorded a 79% decline in maternal mortality ratio between 2000 and 2017 [1]. This reduction has been accelerated by increased access and use of skilled and competent care by women during the pregnancy continuum. However, about 73% of the global maternal deaths remain due to direct obstetric causes including obstetric interventions and complications [3] despite most of them being preventable. The provision of basic and comprehensive emergency obstetric and newborn care (EmONC) within a continuum of care is essential to reduce maternal and newborn morbidity and mortality [4, 5].

Caesarean section (CS) is an important comprehensive EmONC signal function and medical intervention for reducing risks of perinatal morbidity and mortality [6]. The proportion of delivery by CS is used to estimate the level of access and use of the intervention in saving maternal and child health at a population level [7]. Over the past few decades, global trends have shown a steady increase in CS use [8]. Gibbons and colleagues found that half of the countries surveyed globally had CS rates of above 15% [9] while Betran and colleagues estimated that by 2030, 29% of women will be giving birth through CS globally; about 7% in SSA and 63% in Eastern Asia [10]. Countries in SSA are also reporting high CS rates despite the high burden of preventable

maternal and neonatal mortality [1]. However, huge disparities in CS use exist in SSA countries with some countries like South Sudan reporting rates lower than 1% while others like Ghana reporting a prevalence of 16% [11, 12].

These observed global increases in CS are driven majorly by medical and non-medical factors [6, 9]. Medically, CS deliveries are indicated in high risk conditions such as placenta previa, breech presentation, contracted pelvis, post-term pregnancy and hypertensive disorders [13]. However, CS deliveries have been conducted due to non-medical factors including maternal age, socioeconomic status, literacy levels, occupation, religion and culture [12, 14] and other demand-driven factors such as private practice and the cost of accessing CS [12]. In LMICs, the causes for the increasing CS use remain unclear though socioeconomic factors have been shown to contribute to the increase [6, 15]. The World Health Organization (WHO) recommends an optimal CS rate of 10–15% where rates below the lower limit suggest the unmet need for CS while rates above the upper limit suggest overuse of CS [16, 17]. The use of CS without medical indication is of no significance in reducing maternal and child mortality [6, 7], with recent evidence showing no beneficial effect of CS rates of above 10% on perinatal mortality rate [7].

Although Rwanda has made great strides in reducing maternal and child mortality in recent years, there is a risk of reversing these gains through the overuse of CS. Rwanda, like many countries in SSA, has shown a consistent rise in the use of CS, which is estimated to account for 13% [18] to 25.9% [19] of all deliveries. A recent study reported CS rates of 64% in private health facilities in Rwanda [11]. In addition, evidence indicates that if uncontrolled, the use of CS will continue to rise and with it the dire consequences [20]. Therefore, understanding the trends and patterns of CS use is the mainstay of preventing risks and developing context-specific evidence for policies to reduce maternal and neonatal mortality. However, comprehensive evidence on trends and patterns of CS use is lacking in Rwanda. This study used national-level data from the Rwanda Demographic and Health Survey between 2000 and 2019-20 to assess the trends and factors associated with CS delivery in Rwanda at both population and hospital levels.

Methods

Study setting

Rwanda is a low-income, agricultural and landlocked country with approximately 11 million people living in five regions covering an area of 26,338 square kilometres [20]. It has an average of 4.4 persons per household [19] and a gross domestic product per capita of US \$780.80 [21]. About half (48%) of its population is under 19 years of age and 39% live below the poverty line with a life expectancy at birth of 71.1 years for women and an adult literacy rate of 80% among 15–49 years old women. In addition, 87.3% of the population has health insurance and access to health services; spending an average of 47.4 minutes to reach a health centre [19]. In 2016, CS in Rwanda were conducted in 27 (75%) of the 36 districts, provincial and referral hospitals [19].

Data source and sample

The study used the child datasets from the Rwanda Demographic Health Surveys (RDHS) conducted in 2000, 2005, 2010, 2014-15 and 2019-20 using stratified, two-stage cluster sampling [20, 22–25]. Households were

stratified into urban or rural and all eligible women 15–49 years in selected households were interviewed using standard DHS questionnaires. All babies born within the preceding three years of each survey and with complete data were included in the population-based analysis while only babies delivered at a hospital were included in the hospital-based analysis. Of the 75,777 children born within the three years preceding each survey, 34,144 children were included after excluding 41,633 children with missing observations in the outcome variable (Suppl. Figure 1).

Measures

The outcome variable was delivery by CS, which was categorized into “Yes” or “No”. Women were asked if they had been delivered by CS within the three years preceding the survey. Since it is possible for women to have more than one CS in three years, we used the participants’ unique identifiers and weighted samples to account for the clustering of CS. The explanatory variables included in the study were identified from a review of literature on factors associated with CS use [12, 26–32]. Supplementary Table 1 operationalises these variables that include residence (urban or rural), maternal age at birth (<20, 20–34 and ≥ 35 years), education status (no formal, primary and secondary or higher), access to information (Yes or No), marital status (in-a-union and not-in-a-union), occupation (not working, agricultural and formal employment), place of delivery (private, public and home/others), antenatal care (ANC) attendance (<4 and ≥ 4 visits and missing), the weight of the baby (normal, low birth weight and big baby), sex of the baby (male or female), type of pregnancy (singleton or multiple), parity (1, 2–4, ≥ 5), partner’s education (no formal, primary and secondary or higher), and region (East, West, South, North and Kigali City).

Statistical analysis

We performed analyses for each of the surveys and the pooled datasets using Stata version 17.0 (Stata Corporation, College Station, TX). Pooled datasets were created by appending individual datasets for each of the five surveys. Participants’ characteristics and trends in the prevalence of CS were analysed using frequencies and percentages. To assess the factors associated with population-based and hospital-based CS, bivariate and multivariable logistic regression models were performed for each of the surveys and pooled data. Variance inflation factor was used to assess multicollinearity. All variables included in the unadjusted model were hierarchically included in the adjusted model due to their importance in explaining CS. We reported both the unadjusted and adjusted odds ratios and considered significance at a p-value of less than or equal to 0.05. Only children with complete data were included in the analyses. The reporting in this study were guided by the STROBE guidelines for cross-sectional studies (Suppl. Table 3) [33].

Ethics

The study used anonymised open-access secondary data from the RDHS, which received ethical approvals from the Rwanda National Ethics Committee and the Institutional Review Board of ICF International. The data were accessed upon approval of data request to the DHS program and were used as per the data agreement. Additional information on the ethical approvals and processes for the surveys can be obtained from the published reports [20, 22–25].

Results

Respondents' characteristics

Overall, the study included 34,144 children born within the three years preceding each survey (Suppl. Figure 1). A majority of the children were born to middle-aged women (20–34 years), women who resided in rural areas, had a primary level of education, had two to four children, and had attended less than four ANC visits across the years. An almost equal proportion of participants lived in the West, East, and South provinces of Rwanda with the smallest proportion of participants living in Kigali City (Table 1).

Table 1
Participants' characteristics

Characteristics	2000 (N=6706)		2005 (N=7712)		2010 (N=7159)		2014-15 (N=6248)		2019-20 (N=6319)	
	n	%	n	%	n	%	n	%	n	%
Age, years										
15-19	431	6.4	318	4.1	342	4.8	344	5.5	286	4.5
20-34	4,881	72.8	5,830	75.6	5,605	78.3	4,875	78.0	4,520	71.5
35-49	1,394	20.8	1,564	20.3	1,212	16.9	1,029	16.5	1,513	23.9
Residence										
Urban	1,460	21.8	1,478	19.2	906	12.7	1,384	22.2	1,284	20.3
Rural	5,246	78.2	6,234	80.8	6,253	87.3	4,864	77.9	5,035	79.7
Marital status										
Not in a union	841	12.5	904	11.7	988	13.8	1032	16.5	1,004	15.9
Married/cohabiting	5,865	87.5	6,808	88.3	6,171	86.2	5,216	83.5	5,315	84.1
Education										
No formal	2,115	31.5	2,082	27.0	1,327	18.5	893	14.3	691	10.9
Primary	3,802	56.7	4,941	64.1	5,222	72.9	4,479	71.7	4,076	64.5
Secondary and higher	789	11.8	689	8.9	610	8.5	876	14.0	1,552	24.6
Occupation										
Not working	149	2.6	1,552	20.1	831	11.6	534	8.6	1,269	20.1
Agriculture	4,915	86.4	5,475	71.0	5,473	76.5	4,572	73.2	2,510	39.7
Formal employment	624	11.0	685	8.9	855	11.9	1,140	18.3	2,540	40.2
Wealth, quintiles										
Poorest	1,191	18.0	1,604	20.8	1,703	23.8	1,542	24.7	1,604	25.4
Poorer	1,587	24.0	1,518	19.7	1,567	21.9	1,294	20.7	1,241	19.6
Average	824	12.5	1,517	19.7	1,419	19.8	1,152	18.4	1,178	18.6
Richer	1,300	19.7	1,591	20.6	1,289	18.0	1,067	17.1	1,142	18.1
Richest	1,707	25.8	1,482	19.2	1,181	16.5	1,193	19.1	1,154	18.3
ANC attendance, visits										

Characteristics	2000 (N=6706)		2005 (N=7712)		2010 (N=7159)		2014-15 (N=6248)		2019-20 (N=6319)	
	n	%	n	%	n	%	n	%	n	%
< 4	3,452	51.5	50.85	50.0	2,929	40.9	39.36	38.1	2,367	37.5
≥4	442	6.6	7.659	7.0	1,668	23.3	31.33	29.9	2,102	33.3
Missing	2,812	41.9	41.5	40.8	2,562	35.8	29.31	28.4	1,850	29.3
Parity										
1	694	10.4	786	10.2	1,173	16.4	1,222	19.6	1,141	18.1
2-4	3,505	52.3	3,925	50.9	3,776	52.7	3,617	57.9	3,612	57.2
5+	2,507	37.4	3,001	38.9	2,210	30.9	1,409	22.6	1,566	24.8
Baby's sex										
Male	3,415	50.9	3,923	50.9	3,601	50.3	3,149	50.4	3,205	50.7
Female	3,291	49.1	3,789	49.1	3,558	49.7	3,099	49.6	3,114	49.3
Baby's birth weight										
Average	1,591	23.8	1,855	24.1	3,844	53.7	4581	73.4	4,839	76.6
Low birth weight	218	3.3	207	2.7	501	7.0	600	9.6	692	11.0
Big baby	4,872	72.9	5,650	73.3	2,814	39.3	1,061	17.0	788	12.5
Twin Status										
Singleton	6,542	97.6	7,518	97.5	6959	97.2	6069	97.1	6,151	97.3
Multiple	164	2.5	194	2.5	200	2.8	179	2.9	168	2.7
Access to information										
No	2,375	35.4	1,661	21.5	673	9.4	1,028	16.5	1,359	21.5
Yes	4,331	64.6	6,051	78.5	6,486	90.6	5,220	83.6	4,960	78.5
Partner's education										
No formal	1,916	29.8	1,986	27.1	1,318	19.7	906	15.9	673	12.7
Primary	3,551	55.2	4,409	60.1	4,649	69.6	4,049	71.2	3,521	66.5
Secondary and higher	961	15.0	945	12.9	715	10.7	730	12.8	1,103	20.8
Region										
Kigali City	837	12.5	504	6.5	750	10.5	729	11.7	731	11.6
West	1,605	23.9	1,906	24.7	1,805	25.2	1,624	26.0	1,681	26.6

Characteristics	2000 (N=6706)		2005 (N=7712)		2010 (N=7159)		2014-15 (N=6248)		2019-20 (N=6319)	
	n	%	n	%	n	%	n	%	n	%
East	1,533	22.9	1,973	25.6	1,790	25.0	1,545	24.7	1,512	23.9
South	1,490	22.2	2,014	26.1	1,771	24.7	1,503	24.1	1,432	22.7
North	1,241	18.5	1,315	17.1	1,043	14.6	847	13.6	963	23.9
Place of delivery										
Home/others	4,723	70.5	5,429	70.5	2,005	28.0	525	8.4	435	6.9
Public health facility	1,856	27.7	2,169	28.2	5,101	71.3	5,702	91.3	5,775	91.4
Private health facility	121	1.8	98	1.3	50	0.7	18	0.3	109	1.7

Trends in prevalence of CS in Rwanda

Overall, the rate of CS increased significantly from 2.2% (95% CI 1.8–2.6) in 2000 to 15.6% (95% CI 13.9–16.5) in 2019-20. The rate was consistently high among women 15-19 years of age, women residing in urban areas, those with secondary or higher levels of education, from the richest households, with access to information, on paid employment, and those who had one child, male babies, and multiple pregnancies across the years (Table 2).

We found regional disparities in the prevalence of CS across the years. Kigali city had a significantly higher prevalence than the other regions; with a three-fold increase in CS from 8.8% in 2000 to 26.4% in 2019-20. The Northern region had the lowest prevalence of CS despite a 10-fold increase between 2000 (1.3%) and 2019-20 (13.2%) (Table 2).

There was an upward trend in the prevalence of CS in both public and private health facilities. The prevalence of CS in public facilities increased by about seven percentage points from 8.2% (95% CI 6.8–10.0) in 2000 to 15.4% (95% CI 14.1–16.8) in 2019-20. On the other hand, there was about a four-fold increase in the prevalence of CS in private facilities from 13.6% (95% CI 7.4–23.8%) in 2000 to 60.6% (95% CI 47.2–72.5) in 2019-20; though the 2019-20 rate was a 20% decrease from the 2014-15 rate (Table 2). The prevalence of CS between public and private health facilities in 2010, 2014-15 and 2019-20 differed significantly despite having almost similar rates in 2005 (Table 2).

Table 2
Prevalence of caesarean section according to participants' characteristics

Characteristics	2000		2005		2010		2014-15		2019-20	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Age, years										
15-19	3.7	(2.0-6.9)	4.1	(2.3-7.2)	9.9	(7.0-13.8)	14.1	(10.3-18.9)	14.2	(10.1-19.6)
20-34	2.2	(1.8-2.8)	3.1	(2.5-3.7)	7.4	(6.5-8.3)	13.3	(12.1-14.7)	15.8	(14.3-17.4)
35-49	1.5	(0.9-2.5)	1.8	(1.2-2.6)	5.2	(3.9-6.9)	9.7	(7.8-12.0)	13.5	(11.2-16.1)
Residence										
Urban	6.4	(5.0-8.1)	7.4	(5.5-9.97)	16.0	(13.0-19.6)	22.1	(18.9-25.8)	14.7	(12.4-17.4)
Rural	1.4	(1.1-1.9)	2.1	(1.7-2.6)	6.0	(5.3-6.8)	10.8	(9.7-12.1)	15.3	(13.9-16.7)
Marital status										
Not in a union	1.6	(1.0-2.7)	3.9	(2.6-5.7)	7.8	(6.2-9.7)	13.1	(10.9-15.7)	26.4	(22.9-30.3)
Married/cohabiting	2.2	(1.8-2.7)	2.7	(2.2-3.3)	7.0	(6.2-7.9)	12.7	(11.5-14.1)	12.9	(11.6-14.3)
Education										
No formal	1.1	(0.7-1.7)	2.2	(1.5-3.1)	5.1	(3.9-6.8)	7.7	(5.7-10.3)	8.9	(6.7-11.9)
Primary	2.3	(1.8-3.0)	2.4	(1.9-3.1)	6.4	(5.6-7.2)	12.1	(10.8-13.5)	12.7	(11.4-14.2)
Secondary	5.1	(3.7-7.0)	8.4	(6.1-11.5)	18.6	(15.0-22.8)	22.4	(19.1-26.1)	24.3	(21.1-27.9)
Occupation										
Not working	7.7	(3.2-17.1)	4.6	(3.4-6.2)	9.4	(7.4-11.9)	13.9	(11.2-17.2)	19.0	(16.4-22.0)
Agriculture	1.4	(1.0-1.8)	1.9	(1.5-2.4)	5.7	(5.0-6.6)	10.0	(8.9-11.2)	12.2	(10.5-14.0)
Formal employment	6.1	(4.1-8.9)	7.2	(5.1-10.1)	14.2	(11.4-17.6)	24.5	(20.9-28.5)	16.2	(14.3-18.3)
Wealth, quintiles										

ANC: Antenatal care

Characteristics	2000		2005		2010		2014-15		2019–20	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Poorest	1.6	(0.9–2.8)	1.0	(13.7–18.0)	5.5	(4.5–6.8)	9.7	(7.9–11.8)	10.4	(8.6–12.6)
Poorer	1.0	(0.6–1.8)	2.1	(1.3–3.3)	5.6	(4.3–7.2)	9.2	(7.4–11.4)	9.84	(8.1–11.9)
Average	1.6	(1.0–2.7)	1.8	(1.1–2.8)	6.5	(5.0–8.3)	9.9	(7.8–12.5)	12.5	(10.3–15.1)
Richer	2.2	(1.4–3.4)	2.5	(1.8–3.6)	5.8	(4.4–7.5)	14.4	(11.8–17.3)	16.8	(14.0–20.0)
Richest	4.3	(3.2–5.7)	7.8	(6.0–10.1)	14.2	(11.9–16.8)	23.2	(20.4–26.2)	28.3	(24.5–32.5)
ANC attendance, visits										
1–3	1.9	(1.5–2.4)	2.5	(2.0–3.0)	7.2	(6.3–8.2)	11.0	(9.8–12.3)	13.6	(12.1–15.3)
≥4	4.9	(3.3–7.4)	6.8	(5.2–9.0)	10.4	(8.9–12.1)	15.5	(13.8–17.4)	19.6	(17.8–21.5)
Missing	2.1	(1.6–2.8)	2.6	(2.0–3.4)	4.9	(4.0–6.0)	12.2	(10.5–14.2)	12.2	(10.5–14.1)
Parity										
1	4.2	(3.0–6.1)	6.0	(4.6–7.9)	15.1	(13.1–17.4)	17.9	(15.7–20.4)	20.7	(18.4–23.1)
2–4	2.6	(2.0–3.3)	3.2	(2.5–4.1)	7.2	(6.1–8.5)	13.8	(12.2–15.5)	16.6	(14.9–18.5)
≥5	1.1	(0.7–1.6)	1.6	(1.2–2.3)	2.8	(2.2–3.7)	6.0	(4.6–7.7)	7.9	(6.4–9.9)
Baby's sex										
Male	2.4	(1.9–3.0)	3.2	(2.6–3.9)	7.9	(7.0–9.0)	14.2	(12.7–15.7)	16.2	(14.7–17.8)
Female	1.9	(1.4–2.6)	2.5	(2.0–3.2)	6.3	(5.5–7.2)	11.4	(10.0–12.9)	14.1	(12.4–16.0)
Baby's birth weight										
Average	6.7	(5.3–8.4)	7.7	(6.3–9.4)	9.0	(7.9–10.2)	12.5	(11.3–13.8)	15.4	(14.0–16.9)
Low birth weight	8.8	(5.0–15.0)	9.5	(5.9–15.0)	10.0	(7.7–12.8)	15.2	(12.0–19.0)	14.7	(12.0–17.8)

ANC: Antenatal care

Characteristics	2000		2005		2010		2014-15		2019-20	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Big baby	0.7	(0.5-1.0)	1.1	(0.8-1.5)	4.1	(3.3-5.1)	12.5	(10.3-15.3)	14.3	(11.4-17.7)
Twin status										
Singleton	2.0	(1.6-2.4)	2.8	(2.4-3.4)	6.8	(6.1-7.5)	12.0	(11.0-13.2)	14.8	(13.6-16.2)
Multiple	8.6	(3.8-18.4)	4.4	(1.9-10.1)	19.1	(12.3-28.4)	37.2	(27.3-48.4)	27.2	(18.4-38.3)
Access to information										
No	0.9	(0.6-1.4)	1.6	(1.0-2.6)	6.4	(4.6-8.9)	9.9	(7.8-12.5)	11.7	(9.6-14.1)
Yes	2.9	(2.3-3.6)	3.2	(2.7-3.9)	7.2	(6.4-8.0)	13.4	(12.1-14.7)	16.1	(14.6-17.7)
Partner's education										
No formal	1.5	(1.0-2.3)	1.3	(0.8-1.9)	5.7	(4.3-7.4)	9.0	(6.8-11.9)	8.9	(6.5-12.1)
Primary	1.9	(1.5-2.6)	2.9	(2.2-3.8)	6.0	(5.2-7.0)	11.8	(10.5-13.1)	13.5	(12.0-15.1)
Secondary and higher	4.4	(2.7-6.9)	5.4	(4.0-7.1)	14.3	(11.3-18.0)	23.6	(20.1-27.7)	25.3	(21.6-29.3)
Region										
Kigali City	8.8	(6.8-11.5)	12.1	(8.2-17.5)	15.2	(11.9-19.1)	21.8	(18.0-26.0)	26.4	(22.3-31.0)
South	2.0	(1.3-3.1)	2.8	(2.1-3.8)	7.5	(6.0-9.3)	14.5	(12.1-17.2)	16.2	(13.8-19.0)
West	1.9	(1.3-2.8)	2.8	(2.0-3.9)	6.1	(5.0-7.5)	11.4	(9.2-14.1)	12.5	(10.4-14.9)
East	2.3	(1.4-3.5)	1.9	(1.2-2.9)	6.5	(5.2-8.0)	10.8	(9.0-13.0)	11.2	(8.6-14.4)
North	1.3	(0.8-2.3)	1.2	(0.7-2.1)	4.5	(3.1-6.5)	8.5	(6.4-11.1)	13.2	(10.7-16.3)
Type of facility										
Public	8.2	(6.8-10.0)	10.2	(8.6-11.9)	9.6	(8.7-10.7)	13.9	(12.6-15.2)	15.4	(14.1-16.8)

ANC: Antenatal care

Characteristics	2000		2005		2010		2014-15		2019–20	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Private	13.6	(7.4–23.8)	10.9	(5.7–20.0)	41.5	(26.6–58.1)	76.5	(36.9–94.8)	60.6	(47.2–72.5)
ANC: Antenatal care										

Factors associated with CS in Rwanda

Based on the unadjusted logistic regression models, there was an association between CS and residential area, education, employment, wealth, women's age, access to media, parity, ANC attendance, multiple births, baby's sex and birth weight (Suppl. Table 2).

Table 3 presents the results of the population-based multivariable logistic regression models for each of the four surveys and the pooled model. Results from the pooled model indicate an association between CS and maternal age, occupation, wealth, ANC attendance, parity, sex and size of the child, and region of residence. The odds of CS were higher among women aged 35 years or older (aOR: 1.77, 95% CI 1.26–2.49) and those who had attended four or more ANC visits (aOR: 1.64, 95% CI 1.46–1.84) compared to women 15-19 years of age and those who had visited ANC less than four times, respectively. Moreover, women in formal employment (aOR: 1.21, 95% CI 1.00–1.46), those with primary (aOR: 1.24, 95% CI 1.03–1.51) and secondary or higher levels of education (aOR: 1.58, 95% CI 1.24–2.04) and from the richest households (aOR: 1.52, 95% CI 1.23–1.87) had higher odds of CS compared to unemployed, uneducated, and poorest women, respectively. On the other hand, multiparous women and those residing outside Kigali City had 34–75% and 30–53% lower odds of CS, respectively. Besides, women who delivered big babies had lower odds of CS (aOR: 0.42, 95% CI 0.36–0.48) compared to those with normal-weight babies (Table 3).

Across the surveys, women with multiple pregnancies, with ≥ 4 ANC visits and from the richest households had higher odds of CS while multiparous women and women with female babies had lower odds of CS. In 2000, women working in the agricultural sector had lower odds of CS while in 2014, women in formal employment had higher odds of CS. Region of residence and partner education, and marital status were associated with CS in 2005 and 2010, respectively (Table 3).

Table 3
Factors associated with caesarean section at a population level in Rwanda

Characteristics	2000	2005	2010	2014	2019–20	Pooled
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Age, years						
15–19	1	1	1	1	1	1
20–34	0.76 (0.32–1.78)	1.05 (0.42–2.60)	1.18 (0.67–2.05)	1.12 (0.72–1.72)	1.17 (0.60–2.25)	1.12 (0.83–1.50)
35–49	1.13 (0.31–4.07)	0.92 (0.33–2.51)	1.86 (0.91–3.79)	1.45 (0.86–2.45)	1.67 (0.82–3.37)	1.77 (1.26–2.49)*
Residence						
Urban	1	1	1	1	1	1
Rural	1.03 (0.45–2.35)	1.07 (0.59–1.95)	0.61 (0.34–1.09)	0.86 (0.59–1.24)	0.80 (0.58–1.12)	0.89 (0.72–1.09)
Marital status†						
Not in a union	1	1	1	1		1
Married/cohabiting	1.08 (0.48–2.43)	0.70 (0.37–1.35)	1.97 (1.23–3.12)**	1.01 (0.73–1.40)		1.27 (1.00–1.61)
Education						
No formal	1	1	1	1	1	1
Primary	1.66 (0.82–3.34)	0.63 (0.39–1.00)	1.05 (0.72–1.53)	1.27 (0.88–1.83)	1.14 (0.75–1.73)	1.24 (1.03–1.51)*
Secondary	2.68 (0.62–4.57)	1.04 (0.57–1.91)	1.83 (1.06–3.18)*	1.30 (0.83–2.05)	1.26 (0.76–2.08)	1.58 (1.24–2.04)*
Occupation						
Not working	1	1	1	1	1	1
Agriculture	0.27 (0.10–0.72)**	0.76 (0.49–1.17)	0.93 (0.62–1.38)	1.02 (0.69–1.52)	1.00 (0.74–1.35)	0.78 (0.66–0.93)*
Formal employment	0.39 (0.11–1.41)	0.72 (0.42–1.25)	1.34 (0.89–2.01)	1.92 (1.34–2.77)***	1.00 (0.75–1.32)	1.21 (1.00–1.46)*

*p<0.05; **p<0.01; ***p<0.001; ANC, antenatal care; CI, confidence interval; † Marital status was excluded in 2019-20 due to multicollinearity

Characteristics	2000	2005	2010	2014	2019–20	Pooled
Wealth, quintiles						
Poorest	1	1	1	1	1	1
Poorer	0.88 (0.34–2.29)	1.77 (0.84–3.72)	1.02 (0.69–1.52)	0.90 (0.63–1.30)	0.92 (0.64–1.32)	0.91 (0.75–1.11)
Average	1.06 (0.38–2.99)	1.35 (0.61–3.00)	1.23 (0.84–1.80)	1.02 (0.70–1.49)	1.18 (0.82–1.18)	1.06 (0.86–1.29)
Richer	1.28 (0.46–3.56)	1.65 (0.79–3.43)	1.02 (0.68–1.52)	1.51 (1.06–2.16)*	1.50 (1.03–2.21)**	1.18 (0.97–1.44)
Richest	1.69 (0.68–4.21)	2.78 (1.19–6.50)*	1.44 (0.87–2.39)	1.76 (1.15–2.71)*	2.43 (1.58–3.72)**	1.52 (1.23–1.87)*
ANC attendance, visits						
1–3	1	1	1	1	1	1
≥4	1.19 (0.65–2.16)	1.86 (1.22–2.83)**	1.18 (0.93–1.52)	1.27 (1.04–1.57)*	1.44 (1.18–1.75)*	1.64 (1.46–1.84)*
Missing	0.89 (0.59–1.34)	1.16 (0.88–1.53)	0.82 (0.67–1.01)	1.12 (0.93–1.34)	0.91 (0.76–1.09)	1.00 (0.90–1.10)
Parity						
1	1	1	1	1	1	1
2–4	0.45 (0.25–0.84)*	0.83 (0.49–1.39)	0.48 (0.37–0.64)***	0.64 (0.50–0.81)***	0.84 (0.64–1.11)	0.66 (0.57–0.75)***
5+	0.22 (0.08–0.61)**	0.53 (0.27–1.01)	0.15 (0.10–0.23)***	0.22 (0.14–0.34)***	0.35 (0.23–0.54)**	0.25 (0.20–0.31)***
Baby's sex						
Male	1	1	1	1	1	1
Female	0.80 (0.55–1.18)	0.73 (0.55–0.97)*	0.81 (0.67–0.97)*	0.79 (0.67–0.94)**	0.81 (0.68–0.96)*	0.78 (0.71–0.86)*
Baby's birth weight						
Average	1	1	1	1	1	1

*p<0.05; **p<0.01; ***p<0.001; ANC, antenatal care; CI, confidence interval; † Marital status was excluded in 2019-20 due to multicollinearity

Characteristics	2000	2005	2010	2014	2019–20	Pooled
Low birth weight	1.49 (0.68–3.27)	1.31 (0.70–2.45)	0.78 (0.53–1.14)	1.06 (0.77–1.44)	0.99 (0.73–1.34)	1.03 (0.85–1.24)
Big baby	0.14 (0.07–0.26)***	0.20 (0.13–0.32)***	0.59 (0.45–0.78)	1.23 (0.96–1.58)	1.31 (0.97–1.77)	0.42 (0.36–0.48)***
Twin status						
Singleton	1	1	1	1	1	1
Multiple	8.55 (3.36–21.76)***	1.57 (0.57–4.32)	6.11 (3.27–11.40)***	6.49 (3.93–10.74)***	3.24 (1.84–5.70)**	4.53 (3.38–6.06)**
Access to information						
No	1	1	1	1	1	1
Yes	1.45 (0.70–2.99)	1.27 (0.71–2.28)	0.75 (0.48–1.17)	0.98 (0.70–1.38)	0.92 (0.68–1.24)	1.06 (0.88–1.27)
Partner's education						
No formal	1	1	1	1	1	1
Primary	0.60 (0.32–1.13)	1.79 (1.07–2.99)*	0.78 (0.55–1.10)	1.01 (0.74–1.36)	1.23 (0.85–1.80)	1.10 (0.92–1.31)
Secondary and higher	0.47 (0.21–1.06)	1.03 (0.55–1.95)	0.90 (0.53–1.54)	1.15 (0.77–1.71)	1.40 (0.87–2.25)	1.08 (0.85–1.36)
Region						
Kigali City	1	1	1	1	1	1
South	0.61 (0.25–1.49)	0.46 (0.23–0.92)*	1.10 (0.51–2.39)	1.10 (0.70–1.72)	1.01 (0.69–1.49)	0.76 (0.59–0.97)*
West	0.84 (0.38–1.89)	0.56 (0.26–1.18)	0.97 (0.43–2.19)	0.98 (0.65–1.48)	0.73 (0.49–1.07)	0.70 (0.54–0.90)*

*p<0.05; **p<0.01; ***p<0.001; ANC, antenatal care; CI, confidence interval; † Marital status was excluded in 2019-20 due to multicollinearity

Characteristics	2000	2005	2010	2014	2019–20	Pooled
East	0.74 (0.31–1.73)	0.36 (0.16–0.80)*	1.04 (0.46–2.32)	0.90 (0.59–1.38)	0.74 (0.50–1.10)	0.71 (0.55–0.91)*
North	0.45 (0.17–1.19)	0.22 (0.10–0.51)***	0.74 (0.31–1.75)	0.66 (0.42–1.05)	0.62 (0.40–0.96)*	0.47 (0.35–0.62)***
*p<0.05; **p<0.01; ***p<0.001; ANC, antenatal care; CI, confidence interval; † Marital status was excluded in 2019-20 due to multicollinearity						

The results from the hospital-based model revealed a similar direction of association as those of the population-based model except for higher odds of CS among women who delivered big babies in 2000 (aOR: 2.00, 95% CI 1.11–3.61), 2014-15 (aOR: 1.57, 95% CI 1.22–2.03), 2019-20 (aOR: 1.84, 95% CI 1.34–1.52) and the pooled model (aOR: 1.45, 95% CI 1.26–1.66) (Table 4).

Table 4
Factors associated with caesarean section at the health facility level in Rwanda

Characteristics	2000	2005	2010	2014	2019–20	Pooled
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Age, years						
15–19	1	1	1	1	1	1
20–34	0.69 (0.29–1.64)	1.26 (0.54–2.92)	1.23 (0.70–2.15)	1.09 (0.71–1.70)	1.18 (0.61–2.25)	1.13 (0.84–1.51)
35–49	1.06 (0.26–4.22)	1.08 (0.41–2.83)	1.97 (0.95–4.09)	1.43 (0.84–2.42)	1.72 (0.86–3.45)	1.78 (1.26–2.51)*
Marital status†						
Not in a union	1	1	1	1		1
Married/cohabiting	1.18 (0.51–2.76)	0.63 (0.33–1.23)	1.87 (1.16–3.00)*	1.03 (0.74–1.42)		1.21 (0.95–1.54)
Access to information						
No	1	1	1	1	1	1
Yes	1.31 (0.62–2.79)	1.29 (0.69–2.41)	0.73 (0.47–1.14)	0.95 (0.68–1.34)	0.93 (0.69–1.26)	0.94 (0.78–1.13)
Education						
No formal	1	1	1	1	1	1
Primary	1.68 (0.78–3.63)	0.56 (0.34–0.90)*	1.00 (0.69–1.46)	1.21 (0.84–1.75)	1.06 (0.69–1.63)	1.08 (0.89–1.31)
Secondary	1.68 (0.56–5.06)	0.89 (0.49–1.61)	1.69 (0.98–2.92)	1.26 (0.81–1.96)	1.18 (0.71–1.97)	1.37 (1.06–1.75)*
Occupation						
Not working	1	1	1	1	1	1
Agriculture	0.31 (0.11–0.92)*	0.83 (0.53–1.30)	0.91 (0.61–1.36)	1.04 (0.70–1.55)	1.02 (0.76–1.37)	0.82 (0.69–0.98)
Formal employment	0.42 (0.12–1.46)	0.76 (0.45–1.29)	1.24 (0.82–1.87)	1.93 (1.34–2.79)***	1.01 (0.76–1.33)	1.12 (0.93–1.35)*
*p<0.05; **p<0.01; ***p<0.001; † Marital status was excluded in 2019-20 due to multicollinearity						

Characteristics	2000	2005	2010	2014	2019–20	Pooled
Wealth, quintiles						
Poorest	1	1	1	1	1	1
Poorer	0.92 (0.32–2.60)	1.57 (0.71–3.45)	1.05 (0.70–1.57)	0.84 (0.58–1.20)	0.86 (0.60–1.23)	0.94 (0.77–1.15)
Average	0.89 (0.31–2.57)	1.22 (0.53–2.80)	1.21 (0.82–1.78)	0.95 (0.65–1.39)	1.07 (0.74–1.53)	1.04 (0.84–1.27)
Richer	1.32 (0.47–3.73)	1.27 (0.62–2.62)	0.98 (0.65–1.48)	1.37 (0.96–1.97)	1.31 (0.89–1.91)	1.20 (0.98–1.46)
Richest	1.56 (0.64–3.81)	1.82 (0.77–4.29)	1.27 (0.77–2.10)	1.57 (1.02–2.43)*	2.10 (1.38–3.19)**	1.53 (1.23–1.89)**
ANC attendance, visits						
1–3	1	1	1	1	1	1
≥4	1.11 (0.61–2.03)	1.56 (1.02–2.39)*	1.09 (0.85–1.39)	1.22 (0.99–1.50)	1.38 (1.13–1.68)*	1.39 (1.24–1.56)***
Missing	0.85 (0.56–1.30)	1.07 (0.80–1.44)	0.86 (0.70–1.06)	1.08 (0.90–1.30)	0.88 (0.73–1.06)	0.95 (0.85–1.05)
Parity						
1	1	1	1	1	1	1
2–4	0.53 (0.29–0.97)*	1.17 (0.70–1.96)	0.53 (0.40–0.70)***	0.65 (0.51–0.82)***	0.86 (0.66–1.12)	0.70 (0.61–0.81)***
5+	0.29 (0.10–0.86)*	0.87 (0.45–1.68)	0.19 (0.13–0.29)***	0.25 (0.16–0.38)***	0.38 (0.25–0.58)**	0.30 (0.24–0.37)***
Baby's sex						
Male	1	1	1	1	1	1
Female	0.83 (0.55–1.24)	0.82 (0.61–1.10)	0.85 (0.70–1.03)	0.82 (0.69–0.97)*	0.82 (0.69–0.97)*	0.82 (0.75–0.91)**
Baby's birth weight						
Average	1	1	1	1	1	1

*p<0.05; **p<0.01; ***p<0.001; † Marital status was excluded in 2019-20 due to multicollinearity

Characteristics	2000	2005	2010	2014	2019–20	Pooled
Low birth weight	1.28 (0.56–2.91)	1.34 (0.73–2.46)	0.80 (0.55–1.16)	1.03 (0.75–1.41)	0.98 (0.72–1.33)	0.99 (0.83–1.20)
Big baby	2.00 (1.11–3.61)*	1.42 (0.96–2.10)	1.30 (0.99–1.71)	1.57 (1.22–2.03)***	1.84 (1.34–1.52)**	1.45 (1.26–1.66)***
Twin status						
Singleton	1	1	1	1	1	1
Multiple	11.07 (3.36–36.5)***	1.32 (0.50–3.50)	6.08 (3.20–11.56)***	6.43 (3.88–10.66)***	3.63 (2.04–6.48)***	4.77 (3.50–6.51)***
Region						
Kigali City	1	1	1	1	1	1
South	0.52 (0.21–1.29)	0.38 (0.18–0.78)**	1.04 (0.49–2.20)	1.09 (0.70–1.69)	1.00 (0.68–1.47)	0.80 (0.63–1.02)
West	0.75 (0.33–1.71)	0.53 (0.26–1.10)	0.85 (0.39–1.86)	0.94 (0.62–1.41)	0.71 (0.48–1.04)	0.70 (0.55–0.89)*
North	0.38 (0.13–1.12)	0.19 (0.08–0.44)***	0.70 (0.30–1.62)	0.64 (0.41–1.02)	0.61 (0.39–0.94)*	0.50 (0.38–0.66)***
East	0.70 (0.30–1.63)	0.35 (0.16–0.78)**	0.92 (0.42–2.00)	0.88 (0.57–1.34)	0.72 (0.49–1.06)	0.70 (0.55–0.89)*
Residence						
Urban	1	1	1	1	1	1
Rural	1.24 (0.63–2.42)	1.19 (0.67–2.14)	0.61 (0.34–1.10)	0.87 (0.60–1.26)	0.82 (0.59–1.14)	0.91 (0.74–1.11)
Partners education						
No formal	1	1	1	1	1	1
Primary	0.46 (0.23–0.92)*	1.62 (0.95–2.75)	0.73 (0.52–1.03)	0.97 (0.72–1.31)	1.23 (0.84–1.80)	0.96 (0.80–1.16)
Secondary and higher	0.35 (0.14–0.86)*	0.83 (0.44–1.55)	0.85 (0.50–1.45)	1.09 (0.74–1.61)	1.40 (0.86–2.25)	0.95 (0.75–1.20)
*p<0.05; **p<0.01; ***p<0.001; † Marital status was excluded in 2019-20 due to multicollinearity						

Discussion

Over the past two decades, the rate of CS in Rwanda significantly increased from 2.2–15.6%, with disproportionately high rates among high socioeconomic groups and in urban areas, private health facilities and Kigali City. The rising trend in CS in Rwanda mirrors the global trend which shows an average annual increase of 4% [8]. The current CS rate of 15.6% in Rwanda is three times the rate in SSA, [10] and more than twice the average rate in Eastern and Southern African [34] though a previous study in Rwanda has shown a higher CS rate of 21% [35]. The increasing CS rate in Rwanda could indicate increased access to EmONC services and the high utilization of skilled delivery [36]. The current rate of CS is slightly above the 10–15% WHO threshold for beneficial CS and likely to continue increasing if measures are not taken. Importantly, despite a 20% decrease in the prevalence of CS in private hospitals between 2014 and 2019-20, there is a need to continue to monitor CS in private health facilities where there was a disproportionate increase in CS compared to public health facilities resulting in a four-fold difference in the prevalence of CS in 2019-20.

Overall, women of high socioeconomic status (education, occupation, and wealth) had increased odds of CS delivery, which reflects findings from previous studies [11, 37–40]. CS is a high-cost procedure in most settings making it accessible mostly to the rich. However, in Rwanda, a majority of the women are covered under the community-based health insurance schemes that have increased access to affordable healthcare by minimising the out-of-pocket expenditure and reducing the socioeconomic disparities in access and use of CS [19]. Moreover, women with high education levels are associated with ANC attendance [39, 41, 42], providing them with an opportunity to receive health education and counselling and early detection of risks. Mothers with high-risk pregnancies are also more likely to utilise ANC services than those with normal pregnancies though ANC attendance could also be indicative of better access to healthcare including CS.

Multiple pregnancies are high-risk and one of the obstetric indications for CS [43, 44]. In our study, women with multiple pregnancies had higher odds of CS similar to previous studies [37, 45, 46]. In 2014, the rate of CS among women with multiple pregnancies was three times the average rate of CS in Rwanda, having doubled within the preceding five years. However, in 2019-20, the rate of CS among women with multiple pregnancies reduced by ten percentage points while that of singleton significantly increased 23.3%. Hence, there is a need to review the indication for CS among women with multiple and singleton pregnancies to guide clinicians on women who are likely to benefit from the procedure and avoid unnecessary CS in this group.

Our study found lower odds of CS delivery among women who gave birth to female babies compared to those who delivered male babies similar to previous studies [47–52]. Male babies tend to be heavier than female babies [53–55] and are at an increased risk of adverse pregnancy outcomes [53]. We also found that women with two or more children had lower odds of CS delivery compared to primiparous women. This finding is consistent with previous studies in Kenya [56] and Ethiopia [46] and could be possibly attributed to poor dissolution of cervical collagen fibre in primigravid women due to their inexperience in labour [57]. Also, women who may have delivered their first baby via CS may have had successful vaginal delivery after a previous CS [58].

Big babies in the population-based analysis had lower odds of CS but had higher odds of CS in the hospital-based analysis compared to normal-weight babies. Hospital-based studies have found a similar association between CS and big babies [59]. Large babies present difficulty in delivery possibly due to insufficient passage

and prolonged labour. The lower odds of CS among big babies in the population-based analyses could be attributed to a delay in weighing of the babies delivered at home, who may have gained weight by the time of presenting at a health facility but also the fact that having a big baby is not an indication for CS and thus most big babies are delivered vaginally.

Our study adds to the evidence on CS in Rwanda by examining the population- and hospital-based trends and factors associated with CS in Rwanda over the past two decades using repeated nationally representative data making the findings generalisable to Rwanda. Our study, however, has some limitations that should be considered when interpreting the findings. First, there is a potential for overestimation or underestimation due to self-reporting of most variables and that the variables were measured at the time of the survey rather than at the time of delivery. Second, the dataset had missing observations and the study only included variables available from the dataset and could have missed important factors that predict CS in Rwanda. Finally, we could not assess the differences between the private and public health facilities due to the small sample of women who delivered in private health facilities.

Conclusion

Over the past 20 years, the rate of CS in Rwanda has seen an upward trend increasing seven-fold between 2000 and 2019-20 at health facility and population-level with persistent regional disparities over the years. The rates and odds of CS have been disproportionately high among women of high socioeconomic groups, and those who resided in urban areas and Kigali City, used private health facilities, had multiple pregnancies, and attended at least four antenatal care visits. Women in Rwanda seem to have increased access to and use of CS. However, the significant increase in the rate of CS is of concern due to the potential of unnecessary CS. Therefore, there is a need to examine the guidelines for CS use in Rwanda to ensure proper indications for use of CS are adopted for beneficial outcomes.

Abbreviations

ANC: Antenatal care; AOR: Adjusted odds ratio; BMI: Body mass index; CI: Confidence Interval; COR: Crude odds ratio; CS: Caesarean section; DHS: Demographic Health Surveys; SSA: sub-Saharan Africa; SDGs: Sustainable development goals; WHO: World Health Organization

Declarations

Ethical approval and consent to participate

The study used anonymised secondary data from the RDHS, which received ethical approvals from the Rwanda National Ethics Committee and the Institutional Review Board of ICF International [20, 22-25]. All data collection procedures were performed in accordance with the declaration of Helsinki on protection of human subjects. We accessed the data upon approval of request to the DHS program and were used as per the data agreement.

Consent for publication

Not applicable

Availability of data and materials

The Rwanda Demographic Health Survey data used in this study is available on the Demographic Health Survey website at www.dhsprogram.com on request.

Competing interests

Authors declare no competing interests

Funding

This study did not receive any funding

Authors' contributions

PMK and LN conceptualised the study and obtained the data. CA, JO, GM and SG analysed the data and interpreted the results. All the authors reviewed the initial drafts and approved this final version.

Acknowledgements

We thank Measure DHS for granting us access to the data

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