

Trends of Maternal Health Service Coverage in the Democratic Republic of the Congo: A Pooled Cross-Sectional Study of MICS 2010 to 2018

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Abstract

Background Maternal health service is essential for reducing maternal and newborn mortality. However, maternal health service status in the Democratic Republic of the Congo (DRC) remains poorly understood. This study aims to explore the trends of antenatal care (ANC) and skilled birth attendance coverage in the past decade in the DRC.

Methods The 13,313 participants were from two rounds of Multiple Indicators Cluster Survey (MICS) conducted by the National Institute of Statistics of the Ministry of Planning of the DRC, in collaboration with the United Nations Children's Fund (UNICEF), in 2010 and 2017-2018. A regression-based method was adopted to calculate the adjusted coverages of ANC and skilled birth attendance. Subgroup analysis based on different socioeconomic status (SES) was conducted to explore the impact of domestic conflicts.

Results From 2010 to 2018, the overall weighted ANC coverage declined from 87.3% (95% CI 84.1% to 86.0%) to 82.4% (95% CI 81.1% to 84.0%), while the overall weighted skilled birth attendance coverage increased from 74.2% (95% CI 72.5% to 76.0%) to 85.2% (95% CI 84.1% to 86.0%) in the DRC. The adjusted ANC coverage and adjusted skilled birth attendance coverage both declined in the Kasai Oriental, but both increased in the Nord Kivu and Sud Kivu. In the Kasai region, the largest decline for the adjusted coverages of ANC and skilled birth attendance was found among the poorest women. Nevertheless, in the Kivu region, both the adjusted coverages of ANC and the skilled birth attendance increased for the poorest women.

Conclusions With lasting domestic conflicts, there was a systemic deterioration of maternal healthcare coverage in some regions, particularly among people with low SES. While in some other regions, maternal healthcare service was not severely disrupted due possibly to the substantial international health assistance.

Background

Timely and adequate maternal health services, including antenatal care (ANC), delivery care, and postnatal care (PNC), are critical to a mother and her newborn[1]. Maternal health services, usually covering maternal health education, health checkups, immunization, and early identification and treatment of complications[2, 3], have been advocated by many international agencies[4]. However, in low-income countries (e.g., countries in the West and Central Africa), maternal health service coverage is far from ideal. It was estimated that 99% of global preventable maternal deaths happen in low-income countries, where women lack basic essential delivery services[5, 6].

The maternal mortality ratio in the Democratic Republic of the Congo (DRC) was high, estimated at 473 maternal deaths per 100,000 live births in 2017[7], far exceeding the global target of the Sustainable Development Goal 3.1 (SDG3.1)[8]. The DRC also has a low maternal health service coverage. It was reported that 82.4% of women have at least one antenatal care visit with skilled health care workers and 80.1% have skilled attendance at delivery in 2018, both below the global average level[9–11]. Although there was a general promotion of maternal health service coverage in the West and Central Africa, little was known about the status and trends of maternal health service coverage in the DRC.

As one of the poorest and the most fragile countries in the world[12, 13], the DRC has been raged by violent and long-lasting conflicts in the past decade. In addition to the long-lasting conflict in the Kivu region (consisting of Nord Kivu and Sud Kivu), there was a new conflict that occurred in the Kasai region, especially Kasai Oriental and Kasai Central, in 2016. The health system in the conflicting regions deteriorated, with the disruption of essential services[14, 15]. Since 1963, the United Nations Children's Fund (UNICEF) has been supporting the DRC government, including humanitarian assistance, to reduce the negative impact of the conflicts[16]. However, due to the various contexts, the overall international health aid was not evenly distributed in the country. The Kivu region has received significant foreign health aid for more than ten years[17]. On the contrary, the Kasai region had received little foreign assistance[15, 18]. Given such a regional difference in the DRC, it is important to understand the trends of maternal health service coverage at the regional level under different scenarios.

The present study aims to investigate the trends in the coverages of ANC and skilled birth attendance in the past decade in the DRC, with subgroup analysis by socioeconomic status (SES). The findings of this study will provide a picture of the trends of maternal health service and serve as a reference for further policies and programs.

Methods

Data Source

The data was from the 2010 and 2017-2018 Multiple Indicator Cluster Survey (MICS) in the DRC. MICS, which has been conducted in 116 countries in the world, is one of the largest international household survey programs developed by UNICEF. It used a set of survey tools to generate statistically sound and internationally comparable data. To date, there have been six international rounds of the MICS. The DRC have taken part in MICS1 (1995), MICS2 (2001), MICS4 (2010) and MICS6 (2017-2018). Among these four rounds, MICS4 and MICS6 had similar questionnaire structures. They were both conducted by the National Institute of Statistics with support from UNICEF. Following the same protocol, multi-stage stratified sampling processes have been applied in the DRC, proportional to population size in each province. Overall, the surveys included 11,393 (MICS4) and 20,792 (MICS6) successfully interviewed households. Detailed sampling details can be found in the MICS4 and MICS6 summary paper[19, 20].

Participants

Of 12,851 and 21,756 women aged 15-49 in the MICS4 and the MICS6, we included women giving live births within the two years preceding the survey to assess the coverages of ANC and skilled birth attendance in their last delivery. We excluded participants with missing values in age, education attainment, marital status, household head's sex and education attainment, household wealth index group, residential region, province, self-reported ANC visits, and skilled birth attendance. After applying the exclusion criteria, the total sample consisted of 13,313 women, with 4,759 from the MICS4 and 8,554 from the MICS6.

Exposures

The present study aims to explore the trends in coverages of ANC and skilled birth attendance among provinces in the DRC. In 2015, the original 11 provinces in the DRC were divided into the new 26 provinces. To make the province districts comparable between the MICS4 (2010) and the MICS6 (2017-2018), we rearranged the province categories in the MICS6 (2017-2018). The detailed correspondence can be found in *Additional file Table S1 [see Additional file 1]*. Totally, 11 historical province categories were used in the analysis: Katanga, Kasai Oriental, Kasai Occidental, Kinshasa, Bas Congo, Bandundu, Equateur, Province Orientale, Maniema, Nord Kivu, and Sud Kivu.

Additionally, we aimed to study the differentiated trends of ANC coverage and skilled birth attendance among different wealth index groups. In the MICS data, the household wealth index was categorized into five quantiles (poorest, poorer, middle, wealthier, and wealthiest) based on an asset-based wealth index[21]. In the present study, household index groups were used to present the SES of participants.

Outcomes

To ensure comparability with previous studies, we adopted the definitions from WHO[22]. Antenatal care coverage was defined as the percentage of women who utilized antenatal care provided by skilled health personnel for reasons related to pregnancy at least once during pregnancy among all women who gave birth to a live child in a given period. Qualified health personnel includes physicians, nurses, and midwives. For skilled birth attendance coverage, the definition was the proportion of births attended by skilled health personnel among all births. Information about whether the participants having at least one antenatal care provided by skilled birth attendants or having skilled attendance at delivery was retrieved from the MICS database.

Covariates

Based on the literature review[23–27], we chose women’s age, education attainment, marital status, household heads’ sex, household heads’ education attainment, and residence region as covariates. Women were classified into four age groups: 15-19, 20-29, 30-39, and 40-49. Women and their household heads’ education attainment were re-categorized into three groups: below the primary school, primary school, and secondary or higher school. Women’s marital status information was also retrieved from the original datasets and re-categorized into two groups: currently single and married or living with a partner. For the residence region, it is worth noting that Kinshasa, the capital of the DRC, refers both to a city and a province. Thus, there is no rural region in Kinshasa.

Statistical analysis

Descriptive statistics were calculated to show the characteristics of survey participants. The overall coverages of ANC and skilled birth attendance were calculated using sampling weights provided in the MICS database. The weighted coverages were then cross-validated with the survey findings in the UNICEF reports[19, 20]. A logistic regression-based adjusted prevalence method was used to calculate the adjusted coverages of ANC and skilled birth attendance. Details for the method were described elsewhere[28, 29]. Briefly, the method is based on logistic regression. Adjusted values were calculated using the floating method. By attributing variance to the reference group, the floating method makes it possible for comparisons of risks between any

two groups[30]. The coverages of ANC and skilled birth attendance for participants from different provinces in 2010 and 2018 were calculated, adjusted for women's age, education attainment, marital status, household heads' sex and education attainment, residence region, and household wealth status. Maps were drawn to visualize the trends in coverages of adjusted ANC and adjusted skilled birth attendance from 2010 to 2018. To further compare the trends in conflicted but unassisted regions (Kasai region), conflicted and already assisted regions (Kivu region), and relatively non-conflicted regions (other provinces), subgroup analyses were applied. In each region group, adjusted ANC coverage and adjusted skilled birth attendance coverage in different wealth index groups were calculated separately. Percentages with 95% confidence intervals were reported for the adjusted coverage. Data were processed by R 4.0.0 (R Core Team, 2020). Adjusted coverages were calculated by SAS 9.4 statistical software (SAS Institute, Cary NC).

Results

Participants' demographic and socioeconomic characteristics

A total of 13,133 women were included in the analyses. The number of participants increased from 4,759 in MICS4 (2010) to 8,554 in MICS6 (2017–2018). Of all participants, roughly half were aged 20–29 years, with 54.8% participants in 2010 and 45.1% in 2018. Only 37.5% of women had attended secondary school or higher, lower than the percentage of their household heads (59.3%). For women's marital status, about 87.0% of them were married or currently living with a partner, with no significant difference between 2010 and 2018. Most women came from the rural regions in the DRC, with 64.8% in 2010 and 73.5% in 2018. In 2010, the distribution of the SES of women was roughly even. However, the distribution in 2018 was skewed to the right, and more women lived in the poorest and poorer households. Details for participants' demographic and socioeconomic characteristics were shown in Table 1.

Table 1
Sociodemographic characteristics of the study participants by survey year

Variables	2010 (N = 4,759)	2018 (N = 8,554)	p-value
Age, n (%)			< 0.001
15–19	445 (9.4)	873 (10.2)	
20–29	2,606 (54.8)	3,858 (45.1)	
30–39	1,384 (29.1)	3,197 (37.4)	
40–49	324 (6.8)	626 (7.3)	
Educational attainment, n (%)			0.051
Below primary	1,057 (22.2)	1,872 (21.9)	
Primary	1,979 (41.6)	3,408 (39.8)	
Secondary or higher	1,723 (36.2)	3,274 (38.3)	
Marital status, n (%)			0.869
Currently Single	622 (13.1)	1,108 (13.0)	
Married or living with a partner	4,137 (86.9)	7,446 (87.0)	
Residential region, n (%)			< 0.001
Rural	3,082 (64.8)	6,287 (73.5)	
Urban	1,677 (35.2)	2,267 (26.5)	
Wealth index group, n (%)			< 0.001
Poorest	948 (19.9)	2,873 (33.6)	
Poorer	956 (20.1)	2,270 (26.5)	
Middle	932 (19.6)	1,713 (20.0)	
Wealthier	1,057 (22.2)	1,160 (13.6)	
Wealthiest	866 (18.2)	538 (6.3)	
Province, n (%)			< 0.001
Bandundu	416 (8.7)	840 (9.8)	
Bas Congo	342 (7.2)	263 (3.1)	
Equateur	477 (10.0)	1,665 (19.5)	
Kasai Occidental	452 (9.5)	759 (8.9)	
Kasai Oriental	455 (9.6)	1,129 (13.2)	

Variables	2010 (N = 4,759)	2018 (N = 8,554)	p-value
Katanga	543 (11.4)	1,422 (16.6)	
Kinshasa	364 (7.6)	255 (3.0)	
Nord Kivu	449 (9.4)	339 (4.0)	
Sud Kivu	482 (10.1)	389 (4.5)	
Maniema	424 (8.9)	324 (3.8)	
Province Orientale	355 (7.5)	1,169 (13.7)	
Household head's sex, n (%)			< 0.001
Male	4,148 (87.2)	6,514 (76.2)	
Female	611 (12.8)	2,040 (23.8)	
Household head's educational attainment, n (%)			< 0.001
Below primary	535 (11.2)	1,118 (13.1)	
Primary	1,417 (29.8)	2,353 (27.6)	
Secondary and higher	2,807 (59.0)	5,083 (59.4)	

The trend of prevalence of maternal health care service from 2010–2018

The overall weighted ANC coverage decreased from 87.3% (95% CI 84.1–86.0%) to 82.4% (95% CI 81.1–84.0%) in 2018, and the weighted skilled birth attendance coverage increased from 74.2% (95% CI 72.5–76.0%) to 85.2% (95% CI 84.1–86.0%) in 2018. The prevalence is consistent with what was reported in the UNICEF reports of MICS4 and MICS6 in the DRC[19, 20].

As shown in Fig. 1, the adjusted ANC coverage declined in most provinces in the DRC, except Kinshasa, Nord Kivu, and Sud Kivu. In Nord Kivu, the adjusted ANC coverage was 95.6% (95% CI 93.3–97.8%) in 2010, and 98.8% (95% CI 97.9–99.7%) in 2018. In Sud Kivu, the adjusted ANC coverage was 86.8% (95% CI 83.9–89.8%) in 2010 and 89.5% (95% CI 87.9–91.1%) in 2018, as shown in Table 2. However, the trends of adjusted ANC coverage were not consistent between rural and urban regions in the Sud Kivu. The coverage increased from 86.5% (95% CI 83.4–89.5%) to 88.0% (95% CI 85.5–90.5%) in the rural region, but decreased from 96.4% (95% CI 93.6–99.2%) to 90.3% (95% CI 88.0–92.6%) in the urban region [see Additional file 2 Table S2].

Table 2

Adjusted coverages of maternal health service in the DRC 2010–2018^a

Province	Antenatal Care				Skilled Birth Attendance			
	2010 (N = 4,759)		2018 (N = 8,554)		2010 (N = 4,759)		2018 (N = 8,554)	
	Percentage (%)	95% CI (%)	Percentage (%)	95% CI (%)	Percentage (%)	95% CI (%)	Percentage (%)	95% CI (%)
Bandundu	89.8	87.8–91.9	82.8	80.4–85.2	84.4	82.0–86.7	84.4	82.5–86.2
Bas Congo	95.7	94.6–96.9	89.7	87.0–92.3	95.3	93.4–97.1	94.2	92.7–95.7
Equateur	84.9	82.3–87.5	77.9	76.1–79.7	53.0	49.8–56.3	63.0	61.0–65.0
Kasai Occidental	79.5	76.4–82.5	70.9	68.2–73.6	69.8	66.8–72.8	80.1	77.6–82.5
Kasai Oriental	79.7	76.6–82.8	66.7	64.3–69.2	68.5	65.2–71.8	64.9	62.6–67.3
Katanga	78.4	75.1–81.7	71.2	69.2–73.2	55.1	51.7–58.6	63.8	61.6–66.1
Kinshasa	88.2	87.0–89.9	92.2	88.7–95.8	97.5	96.3–98.7	99.8	99.6–100.0
Maniema	76.9	73.6–80.3	71.2	67.8–74.5	70.4	67.5–73.3	72.2	69.3–75.1
Nord Kivu	95.6	93.3–97.8	98.8	97.9–99.7	95.2	92.9–97.5	96.9	96.2–97.5
Province Orientale	90.6	88.4–92.9	81.9	80.0–83.8	80.0	77.0–82.9	86.7	85.0–88.4
Sud Kivu	86.8	83.9–89.8	89.5	87.9–89.8	83.0	81.0–85.0	83.6	81.4–85.8
Overall ^b	87.3	84.1–86.0	82.4	81.1–91.1	74.2	72.5–76.0	85.2	84.1–86.0
Notes:								
a Data in this table present the adjusted coverage unless stated. Standardized prevalence was calculated after adjusting for women's age, educational attainment, marital status, household heads' sex, and educational attainment, residential region, and household wealth index group.								
b Overall coverage was calculated using the sampling weight of each woman.								

Figure 2 shows the trend of adjusted skilled birth attendance coverage in the DRC from 2010 to 2018. In contrast to the adjusted ANC coverage, the adjusted skilled birth attendance coverage increased in most provinces. However, there was still a decrease in Kasai-Oriental, with the adjusted skilled birth attendance coverage decreasing from 68.5% (95% CI 65.2–71.8%) in 2010 to 64.9% (95% CI 62.6–67.3%) in 2018 (Table 2). Subgroup analysis shows that trends of adjusted skilled birth attendance coverage were not

consistent between rural and urban regions in Kasai-Oriental. The adjusted coverage decreased from 63.3% (95% CI 59.0–67.6%) to 53.3% (95% CI 49.7–56.9%) in the rural region, but increased from 86.8% (95% CI 84.5–89.1%) to 91.4% (89.4–93.4%) in the urban region [see Additional file 2 Table S3].

The prevalence of maternal health care service for women in different SES

Figure 3 presents the adjusted ANC coverage and adjusted skilled birth attendance coverage for women from different wealth index groups in the Kasai region, Kivu region, and the other provinces in the DRC. For adjusted ANC coverage, a general decreasing trend from 2010 to 2018 was observed in the Kasai region and other provinces in the DRC. The most significant decline of adjusted ANC coverage in the Kasai region was in the poorest women from 85.2% (95% CI 82.1–88.2%) in 2010 to 63.4% (95% CI 60.0–66.8%) in 2018. In contrast to most provinces in the DRC, there was an increasing trend of adjusted ANC coverage for all groups in the Kivu region except the wealthiest group, with a slight decrease from 98.2% (95% CI 96.5–99.9%) in 2010 to 97.3% (95% CI 93.7–100.0%) in 2018. Within each wealth index group in 2018, the adjusted ANC coverage in the Kivu region was higher than in the other provinces.

When it comes to the adjusted skilled birth attendance coverage, there was a general increasing trend for all women in the Kivu region and the other provinces in the DRC. The adjusted skilled birth attendance coverage also increased for most women in the Kasai region, except for women from the poorest household, with the coverage declining from 71.3% (95% CI 67.0–75.6%) in 2010 to 64.3% (95% CI 60.9–67.6%) in 2018. Contrary to the Kasai region, there was a significant increase in the adjusted skilled birth attendance coverage for the poorest women in the Kivu region (77.50% in 2010 vs. 86.17% in 2018). Besides, except for the wealthiest women, the adjusted skilled birth attendance coverage in the Kivu region was higher than in the other provinces for all wealth index groups in 2018.

Discussion

In the present study, we observed a decline of ANC coverage in the DRC from 2010 to 2018, while an increase in skilled birth attendance coverage was observed. The ANC coverage and skilled birth attendance coverage were found both declining in Kasai-Oriental, while both were increasing in the Kivu region. In the Kasai region, the largest decline of ANC and skilled birth attendance coverage was observed among people in the lowest SES. Nevertheless, for women in the Kivu region, those in the lowest SES group saw a significant increase in both ANC coverage and skilled birth attendance coverage.

The DRC, with the most severe health challenge of its high maternal mortality ratio, has received a large amount of health assistance from various international organizations, of which a significant share was devoted to the maternal and reproductive health interventions[31–33]. Given the unstable political and conflicting situations, however, not all of the health assistance programs were effective. The results of this study suggested that skilled birth attendance coverage has increased from 2010 to 2018, which was consistent with the overall trend in West and Central Africa[11]. This increase illustrated great progress made by the programs targeting improving the delivery situation[34, 35]. However, the ANC coverage was found to

decrease in most regions, with the country-level coverage below the world average[10]. The conflicts in the country and the lack of funding for the maternal health service from the DRC government contributed to the decline. ANC plays a crucial role in promoting maternal health[36–38]. The low level of ANC coverage suggests that more efforts and targeted public health interventions are needed to promote maternal and child health in the DRC.

It was found that the ANC coverage and skilled birth attendance coverage both decreased in Kasai Oriental, indicating a systemic problem in the province. Due to the horrific violence that erupted in 2016, women in the Kasai region were reported to have limited access to essential health care[15, 18]. Previous studies found that serious atrocities in the Kasai region forced people to leave their homes and even their country[39]. While some of them are returning, the situation in the Kasai remains volatile as the wider political situation continues to deteriorate. Maternal health service coverage there was inadequate. Unlike the Kasai region, where health intervention programs have not been fully implemented yet, the Kivu region has received continuous international health assistance for sexual and reproductive health. A previous study showed that the operational capacity score for primary emergency obstetric care in Nord Kivu and Sud Kivu ranked the second and the third in the whole country, respectively, making them just behind Kinshasa, the capital city of the DRC[40]. The Kivu region also had the highest percentage of health facilities with family planning services available[33]. Although the previous literature did not measure the percentage of maternal health service coverage directly, they have shown a high level of available sexual and reproductive health services in the Kivu region. Consistent with previous findings, the present study found that the coverage of ANC and skilled birth attendance increased from 2010 to 2018 in the Kivu region, given the circumstance of an overall decline of ANC coverage at the country level. Despite the long-lasting instabilities, which may have caused difficulties for women to have access to adequate maternal health care in the region, such results demonstrated the potential efficiency of health aids in the Kivu region.

Additionally, health interventions and social changes usually have differentiated impacts concerning health service coverage bases on people's SES[41]. It was reported that the domestic conflict in the Kasai region had affected 170 health centers as of October 2017, leaving women with limited access to health care[15]. Without enough local health care services, traveling to distant health centers became the only choice for many women to seek maternal health services. The traveling cost may become an important obstacle for low-income families. On the other hand, although influenced by longer conflicts, the situation of women with low SES in the Kivu region has been improved over the years. The coverage of skilled birth attendance in women with the lowest SES was found to increase by one quarter, more extensive than most of their wealthier peers. Although the disparities in maternal health care coverage among different SES groups still existed, it has been reduced gradually in the Kivu region. The opposite trend between the Kasai region and the Kivu region may suggest the critical role of international health aids. When facing armed conflicts, health centers with better access to international health aids may be able to provide accessible and affordable health services to the most vulnerable populations.

The results of this study also show that the ANC coverage and skilled birth attendance coverage in the Kivu region are higher than in other provinces with little or no conflicts. Although it demonstrates the efficacy of the health interventions, another question arises – whether further health resources should be reallocated to other regions of the country? On the one hand, Kivu is still in conflict and is facing the challenges of the Ebola

outbreak in the region. Continued health aids are needed to keep the high level of maternal health service coverage in the area. On the other hand, maternal health coverage in other provinces in the DRC was much lower than that in the Kivu region. Accessible and affordable health service was also in urgent need for those regions. The vertical health aid programs targeting specific conflict areas may largely ignore the poor situation in other parts of the country, and a horizontal investment of the country's overall health system should be considered as a priority.

Strength And Limitations

To our knowledge, this article is one of the first studies exploring the temporal trends of maternal health service coverage in the DRC by using two rounds of nationally representative surveys of the MICS4 and MICS6. We applied adjusted prevalence to provide an unbiased estimate of the health service coverage in DRC by region and individual's socioeconomic status. Besides, our results illustrate how conflicts impact women of different SES in the Kasai and Kivu regions and the potential role of international health aids in conflicting areas.

There are several limitations to this study. Firstly, without comparable indicators in MICS1 and MICS2 in the DRC, long-term trends of maternal health service coverage could not be entirely assessed in this study. Secondly, due to the re-division of the provinces in 2015, the sampling process was different between MICS4 and MICS6 at the province level. To make it comparable between the two surveys, we re-categorized the provinces in MICS6 into those in the MICS4. Lastly, the method of adjusted prevalence has its limitations. Although it can compare groups efficiently and achieve the goals of unbiased estimation of population prevalence, it is substantially more challenging to attain when the sampling strategy is more complicated than the simple random sampling schemes.

Conclusions

Based on the analysis of two rounds of MICS data in the DRC, opposite trends in the coverages of ANC and skilled birth attendance were found between 2010 and 2018. Overall, while the skilled birth attendance coverage increased, the ANC coverage decreased over the years. In Kasai-Oriental, where conflicts newly erupted, the situation became worse for both services. Women with lower SES were found to have significantly less access to maternal health services. Although influenced by long-lasting conflicts, the Kivu region saw an increase both in ANC coverage and skilled birth attendance coverage. The disparities between women in higher and lower SES have also slightly reduced from 2010 to 2018 in the Kivu region. There was a higher maternal health service coverage in the Kivu region despite conflicts, suggesting a successful implementation of an international health aid program. However, this raised further questions of the effective resource allocation and the role of international health aids in supporting vertical programs versus horizontal programs.

List Of Abbreviations

DRC

Democratic Republic of the Congo; ANC:antenatal care; UNICEF:United Nations Children's Fund; MICS:Multiple Indicators Cluster Survey; SES:socioeconomic status.

Declarations

Ethical approval: The data used in the study consisted of a publicly available de-identified dataset, which was retrieved from the UNICEF MICS website with permission.

Consent for publication: Not applicable.

Availability of data and materials: The datasets generated and/or analysed during the current study are available in the UNICEF MICS repository, [<https://mics.unicef.org/>]

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: F.G. contributed to the study concept and design, statistical analysis, results interpretation and was a major contributor in writing the manuscript. X.Q. and H.Q. contributed to the study concept and design, and drafting and revision of the manuscript. Q.H., T.Z., S.Z., H.W., R.T., and K.T. contributed to study concept and design and revision of the manuscript. All authors reviewed and approved the final manuscript.

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References

1. World Health Organization. Maternal Health. 2019. https://www.who.int/health-topics/maternal-health#tab=tab_1. Accessed 6 Sep 2020.
2. Onasoga OA, Afolayan JA, Oladimeij BD. Factor's influencing utilization of antenatal care services among pregnant women in Ife Central LGA, Osun State Nigeria. *Adv Appl Sci Res.* 2012;3:1309–15.
3. Graham WJ, Bell JS, Bullough CHW. Can skilled attendance at delivery reduce maternal mortality in developing countries? *Safe Mother Strateg a Rev Evid.* 2001.
4. Bell J, Hussein J, Jentsch B, Scotland G, Bullough C, Graham W. Improving skilled attendance at delivery: a preliminary report of the SAFE strategy development tool. *Birth.* 2003;30:227–34.
5. Karkee R, Lee AH, Khanal V. Need factors for utilisation of institutional delivery services in Nepal: an analysis from Nepal Demographic and Health Survey, 2011. *BMJ Open.* 2014;4.
6. World Health Organization. Trends in maternal mortality: 1990 to 2008. 2010.
7. World Health Organization. Global Health Observatory (GHO) data. 2020.
8. World Health Organization. SDG 3: Ensure healthy lives and promote wellbeing for all at all ages. 2020.
9. UNICEF. UNICEF Data Warehouse. 2020.
10. United Nations Children's Fund. Antenatal care. 2019. <https://data.unicef.org/topic/maternal-health/antenatal-care/#more-1590>. Accessed 4 Oct 2020.

11. World Health Organization; United Nations Children's Fund. Delivery care. 2020.
12. Soeters R, Peerenboom PB, Mushagalusa P, Kimanuka C. Performance-based financing experiment improved health care in the Democratic Republic of Congo. *Health Aff.* 2011;30:1518–27.
13. Woolcock M. Engaging with fragile and conflict-affected states: An alternative approach to theory, measurement and practice. WIDER Working Paper; 2014.
14. World Health Organization. WHO strategic response and operations plan 2018, the Democratic Republic of the Congo. 2018.
15. UNFPA East and Southern Africa. Women attend life-saving mobile clinics in conflict-torn Kasai, DR Congo. 2017.
16. World Health Organization; United Nations Children's Fund. UNICEF for every child. What we do. 2020.
17. Alberti KP, Grellety E, Lin Y-C, Polonsky J, Coppens K, Encinas L, et al. Violence against civilians and access to health care in North Kivu, Democratic Republic of Congo: three cross-sectional surveys. *Confl Health.* 2010;4:17. doi:10.1186/1752-1505-4-17.
18. World Health Organization; United Nations Children's Fund. Conflict in the Kasai, Democratic Republic of the Congo. 2017.
19. Plan I national de la statistique du M du. MICS-Palu 2018 Situation and living conditions of children, women and men in the Democratic Republic of Congo. 2019.
20. Ministry of Planning and Monitoring the Implementation of the Revolution of the Revolution of Modernity. Multiple Indicator Cluster Survey MICS-2010: Monitoring the situation of children and women Summary Report. 2011. <https://www.unicef.org/drcongo/en/reports/multiple-indicator-cluster-survey-2010>. Accessed 9 May 2020.
21. Howe LD, Galobardes B, Matijasevich A, Gordon D, Johnston D, Onwujekwe O, et al. Measuring socio-economic position for epidemiological studies in low- and middle-income countries: a methods of measurement in epidemiology paper. *Int J Epidemiol.* 2012;41:871–86.
22. World Health Organization. The Global Health Observatory. 2020.
23. Abosse Z, Woldie M, Ololo S. Factors influencing antenatal care service utilization in hadiya zone. *Ethiop J Health Sci.* 2010;20.
24. Jayaraman A, Chandrasekhar S, Gebreselassie T. Factors affecting maternal health care seeking behavior in Rwanda. DHS Working Papers No. 59. 2008. <http://dhsprogram.com/pubs/pdf/WP59/WP59.pdf>.
25. Woldemicael G, Tenkorang EY. Women's autonomy and maternal health-seeking behavior in Ethiopia. *Matern Child Health J.* 2010;14:988–98.
26. Navaneetham K, Dharmalingam A. Utilization of maternal health care services in Southern India. *Soc Sci Med.* 2002;55:1849–69.
27. Ye Y, Yoshida Y, Harun-Or-Rashid MD, Sakamoto J, Sakamoto J. Factors affecting the utilization of antenatal care services among women in Kham District, Xiengkhouang province, Lao PDR. *Nagoya J Med Sci.* 2010;72:23–33.
28. Santos CAST, Fiaccone RL, Oliveira NF, Cunha S, Barreto ML, do Carmo MBB, et al. Estimating adjusted prevalence ratio in clustered cross-sectional epidemiological data. *BMC Med Res Methodol.* 2008;8:80. doi:10.1186/1471-2288-8-80.

29. Beckett LA, Scherr PA, Evans DA. Population prevalence estimates from complex samples. *J Clin Epidemiol*. 1992;45:393–402.
30. Easton DF, Peto J, Babiker AG. Floating absolute risk: an alternative to relative risk in survival and case-control analysis avoiding an arbitrary reference group. *Stat Med*. 1991;10:1025–35.
31. Altare C, Malembaka EB, Tosha M, Hook C, Ba H, Bikoro SM, et al. Health services for women, children and adolescents in conflict affected settings: experience from North and South Kivu, Democratic Republic of Congo. *Confl Health*. 2020;14:1–19.
32. Dumbaugh M, Bapolisi W, van de Weerd J, Zabiti M, Mommers P, Balaluka GB, et al. Evaluating the comparative effectiveness of different demand side interventions to increase maternal health service utilization and practice of birth spacing in South Kivu, Democratic Republic of Congo: an innovative, mixed methods approach. *BMC Pregnancy Childbirth*. 2017;17:212.
33. Mpunga D, Lumbayi JP, Dikamba N, Mwembo A, Ali Mapatano M, Wembodinga G. Availability and Quality of Family Planning Services in the Democratic Republic of the Congo: High Potential for Improvement. *Glob Heal Sci Pract*. 2017;5:274–85.
34. Feinstein L, Dimomfu BL, Mupenda B, Duvall S, Chalachala JL, Edmonds A, et al. Antenatal and delivery services in Kinshasa, Democratic Republic of Congo: care-seeking and experiences reported by women in a household-based survey. *Trop Med Int Health*. 2013;18:1211–21. doi:10.1111/tmi.12171.
35. Lee H, Park SJ, Ndombi GO, Nam EW. Community-based maternal and child health project on 4 + antenatal care in the Democratic Republic of Congo: a difference-in-differences analysis. *Reprod Health*. 2019;16:1–10.
36. Pradhan A. Situation of antenatal care and delivery practices. *Kathmandu Univ Med J*. 2005;3:266–70.
37. Iyaniwura CA, Yussuf Q. Utilization of antenatal care and delivery services in Sagamu, south western Nigeria. *Afr J Reprod Health*. 2009;13.
38. Wilunda C, Quaglio G, Putoto G, Takahashi R, Calia F, Abebe D, et al. Determinants of utilisation of antenatal care and skilled birth attendant at delivery in South West Shoa Zone, Ethiopia: a cross sectional study. *Reprod Health*. 2015;12:1–12.
39. The Internatioanl Refugee Rights Initiative. *Conflict and Displacement in the Kasai*. 2018.
40. Mpunga Mukendi D, Chenge F, Mapatano MA, Criel B, Wembodinga G. Distribution and quality of emergency obstetric care service delivery in the Democratic Republic of the Congo: it is time to improve regulatory mechanisms. *Reprod Health*. 2019;16:102.
41. Deaton A. Health, inequality, and economic development. *J Econ Lit*. 2003;41:113–58.

Figures

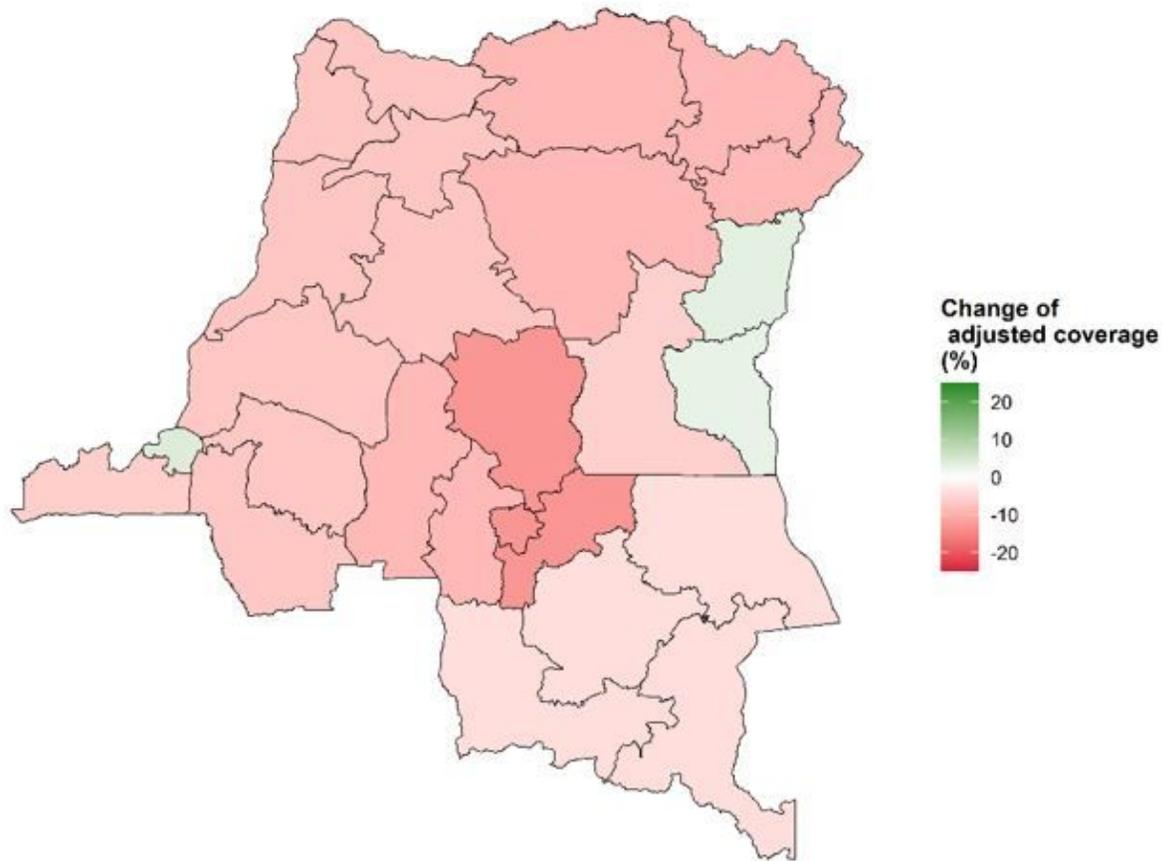


Figure 1

The change of adjusted coverage of antenatal care in the DRC 2010 - 2018 (a) Positive figures in the legend which was shown as green on the map present the increase of adjusted coverage from 2010 to 2018. Negative figures (Red in the map) present the decrease of the adjusted coverage. (b) The adjusted coverage was calculated after adjusting for women's age, educational attainment, marital status, household heads' sex, and educational attainment, residential region, and household wealth index groups. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

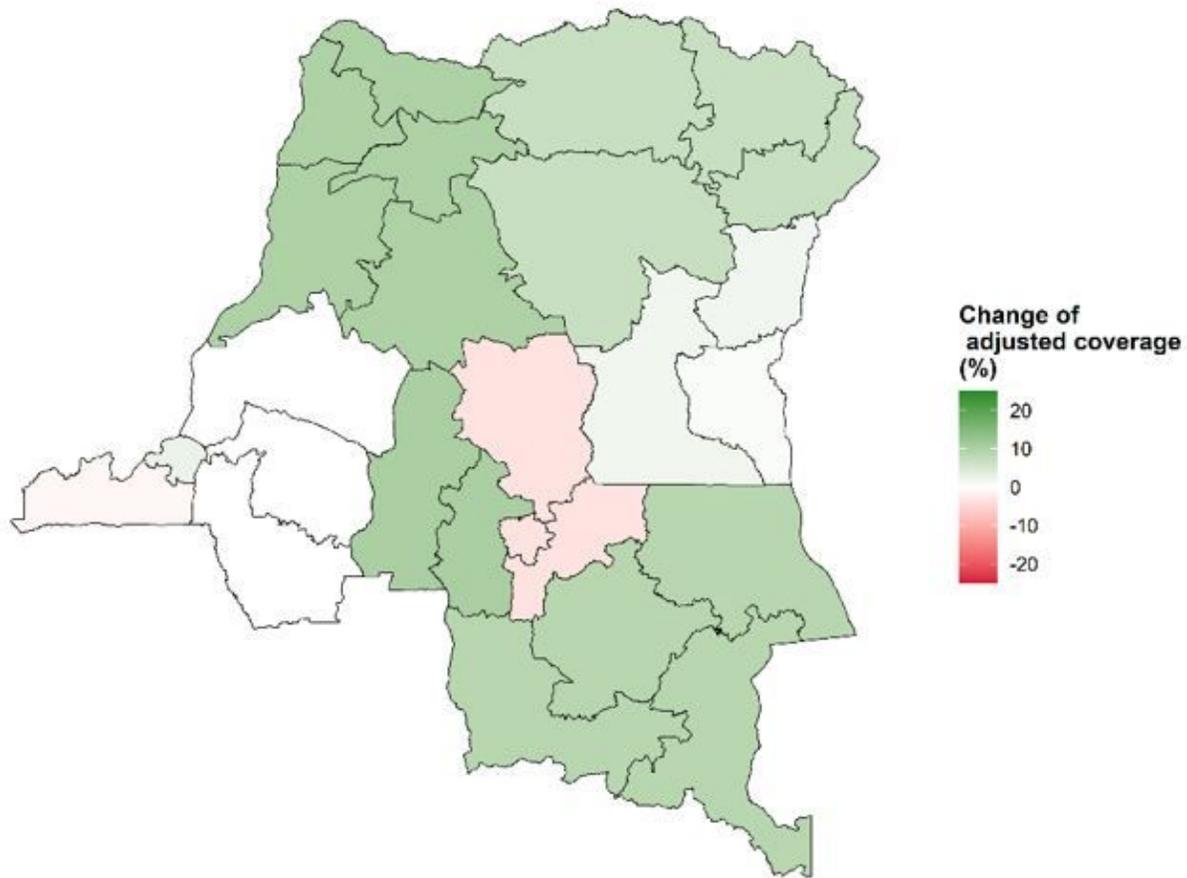


Figure 2

The change of adjusted coverage skilled birth attendance in the DRC 2010 - 2018 (a) Positive figures in the legend which was shown as green on the map present the increase of adjusted coverage from 2010 to 2018. Negative figures (Red in the map) present the decrease of the adjusted coverage. (b) The adjusted coverage was calculated after adjusting for women's age, educational attainment, marital status, household heads' sex, and educational attainment, residential region, and household wealth index groups. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

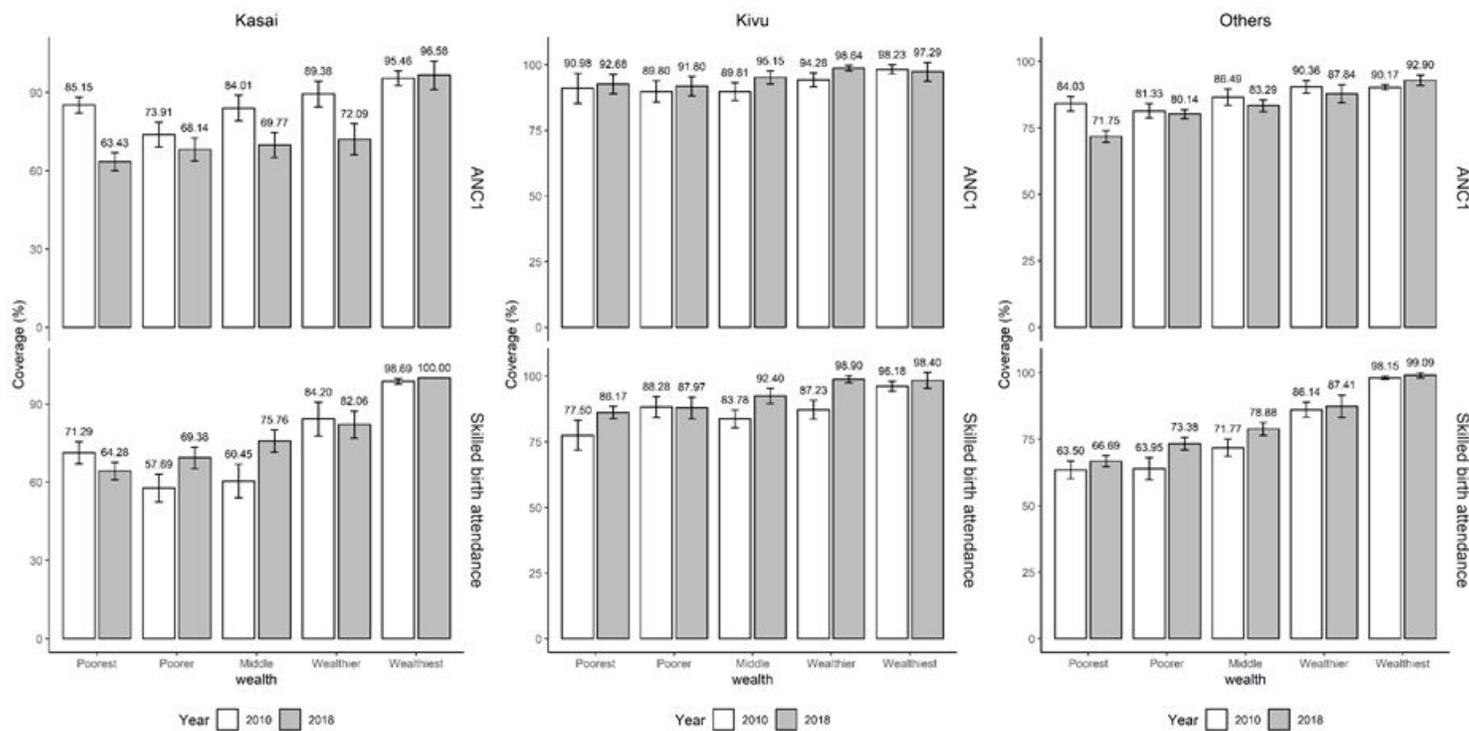


Figure 3

The trends of adjusted coverage of maternal health service among different SES 2010 – 2018 The adjusted coverage was calculated after adjusting for women’s age, educational attainment, marital status, household heads’ sex and educational attainment, residential region, and household wealth index groups.

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