Rising trends and persisting inequalities in cesarean section rates in Nepal: evidence from demographic and health surveys 2006-2016

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Abstract

Background

Sustainable development goals require member countries to reduce maternal mortality below 70 per 100,000 live births by 2030. Addressing inequalities in access to emergency obstetric care is crucial for reducing the maternal mortality ratio. This study was done to examine the time trends and socio-demographic inequalities in the utilization of cesarean section (CS) in Nepal during 2006-2016.

Methods

We used data from the Nepal Demographic and Health Surveys (NDHS) conducted during 2006-2016. Women who had a live birth in the last five years of the survey (most recent birth if there were two or more child birth) were the unit of analysis for this study. Absolute and relative inequalities in CS rates by different characteristics were measured in-terms of rate difference and rate ratios, respectively. Bivariate analyses and multivariate logistic regression models were used to assess the rate of cesarean sections by background socio-demographic characteristics of women.

Results

Age and parity adjusted CS rates were found to have increased almost three-fold (from 3.2%,95% CI:2.1-4.3 in 2006 to 10.5%,95% CI:8.9-11.9 in 2016) over the decade. In 2016, women from Mountain region (3.0%;95% CI:1.1-4.9), those from poorest wealth quintile (2.4%,95% CI:(1.2-3.7) and those living in province 6(2.4%,95% CI:1.3-3.5) had CS rate below 5%. Whereas, women from the richest income quintile (25.1%,95% CI :20.2-30.1), with higher education (21.2%,95% CI:14.7-27.8) and those delivering in private facilities (37.1%,95% CI:30.5-43.7) had CS rate above 15%. The absolute inequality in CS rate increased for maternal educational status, income quintiles, ecological region, province and place of delivery over the period. Relative inequality increased for provinces and place of delivery. Women from the richest income quintile (OR-3.3,95% CI: 1.6-7.0) and those delivered in private/NGO-run facilities (OR-3.6;95% CI:2.7-4.9) were more than three times more likely to deliver by CS compared to women from the poorest income quintile and those delivering in public facilities, respectively.

Conclusion

To improve maternal and newborn health, strategies need to be revised to address the underuse of C-section in poor, mountain region and province 6. Simultaneously, policies and guidelines are needed to reduce overuse in rich women, women with higher education and those delivered in private facilities.

Background

Caesarean section(CS) is one of the vital interventions to save lives of mothers and babies at the time of life threatening complications during pregnancy or child birth(1). While some sections of world's population living in low and middle income countries still have unmet need for this life-saving

intervention, there is a growing public health concerns that population-based CS rates in some of these countries in the world have reached above the WHO recommended level(2, 3). Non-medical factors such as monetary incentives for health care providers and patient preferences are suggested to be key factors for unnecessary CS(4).

Government of Nepal(GoN) aims to reduce maternal and child mortality at the critical time of childbirth by ensuring basic emergency obstetric and newborn care and Comprehensive emergency obstetric and newborn care services to all women who need it(5). Nepal Health Sector strategy has highlighted equitable access to health services and leaving no one behind as one of the major foci of health sector (6). Additionally, in line with sustainable development goals, GoN strives to reduce Maternal mortality rate to less than 70 per 100,000 live births and to reduce newborns and children deaths due to preventable causes to below 1 percent(7). It is critical to have easy access to emergency obstetric and newborn care to achieve these goals. Since 2009, GoN has rolled out free delivery care including CS nationwide by abolishing all user fees from accredited facilities(8). However, given the geographical diversity and socio-cultural barriers ensuring no one is left behind is a distant goal. Furthermore, previous studies have shown increasing trend and inequalities in cesarean section in Nepal by place of residence, wealth quintile, age of the mother, educational status and caste/ethnicity (9).

CS are not easily accessible to women from marginalized sections of the communities and those living in remote areas even when there is a strong medical indication (10). Simultaneously, unnecessary use is common in private hospitals(3), urban areas(11) and among higher educated mothers(12). Although both underuse and overuse were associated with poor health outcomes for mothers and newborn, determining optimal CS rate at the population level is a herculean task(13). WHO's new statement released in 2015 recommended that the CS rates should be below 10%(13).

Besides poor health outcomes, CS is associated with high cost to the health care system and to the families(14). Furthermore, as in other settings(15), surge in CS rate has received increasing attention in Nepal on the grounds of women's rights, over-medicalization of birth and abuse of technology. Therefore, it is imperative to have an optimal CS rate at a population level while protecting the rights of women to have CS when there is a medical indication. Hence, it is important to monitor service utilization pattern and inequalities by population groups to assess program and policy outcomes. Therefore, by utilizing the most recent household level data from last 3 rounds of DHS surveys we present the trend and social determinants of inequalities in utilization of CS in Nepal.

Methods

Data Source

We used data from three rounds of the Nepal Demographic and Health Survey (NDHS) conducted in 2006, 2011 and 2016. Details of the survey design and data collection procedure is available in respective survey reports(16–18). Briefly, NDHS collected nationally representative data every 5 years on a broad

range of issues including fertility, reproductive and maternal health, nutrition, and child health. In each round, a nationally representative sample of households was obtained using stratified cluster sampling approach. Women aged 15–49 years who had a live-birth within 5 years preceding the survey comprised the unit of analysis for the current study. The most recent birth was taken into account if there were more than single birth within the five years. We used sampling weights to adjust for variations in the selection probabilities and interviews among respondents. The data sets for all rounds were downloaded from the website of the DHS program (<https://dhsprogram.com/Data/terms-of-use.cfm>).

Measures

The dependent variable for this study was whether or not the last live-birth of a woman was conducted by C-section. The DHS surveys used same questions: "Was the (name of the last child) delivered by caesarian section?" The responses were recorded as a binary variable either 1 meaning 'Yes' or 0 meaning 'No.'

The independent variables selected for this study include: women's age categories(7 categories with 5 year interval), parity(2 or less, 3–4, more than 4), women's education(No education, Primary, Some secondary, SLC and above), women's current working status(Currently working, not working), wealth index(poorest-richest quintiles), ecological region(Mountain, Hill, Terai: plain region), province(Province 1–7), place of residence(urban/rural), ethnicity(Brhamin/Chhetri others:relatively advantaged ethniciities,Terai/Madhesi,others, Dalits:most disadvantaged ethnicity, Janajati/Newars and Muslim,others) and place of delivery(public facility, private facility/NGO, home, outside Nepal and others)

Data Analysis

Initially, we computed crude CS rates by women's socio-demographic characteristics. Then, we computed the adjusted CS rates and their 95% confidence intervals standardizing for age and parity using direct standardization method. We considered NDHS 2016 sample as the standard population. We calculated absolute inequality in terms of rate difference (highest-lowest) and relative inequality in terms of rate ratio(highest/lowest) for each of the survey periods(19). Presenting both relative and absolute measures of inequalities is important for increasing transparency, and to provide unbiased evidence for policy making (20). We conducted logistic regression analysis adjusting for women's age and parity to estimate the odd ratios of CS according to the women's characteristics. Although recent guideline has suggested CS rate of 10% as adequate at population level(13), we used 5% as minimum rate and 15% as maximum rate to interpret underuse and overuse of CS based on previously accepted standards(21, 22). All analyses were performed using STATA version 15.0.

Ethical Considerations

Nepal DHS surveys were reviewed and approved by the Institutional Review Board of Nepal Health Research Council, Nepal; data were publicly available and didn't include individual identifiers and thus did not require ethics approval. Permission was granted from the USAID'S DHS program for using data.

Results

Table 1 shows the socio-demographic characteristics of overall CS rate among women having a live birth in five years preceding each survey. Most of the women were 20-29 years old and constituted about two-third of the total population in all three surveys. Proportion of women with higher education increased remarkably from 6.2% in 2006 to 21.4% in 2016. Inverse to higher education, the proportion of working women decreased from 69.0% in the 2006 survey to 49.4% in the 2016 survey. Concurrently, little difference was seen in the distribution of women's wealth index. Of the respondents, less than 20% belonged to the rich and richest group in all three surveys. More than 80% of the women lived in rural areas in 2006-2011 while it decreased to 46.0% in 2016. About one third of the women belonged to Newar/janjaties in all surveys. The proportion of women giving birth at health facilities (public and private sectors) increased rapidly, significantly in private sector over the decade. The proportion women giving birth at public facility increased by more than three folds, from 13.1% in 2006 to 43.1% in 2016. While proportion of birth in private facilities also doubled during the same period from 4.6% to 10.8 %.

Table 1. Socio-demographic characteristics and the use of cesarean section from the Nepal Demographic and Health Surveys (NDHS) in 2006, 2011, and 2016

Characteristics	NDHS 2006		NDHS 2011		NDHS 2016	
	(N=5545)		(N=5391)		(N=5060)	
	Frequency	%	Frequency	%	Frequency	%
Maternal age, (years)						
15-19	368	6.6	381	7.1	391	7.7
20-24	1,931	34.8	1,802	33.4	1,665	32.9
25-29	1,742	31.4	1,736	32.2	1,780	35.2
30-34	785	14.2	845	15.7	806	15.9
35-39	465	8.4	402	7.5	297	5.9
40-44	196	3.5	169	3.1	97	1.9
45-49	58	1.0	57	1.1	24	0.5
Parity						
2 or less	3,132	56.5	3,293	61.1	3,472	68.6
3-4	1,459	26.3	1,405	26.1	1,161	22.9
More than 4	954	17.2	693	12.9	427	8.4
Education						
No education	3,343	60.3	2,550	47.3	1,733	34.3
Primary	1,009	18.2	1,079	20.0	1,019	20.1
some secondary	848	15.3	1,039	19.3	1,226	24.2
SLC and above	345	6.2	723	13.4	1,082	21.4
Current working status						
Working	3,824	69.0	2,961	54.9	2,498	49.4
Not working	1,721	31.0	2,431	45.1	2,562	50.6
Wealth index						
Poorest	1,412	25.5	1,390	25.8	1,082	21.4
Poorer	1,180	21.3	1,182	21.9	1,072	21.2
Middle	1,132	20.4	1,133	21.0	1,121	22.2
Richer	983	17.7	938	17.4	1,036	20.5
Richest	838	15.1	748	13.9	748	14.8
Residence						
Urban	677	12.2	503	9.3	2,730	54.0
Rural	4,868	87.8	4,888	90.7	2,330	46.0
Ecological region						
Mountain	483	8.7	428	7.9	361	7.1
Hill	2,261	40.8	2,130	39.5	1,911	37.8
Terai	2,802	50.5	2,833	52.6	2,789	55.1
Province						
Province1	920	16.6	1,135	21.0	819	16.2
Province2	1,171	21.1	1,146	21.3	1,367	27.0
Province3	920	16.6	705	13.1	813	16.1
Province4	571	10.3	589	10.9	388	7.7
Province5	822	14.8	810	15.0	899	17.8
Province6	341	6.1	401	7.4	338	6.7
Province7	800	14.4	605	11.2	437	8.6
Caste/Ethnicity						
Brahamin/Chettri	1,639	29.6	1,618	30.0	1,396	27.6

Terai/Madhesi other	685	12.4	558	10.4	1,021	20.2
Dalits	884	15.9	959	17.8	695	13.7
Newar/Janajatis	1,934	34.9	1,892	35.1	1,573	31.1
Muslim/Other	402	7.3	364	6.7	375	7.4
Place of delivery						
Public facility	724	13.1	1,399	26.0	2,183	43.1
Private facility/NGOs	256	4.6	506	9.4	548	10.8
Outside Nepal	NA	NA	NA	NA	171	3.4
Home	4,492	81.0	3,402	63.1	2,096	41.4
Others	73	1.3	85	1.6	61	1.2
Cesarean section						
Yes	148	2.7	248	4.6	457	9.0
No	5,397	97.3	5,143	95.4	4,603	91

Cesarean section was determined for the most recent birth of women aged 15-49 years who had a livebirth five years preceding the surveys.

All percentages are weighted, so the absolute number of participants doesn't perfectly correspond to percentages.

NA: not available

Crude C-section increased from 2.7% in 2006 to 9.0% in 2016, with large and increasing absolute disparities in C-section according to women's socio-demographic characteristics (Table 2). A higher education level was associated with a markedly higher C-section rate in all three surveys, specifically; in 2016 this rate was at 19.5%. Furthermore, higher C-section rates (28.2% in 2016) was observed among the women from the richest income quintile and the lowest rate (2.4%) among women from the poorest income quintile. Province-wise, province 3 had persistently higher C-section rate (6%, 8.3% and 17.4% in 2006, 2011 and in 2016 respectively) followed by province 4 (1.7%, 4% and 16.7% in 2006, 2011 and 2016 respectively). Similarly, women living in urban areas had higher C-section rates than women in rural areas, although the absolute difference reduced during 2016 compared with 2006 and 2011. Greater difference was seen in the utilization of C-section between public and private health facilities. This was true for all three rounds of the NDHS. The C-section rates in the public and private sectors were 13.9% and 18.4%, respectively, in 2006, 8.6% and 25.4%, respectively, in 2011, and 12.1% and 34.8%, respectively, in 2016. Among the different caste/ethnic groups, the Brahmin/Chettri had a higher C-section rate with an increase from 4.4% in 2006 to 11.3% in 2016 followed by Newar /Janajatis from 2.3% in 2006 to 10.2% in 2016. Both working and not working women had increasing in trend in C-section.

Table 2. Crude cesarean section (CS) rates (%) by socio-demographic characteristics from the Nepal Demographic and Health Surveys (NDHS) in 2006, 2011, and 2016

Characteristics	NDHS 2006			NDHS 2011			NDHS 2016		
	Total births	CS	%	Total births	CS	%	Total births	CS	%
Total (N)	5545	148	2.7	5391	248	4.6	5060	457	9
Maternal age, (years)									
15-19	368	16	4.2	381	14	3.5	391	25	6.3
20-24	1,931	47	2.4	1,802	64	3.6	1,665	142	8.5
25-29	1,742	56	3.2	1,736	93	5.4	1,780	163	9.2
30-34	785	17	2.2	845	52	6.1	806	88	11
35-39	465	3	0.6	402	18	4.4	297	35	11.8
40-44	196	9	4.4	169	7	4.4	97	4	3.6
45-49	58	0	0	57	<1	0.6	24	0	0
Parity									
2 or less	3,132	129	4.1	3,293	203	6.2	3,472	407	11.7
3-4	1,459	7	0.5	1,405	43	3.0	1,161	42	3.6
More than 4	954	11	1.1	693	2	0.3	427	8	1.8
Education									
No education	3,343	37	1.1	2,550	45	1.8	1,733	78	4.5
Primary	1,009	28	2.8	1,079	44	4.1	1,019	57	5.6
some secondary	848	35	4.1	1,039	66	6.3	1,226	110	9
SLC and above	345	48	13.9	723	93	12.9	1,082	211	19.5
Current working status									
Working	3,824	52	1.4	2,961	82	2.8	2,498	193	8
Not working	1,721	96	5.6	2,431	166	6.8	2,562	264	10
Wealth index									
Poorest	1,412	11	0.8	1,390	14	1.0	1,082	26	2.4
Poorer	1,180	6	0.5	1,182	10	0.8	1,072	46	4.2
Middle	1,132	11	1.0	1,133	52	4.6	1,121	77	6.8
Richer	983	19	2.0	938	67	7.1	1,036	97	9.4
Richest	838	100	11.9	748	106	14.1	748	211	28.2
Residence									
Urban	677	57	8.4	503	77	15.3	2,730	320	11.7
Rural	4,868	90	1.9	4,888	171	3.5	2,330	137	5.9
Ecological region									
Mountain	483	4	0.7	428	6	1.4	361	9	2.6
Hill	2,261	70	3.1	2,130	78	3.7	1,911	214	11.2
Terai	2,802	74	2.6	2,833	164	5.8	2,789	234	8.4
Province									
Province1	920	19	2.1	1,135	74	6.5	819	104	12.7
Province2	1,171	25	2.1	1,146	47	4.1	1,367	69	5.0
Province3	920	55	6.0	705	59	8.3	813	141	17.4
Province4	571	10	1.7	589	24	4	388	65	16.7
Province5	822	27	3.3	810	30	3.7	899	57	6.4
Province6	341	5	1.4	401	4	1	338	7	2.2

Province ⁷	800	7	0.8	605	11	1.8	437	13	3.1
Caste/Ethnicity									
Brahamin/Chettri	1,639	72	4.4	1,618	118	7.3	1,396	158	11.3
Terai/Madhesi other	685	15	2.2	558	33	6	1,021	73	7.1
Dalits	884	11	1.2	959	20	2.1	695	38	5.4
Newar/Janajatis	1,934	45	2.3	1,892	64	3.4	1,573	160	10.2
Muslim/Other	402	4	1.0	364	12	3.2	375	28	7.4
Place of delivery									
Public facility	724	101	13.9	1,399	120	8.6	2,183	265	12.1
Private facility/NGOs	256	47	18.4	506	129	25.4	548	191	34.8
Outside Nepal	NA	NA	NA	NA	NA	NA	171	1	0.8
Home	4,492	0	0	3,402	0	0	2,096	0	0
Others	73	0	0	85	0	0	61	0	0

Cesarean section was determined for the most recent birth of women aged 15-49 years who had a live-birth five years preceding the surveys.

All percentages are weighted, so the absolute number of participants doesn't perfectly correspond to percentages.

The question on C-section was asked only of women who delivered in a health facility. In this table, it is assumed that women who did not give birth in a health facility did not receive a C-section.

NA: not available

Age- and parity-adjusted C-section rates increased from 3.2% in 2006 to 10.5% in 2016 representing almost a threefold increase during 10 years' period (Table 3). The greatest increase was seen in women with a higher educational level, those in the richest wealth quintile and women who delivered in private facility. Similar patterns of socioeconomic differences were also observed in women living in province 1, province 3 and province 4. The absolute inequality in CS rate by maternal educational status increased from 9.7% in 2006 to 15.2% in 2016. Similarly, the absolute inequality in CS rate by income quintiles increased from 10.3% in 2006 to 22.7 % in 2016. Furthermore, absolute inequality also increased for ecological region and provinces of Nepal. Notably, the absolute difference in CS rate between public and private facilities increased from 3.5% to 24.5%.

Relative inequality decreased by most of the socio-demographic characteristics and geographical distribution of women. However, it was increased for provinces (from 5.0 in 2006 to 7.3 in 2016) and public versus private place of delivery (1.3 in 2006 to 2.9 in 2016). In 2016, the highest absolute inequalities were observed for place of delivery followed by wealth status, maternal education and province. The highest relative inequality was observed for wealth quintile, province, ecological region and maternal education.

Table 3. Maternal age and Parity-adjusted cesarean section (CS) rates (%) from the Nepal Demographic and Health Surveys (NDHS) in 2006, 2011, and 2016

Characteristics	NDHS 2006	NDHS 2011	NDHS 2016
Overall adjusted CS rates (%)	3.2 (2.1-4.3)	6.6 (5.1-8.1)	10.5 (8.9-11.9)
Education			
No education	1.3 (0.5-2.1)	4.2 (2.7-5.7)	6.3 (3.5-9.0)
Primary	3.7 (1.1-6.3)	5.7 (2.7-8.7)	6.0 (3.5-8.6)
some secondary	4.8 (2.4-7.2)	6.2 (3.9-8.5)	10.5 (7.7-13.3)
SLC and above	11.0 (7.8-14.2)	17.4 (11.3-23.5)	21.2 (14.7-27.8)
<i>Rate difference</i>	<i>9.7</i>	<i>13.2</i>	<i>15.2</i>
<i>Rate Ratio</i>	<i>8.5</i>	<i>4.1</i>	<i>3.5</i>
Current working status			
Working	1.6 (0.8-2.3)	4.8 (3.4-6.2)	9.5 (7.6-11.4)
Not working	6.6 (4.2-9.0)	8.7 (6.6-10.7)	11.6 (9.4-13.9)
<i>Rate difference</i>	<i>5.0</i>	<i>3.9</i>	<i>2.1</i>
<i>Rate Ratio</i>	<i>4.1</i>	<i>1.8</i>	<i>1.2</i>
Wealth index			
Poorest	1.4 (0.1-2.6)	2.7 (0.8-4.6)	2.4 (1.2-3.7)
Poorer	0.5 (0.03-0.9)	1.3 (0.1-2.6)	5.2 (3.0-7.4)
Middle	1.2 (0.09-2.4)	6.2 (4.0-8.4)	8.0 (4.9-11.1)
Richer	1.4 (0.6-2.3)	8.7 (5.7-11.6)	9.3 (6.7-12.0)
Richest	10.8 (7.7-13.9)	13.4 (9.7-17.2)	25.1 (20.2-30.1)
<i>Rate difference</i>	<i>10.3</i>	<i>12.1</i>	<i>22.7</i>
<i>Rate Ratio</i>	<i>21.6</i>	<i>10.3</i>	<i>10.5</i>
Residence			
Urban	8.0 (5.7-10.4)	14.8 (10.8-18.8)	12.4 (10.4-14.4)
Rural	2.0 (1.0-3.0)	5.3 (3.8-6.8)	7.0 (5.1-8.9)
<i>Rate difference</i>	<i>6.0</i>	<i>9.5</i>	<i>5.4</i>
<i>Rate Ratio</i>	<i>4.0</i>	<i>2.8</i>	<i>1.8</i>
Ecological region			
Mountain	0.8 (0.02-1.6)	1.5 (0.6-2.4)	3.0 (1.1-4.9)
Hill	3.6 (2.0-5.2)	6.7 (4.9-8.5)	12.2 (9.9-14.5)
Terai	2.6 (1.6-3.6)	6.6 (5.1-8.1)	10.0 (7.9-12.1)
<i>Rate difference</i>	<i>2.8</i>	<i>5.2</i>	<i>9.2</i>
<i>Rate Ratio</i>	<i>4.5</i>	<i>4.5</i>	<i>4.1</i>
Province			
Province1	1.9 (0.6-3.1)	6.7 (4.0-9.4)	12.2 (8.8-15.6)
Province2	2.1 (0.6-3.5)	6.6 (4.5-8.8)	6.8 (3.6-9.9)

Province3	6.0 (3.2-8.8)	12.1 (8.0-16.2)	16.4 (12.6-20.2)
Province4	2.2 (-0.05-4.5)	4.9 (2.3-7.6)	17.5 (12.5-22.4)
Province5	3.3 (1.6-5.1)	3.9 (2.1-5.7)	7.8 (5.0-10.5)
Province6	3.0 (-0.1-6.1)	2.9 (2.0-3.7)	2.4 (1.3-3.5)
Province7	1.2 (-0.1-2.6)	2.8 (1.4-4.3)	5.7 (2.7-8.7)
<i>Rate difference</i>	4.8	9.3	15.1
<i>Rate Ratio</i>	5.0	4.3	7.3
Caste/Ethnicity			
Brahamin/Chettri	5.2 (3.0-7.4)	8.3 (6.3-10.4)	11.8 (9.3-14.4)
Terai/Madhesi other	2.8 (0.8-4.9)	8.5 (4.0-13.0)	10.3 (6.1-14.6)
Dalits	0.9 (0.2-1.7)	2.7 (0.7-4.6)	7.8 (4.0-11.6)
Newar/Janajatis	2.9 (1.0-4.9)	5.2 (3.3-7.1)	10.2 (7.8-12.6)
Muslim/Other	0.8 (-0.2-1.8)	4.5 (0.5-8.6)	11.1 (4.1-18.2)
<i>Rate difference</i>	4.4	5.8	4.0
<i>Rate Ratio</i>	6.5	3.1	1.5
Place of delivery*			
Public facility	12.3 (9.1-15.6)	11.1 (8.4-13.9)	12.6 (10.4-14.8)
Private facility/NGOs	15.8 (9.9-21.6)	26.4 (20.8-31.9)	37.1 (30.5-43.7)
Outside Nepal	NA	NA	0.7 (-0.6-2.0)
<i>Rate difference</i>	3.5	15.3	24.5
<i>Rate Ratio</i>	1.3	2.4	2.9

*Home deliveries were excluded from the analysis.

Cesarean section was determined for the most recent birth of women aged 15-49 years who had a live-birth five years preceding the surveys. The study sample of NDHS 2016 (N=5060) was used as the standard population in the direct standardization.

Note: For each survey, categories with the highest and lowest CS rate were used to calculate rate difference and rate ratios.

NA: not available

Table 4 shows age- and parity-adjusted odds ratios of C-section using logistic regression. The likelihood of C-section was three times higher among women belonging to the richest group in 2016 (OR 3.3,95% CI: 1.6-7.0) compared to the poorest income quintile. Similarly, women who delivered in private facilities were more than three times likely to have more C-section in both 2011 (OR: 3.2,95% CI: 2.2-4.6) and 2016 NDHS (OR: 3.6,95% CI: 2.7-4.9) surveys compared to those delivered in public facilities.

Discussion

In this study, we examined trend of CS rates in Nepal and inequalities in its utilization by geography (Mountain, Hill Terai), place of residence (urban/rural, Province), population characteristics (educational status, income quintile, caste/ethnicity, occupational status) and place of delivery. The findings show

more than three-fold increase (from 3.2% ;95% CI: 2.1–4.3 during 2002–2006 to 10.5%, 95% CI: 8.9–11.9 during 2012–2016) in age and parity adjusted CS rate over the decade. Women with higher educational level (21.2%;95% CI:14.7–27.8), those from the highest wealth quintile (25.1%;95% CI:20.2–30.1) and women delivering in private facility (37.1, 95% CI:30.5–43.7) have much higher CS rates than WHO's recommended level. Ever increasing CS rate above the recommended level among specific population groups indicates an alarming situation, although overall CS rate in Nepal is still within WHO's maximum limit of 15% and is much lower than in China (34.9%) (23, 24), Bangladesh(14)and Brazil(15).

The rising trend in CS section found in our study is consistent with the experience of other low and middle income countries(25, 26). This increase is largely due to increase in the proportion of institutional deliveries. Between 2006 and 2016, proportion of institutional deliveries (at public and private/NGO run facilities) in Nepal increased from 17.7–54%(16, 17). Similarly, expansion of 24 hour birthing centers and emergency obstetric care in selected facilities has eased identification of possible complications and referral to higher facilities(27). Furthermore, in the fiscal year 2016/17, CS service was expanded to 72 districts(5), which was available only in 45 districts until 2009/10(28). Additionally, GoN has implemented demand side financing scheme all over Nepal since 2009 to remove financial barriers to receive institutional deliveries, including CS when needed (27).While service expansion and demand side financing played a major role in increasing CS rate in Nepal, role of patients' preferences (choice of private facility over public facility, lower pain, choice of exact moment for delivery based on astrological belief) and provider preferences(save time, manage scheduling, increase earning, avoid litigation/ harassment)(25) cannot be overlooked. Moreover, increase in maternal age at first birth, growing proportion of pregnant women with the history of CS, and improvement in CS procedure were also found to be associated with increase in CS rates(29, 30).

Current analysis indicated that the most significant determinants of inequality in the use of caesarian section are ecological region, wealth index, maternal education and place of delivery. In Nepal, women from Mountain region and province 6, and those from poorest income quintile have CS rates below the recommended level of 5%.Furthermore, the absolute difference in age and parity adjusted CS rate between the poorest-fifth income quintile(2.4%) and richest income quintile(25.1%) is nearly 22.7% in 2016 and has increased compared to 2006 and 2011 .Furthermore, while CS rate among the richest quintile is ever increasing, it declined among women from the poorest income quintile after 2011 initially increasing from the level of 2006. These findings clearly show that significant barriers exist for women from the poorest income quintiles to access CS despite the existence of demand side financing scheme that cover transportation incentives and free delivery. To make things worse, unavailability/irregular functionality of birthing centers, and emergency obstetric services and geographical difficulties might have contributed to lower service utilization in Mountain region and province 6. A further analysis of Nepal Health Facility Survey data also showed that among hospitals and primary health care centers offering normal delivery services, province 6 had the lowest proportion of facilities offering CS(28.6%) which was much below the national average of 37%(31).

Anecdotal evidence suggests transportation incentive offered by the maternity incentive scheme is inadequate in case of complicated delivery for women from difficult geographical terrain, and remote areas. In such cases, women need to spend significant amount of indirect costs to access services. Lack of ready to use money, and lack of means of transportation often delays transportation to referral facilities. On the basis of current findings and anecdotal evidence, the maternity incentive program needs to be revised targeting poor women from remote areas /mountain region areas when maternity complications arise. Although, GoN has established emergency referral fund to airlift women from poor, Dalit, Janajati, geographically disadvantaged and from mountainous region to transport to a higher facility in case of life threatening maternity complications, the use of this fund is very low. Only nine women in FY 2017/2018 used this fund to be air lifted(27). There is a need of an in-depth study to understand barriers in the use of emergency referral funds.

There is growing concern on the rise of C-section in the private facilities. Age and parity adjusted C-section rate in private facilities more than doubled from 15.8% in 2006 to 37.1% in 2016 while it remained almost constant (12.3% in 2006 to 12.6% in 2016) in public facilities over ten years' period. In 2016, women delivered in private/NGO-run facilities were nearly 4 times more likely to have CS (adjusted OR 3.6; 95%CI: 2.7–4.9) compared to women delivering in Public facilities. Such a high proportion of CS in these facilities suggest that non-medical factors (economic gain, manage scheduling or others) motivate health care providers to perform CS. In Brazil too, rise in CS was observed in the private sector (4).The rise in C-section in Brazil did not reflect upper and middle class women's preferences for CS(4) .The authors deduced that it is driven by obstetrician's preferences and perceptions. Obstetricians might believe that CS is safer to vaginal delivery, or they might assume women in private facilities would prefer CS without exploring women's choices and expectations. Alternatively, it was suggested that given the staff constraints and workload issues, CS might be an easier option to manage schedules for managers and service provides(4)

It is beyond the scope of this study to determine the cause for high C-section in private facilities. However, such a high CS rate in private/NGO-run facilities in Nepal warrants an appropriately defined quality assurance mechanism (32). Appropriate government policies and clinical practice protocols should be enacted to achieve an optimal C-section rates. Increasing rates of C-section has created a huge financial burden for Bangladesh's health care system (14). A study on an economic burden of CS in Nepal may be a starting point to understand it's significance. The findings can be used to develop advocacy tool, eventually to implement a contextual and validated standard clinical protocols such as Robson classification to support health workers to assess need and monitor the use of CS(33)..

Some studies have indicated that midwife led maternity care can reduce C-section rates including the maternity costs(34). In Nepal, maternity care in hospitals is obstetrician led and it is high time to consider promoting physiological birth through midwife led maternity care(35).There is a need to scale up current midwifery education to improve maternity care as well as to reduce over-burden of normal deliveries in tertiary care facilities.

Although the overall CS rates in Nepal is within WHO standard [15], due attention is necessary to monitor the increasing C-section rate (crude CS rate from 2.7% in 2006 to 9% in 2016) and appropriate measures should be in place to curb the increasing trend. More importantly, women from the poorest income quintiles with maternity complications need special targeting. Furthermore, there is a need to expand C-section in Mountain districts to reduce geographical inequality. Overall, considering rising trend and persisting inequalities, Nepal needs to adopt policies and strategies to increase access among women from the poorest income quintile and Mountain region and reduce CS rate among women from the richest income quintile, those with higher education and those delivering in private/NGO facilities.

Strengths and limitations

We used high quality nationally representative data to assess trend and inequalities in CS. However, DHS survey lacks clinical data to evaluate appropriateness of CS. However, it is unlikely that clinical factors drive these variations. Furthermore, supply side variables and variables related to socio-cultural norms and beliefs were not available.

Conclusion

In this paper, we found age and parity adjusted CS rate in Nepal to have increased almost three fold within ten years' period and is consistently high among women from the richest income quintiles, those with higher education and those delivering in private sector. This study also reveals that inequality persists and is increasing among some population groups. Strategies are needed to support mothers from the poor households, those from mountain region and those from province 6 to utilize C-section when there is a medical need. Contextual and evidence-based clinical guidelines and protocols with frequent monitoring visits, especially in private facilities would help reduce unnecessary C-section.

Declarations

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Conceptualization (YRP and KA), Data Analysis (KA), Methodology (YRP and KA), Supervision (YRP, KA and CMD), Validation (YRP, KA and CMD), Writing-original draft, review and editing (YRP, KA and CMD), read and approved the final version of the manuscript (YRP, KA and CMD)

Ethics approval

All three round of DHS surveys in Nepal were approved by the Institutional Review Board of Nepal Health Research Council, Nepal; data were publicly available and did not include individual identities and thus did not require ethics approval.

Consent for publication

Not Applicable

Data Availability

Data is easily accessible from the DHS program website (<https://dhsprogram.com/Data/terms-of-use.cfm>) upon the request.

Competing interests

The authors declare that there are no conflicts of interest regarding the publication of this paper. The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the organizations authors are affiliated with.

List of abbreviations

CI Confidence Interval

CS Cesarean Section

C-section Cesarean Section

DHS Demographic and Health Survey

GoN Government of Nepal

NDHS Nepal Demography and Health Survey

NGO Non-governmental Organization

NHRC Nepal Health Research Council

OR Odds Ratio

USAID United States Agency for International Development

WHO World Health Organization

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Table 4. Maternal age and Parity-adjusted odd ratio of cesarean section (CS) from the Nepal Demographic and Health Surveys (NDHS) in 2006, 2011, and 2016

Characteristics	NDHS 2006	NDHS 2011	NDHS 2016
Education			
No education	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Primary	1.0 (0.5-2.1)	1.6 (0.8-3.1)	0.7 (0.4-1.1)
some secondary	0.5 (0.2-1.1)	1.5 (0.8-3.0)	0.6 (0.3-1.1)
SLC and above	0.6 (0.2-1.5)	1.4 (0.6-3.0)	0.7 (0.4-1.6)
Current working status			
Working	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Not working	2.1** (1.3-3.5)	1.5 (0.8-3.0)	1.1 (0.8-1.4)
Wealth index			
Poorest	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Poorer	0.2 (0.0-1.1)	0.3 (0.1-1.2)	1.0 (0.5-1.9)
Middle	0.3 (0.1-1.5)	0.9 (0.3-2.7)	1.1 (0.6-2.2)
Richer	0.3 (0.1-1.8)	0.6 (0.2-1.8)	1.1 (0.6-2.0)
Richest	1.1 (0.2-6.3)	0.5 (0.2-1.6)	3.3** (1.6-7.0)
Residence			
Urban	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Rural	1.3 (0.7-2.3)	0.5** (0.3-0.8)	1.2 (0.9-1.6)
Ecological region			
Mountain	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Hill	0.9 (0.2-4.4)	1.0 (0.5-1.9)	1.5 (0.7-3.2)
Terai	1.0 (0.2-6.1)	1.5 (0.7-3.1)	1.6 (0.7-3.6)
Province			
Province1	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Province2	1.7 (0.6-4.7)	1.1 (0.5-2.2)	0.4** (0.2-0.8)
Province3	1.2 (0.5-3.2)	1.9* (1.1-3.4)	1.1 (0.7-1.9)
Province4	0.7 (0.1-3.9)	1.0 (0.5-1.8)	1.7* (1.1-2.8)
Province5	1.7 (0.7-4.2)	0.8 (0.4-1.6)	0.4*** (0.3-0.7)
Province6	0.7 (0.2-3.0)	0.7 (0.2-2.8)	0.5 (0.2-1.1)
Province7	0.7 (0.2-2.5)	0.5 (0.3-1.2)	0.4** (0.2-0.7)
Caste/Ethnicity			
Brahamin/Chettri	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Terai/Madhesi other	0.6 (0.2-1.7)	0.9 (0.4-2.0)	1.9* (1.0-3.6)
Dalits	1.1 (0.5-2.8)	0.7 (0.4-1.4)	1.3 (0.8-2.2)
Newar/Janajatis	0.6 (0.3-1.2)	0.6* (0.4-0.9)	1.1 (0.8-1.5)
Muslim/Other	0.3 (0.1-1.1)	0.7 (0.2-1.9)	1.1 (0.6-2.1)

Place of delivery#			
Public facility	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Private facility/NGOs	1.5 (0.9-2.8)	3.2*** (2.2-4.6)	3.6*** (2.7-4.9)
Outside Nepal	NA	NA	0.1** (0.0-2.5)

#Home deliveries were excluded from the analysis.

Cesarean section was determined for the most recent birth of women aged 15-49 years who had a live-birth five years preceding the surveys.

NA: not available

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$