Social Science & Medicine 226 (2019) 164–175

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Spatio-temporal disparities in maternal health service utilization in Rwanda: What next for SDGs?

Daniel Kpienbaareh[a,*], Kilian N. Atuoye[a], Anaclet Ngabonzima[b], Patrick G. Bagambe[c], Stephen Rulisa[c], Isaac Luginaah[a], David F. Cechetto[d]

[a] Department of Geography, Western University, London, Ontario, Canada
[b] TSAM Project, KG, 28 Ave., House #58, Kimihurura, Kigali, Rwanda, Canada
[c] University of Rwanda, Kigali, Rwanda
[d] Department of Anatomy and Cell Biology, Schulich School of Medicine and Dentistry, Western University, London, Ontario, N6A 5C1, Canada

ARTICLE INFO

Keywords:
Rwanda
Maternal health service
Antenatal care utilization
Skilled birth delivery
Sustainable development goals
Millennium development goals

ABSTRACT

The Sustainable Development Goals (SDGs) in part aim to further improve maternal health outcomes by reducing spatial disparities in utilization of critical services such as antenatal and assisted delivery, with emphasis on decentralization and integration of strategies. Yet, our understanding of within country spatial disparities in maternal health services (MHS) utilization over time has been scant. By fitting multiple regression models to a pooled dataset of the 2010/11 and 2014/15 Rwanda Demographic and Health Surveys (n = 12,273), and employing post-estimation margins analysis, we examined spatial differentiation of MHS trends prior to the SDGs in Rwanda. Our study found that women in 2014/15 were more likely to utilize antenatal services and assisted delivery (OR = 1.757, $p \leq 0.001$) compared with 2010/11, but with nuanced spatial variations. Compared with Nyarugenge, women in nineteen out of the twenty-nine remaining districts were more likely to report utilization of antenatal services and skilled birth delivery, while the probability of accessing four or more antenatal services in seven districts declined between 2010/11 and 2014/15. Physical, financial and socio-cultural factors were associated with maternal health service utilization over the period. Based on our findings, we present policy suggestions for improving utilization of MHS in Rwanda and in similar contexts in the SDGs period.

1. Introduction

Reducing maternal and child mortality, especially in developing countries, has become paramount for national governments and global actors (Cha, 2017; World Health Organization, 2017). Leading up to the elapse of the Millennium Development Goals (MGDs) in 2015, utilization of antenatal services increased by 44%, assisted delivery by 12% while maternal mortality rate (MMR) declined by about 44%, from 283.2 maternal deaths per 100,000 live births in 1990 (Alkema et al., 2016; Moller et al., 2017). Of these maternal deaths, 99% occurred in low and middle-income countries, with about 66% occurring in sub-Saharan Africa (SSA) alone (World Health Organization et al., 2015). Geographical inequalities in maternal health access persist. Countries and regions that have suffered health policy drawbacks, political instability and deprivation reported worse performance over the period (World Health Organization, 2017; Atti and Gulis, 2017). Rwanda was one of two countries in SSA to have reported over 75% reduction in maternal mortality rate over the MDGs period (World Health Organization et al., 2015). In this study, we examined spatial disparities and trends in MHS utilization in Rwanda to inform maternal health policy in the Sustainable Development Goals (SDGs) period.

Failure to meet maternal health targets in the MDGs, and with stark spatial disparities, the world has again united under the SDGs to improve quality of life for all people, with maternal health prominently targeted. Indeed, not only have the SDGs, in Goal 3.1, set an ambitious target of reducing global MMR to less than 70 per 100,000, they also, in Goal 3.7, aim to achieve universal access to sexual and reproductive health care services by 2030 through integrated national strategies and programmes. However, the point of departure from previous universal agendas on maternal health is the focus on integration and decentralization of health programmes to sustain gains made during the MDGs period (World Health Organization, 2017). This approach enjoins respective countries to mobilise resources, draw strategies, and implement them in their local settings.

Despite the prospects for empowerment of local institutions and national governments, and associated benefit of ownership and

* Corresponding author. Department of Geography, Western University, London, N6A 5C2, Canada.
E-mail address: dkpienba@uwo.ca (D. Kpienbaareh).

https://doi.org/10.1016/j.socscimed.2019.02.040
Received 9 May 2018; Received in revised form 17 December 2018; Accepted 24 February 2019
Available online 01 March 2019
0277-9536/

sustainability of both the SDGs implementation process and outcomes, the integrated decentralised approach is exposed to the persistent bottlenecks in health policymaking and implementation in most developing countries. Constrained by resource inadequacy, and with limited evidence of in-country disparities in maternal health, competing interest from political and other groups tend to overwhelm policymaking and resource allocation decisions in most low-income countries (Atti and Gulis, 2017; Lieberman, 2007). Thus, it is crucial to highlight disparities in MHS utilization in a manner that points directly to gaps, both spatially and among local population groups. This paper contributes to our understanding of spatial differentiation of MHS utilization over time in Rwanda, and some of the factors accounting for variation in space-time trends in the MDGs period. We examined the influence of geographical regions and compositional factors on utilization of the WHO-recommended antenatal services and assisted delivery to inform maternal health policy in the SDGs period using Rwanda as a case study.

1.1. Maternal health service utilization in the context of SDGs

The WHO recommends, through its 2002 Focused Antenatal Care (FANC) model, that pregnant women should utilize antenatal services at least four times during pregnancy to avert preventable pregnancy-related deaths. It further recommends that the first of these visits takes place within the first trimester of pregnancy (Lincetto et al., 2006a; World Health Organization, 2002). Meeting the timing of the first visit is crucial because it is during this initial visit that pre-existing medical conditions, which are responsible for a greater portion of maternal deaths, are diagnosed and remedial actions taken. Generally, women are more likely to utilize assisted delivery if they had at least four antenatal visits during pregnancy (Lincetto et al., 2006b). Indeed, the WHO suggests that quality care at childbirth is important for safe delivery, which culminates into reduction of maternal and child mortality. In their 2001 study, Graham et al. (2001) found that having assisted delivery would likely reduce maternal mortality by 13–33%. Antenatal service and assited delivery continue to serve as important indicators for maternal health in the SDGs (World Health Organization, 2017).

Prior to the SDGs, low-income countries vigorously implemented various strategies including expansion of health infrastructure, training and deployment of health personnel, and cost reduction policies to improve physical and financial access to MHS. For instance, Rwanda improved access to MHS with the implementation of the Health Sector Strategic Plan I and II, which decentralised and improved the quality of health in line with the country's Economic Development and Poverty Reduction Strategies (Bucagu et al., 2012; Republic of Rwanda, 2015). Most noticeable programs implemented in this context included the Community Health Program (CHP). Started in 2005, the CHP placed nurses in communities, and along with a Pre-Hospital Emergency Care Service, strengthened primary healthcare and referral systems to improve maternal health delivery. The country also implemented a national health insurance policy to reduce the financial cost of health care for everyone, including pregnant mothers and children. It has been suggested that the combined effect of these interventions in the health sector improved the health status of Rwandans, as witnessed in the rise in life expectancy to 64.5 in 2012, and reduction in maternal and child mortality rates (Republic of Rwanda, 2015). In addition, the introduction of performance based financing, whereby health personnel sign performance-based contracts upon which extra funding is provided to motivate and support health delivery, is one important innovation in healthcare financing in Rwanda. Studies on the impact of this policy have reported improvement in the efficiency of health delivery, and improvement of health access for individuals in high socio-economic status who have lower burden of reaching health facilities (Lannes et al., 2016).

Similar programs were implemented in other low-income countries to improve health access. In Ghana, the Community Health Planning and Services (CHPS) policy, free MHS, and a nationwide health insurance programme were implemented (Atuoye et al., 2015; Nyonator et al., 2005), while Malawi implemented free maternal health programmes in a decentralised primary healthcare system in order to bring healthcare closer to pregnant women (IPPF et al., 2011; Kumbani et al., 2013). Alongside the focus on geographical and socio-economic disparities, policy has also attempted to address some of the socio-cultural and behavioural practices found to constrain utilization of MHS. For example, men's involvement in MHS is employed as an approach to shift male-dominated health decision making in most patriarchal societies to support maternal health uptake (Ganle, 2015a; Singh et al., 2014). Others have embraced community empowerment to galvanize local support for maternal health as in the CHPS in Ghana (Woods et al., 2018). Undoubtedly, these programmes have contributed to reducing the impact of socio-economic disparities and locational differentiation in MHS uptake (Bucagu et al., 2012; Kuuire et al., 2017; Saksena et al., 2011). Indeed, Moller et al. (2017) suggested that a 43.5% increase in overall antenatal attendance recorded between 1990 and 2013 could largely be attributed to global action on maternal health, which reduced financial and physical access to health services for women in most low-income countries.

However, given the complexity of factors influencing the uptake of MHS in developing countries, there is an emerging 'supply' – 'demand' approach to the analysis. With the 'supply side' examining policymaking and service provision, the 'demand side' focuses on the physical, environmental, social and economic contexts of maternal health service consumers (Hurst et al., 2015; Nguyen et al., 2016). Despite providing ease of analysis, the ascription 'demand side' bestows on women a responsibility to seek health services even in contexts where these services are limited. Women's individual health access behaviours and their socio-cultural contexts are blamed for low utilization of MHS, and poor maternal health outcomes. Without discounting the role of women and their communities in influencing maternal health uptake, entrenching a dualist paradigm over-simplifies the analysis, which may undermine potential gains in an integrative approach to maternal health as envisaged in the SDGs (World Health Organization, 2017; Moller et al., 2017). In this context, we employ structuration theoretical perspectives (Giddens, 1984) and Andersen's behavioural model (Andersen, 1995) to examine utilization of MHS in Rwanda as a contribution to the maternal health during the SDGs.

1.2. Theoretical context

The theory of structuration (Giddens, 1984) provides an opportunity for analysis of MHS utilization over space and time, incorporating challenges of duality in the factors that shape utilization of care in general. The focus on either agency (demand side factors) or structure (policy and service provision) often missed the combined effect of both on MHS utilization. This problem is reduced when analyses frame both agency and structural factors as independent, but reinforcing each other to influence MHS provision and utilization over time. The structuration theory settles a core assumption that "…structural forces, institutional practices, and everyday routines of agents interact to produce concrete manifestations" (Dear and Wolch, 1987, pg 5). These manifestations, such as utilization of MHS, and maternal mortality, are localised within contexts. Structuration theory has been utilized in the analysis of place effects on health of populations (Kearns, 1991) and the complexity of place and community in health policy (Jones and Moon, 1993). In this regard, understanding trends in MHS utilization prior to the SDGs in Rwanda should account for the impact of structure (the policy environment), institutions, and agency, which are interacting through complex processes over space and time.

Furthermore, Andersen's behavioural model for analysing health services utilization is adopted to support the analysis in this paper. This model has been employed in several health service utilization studies including MHS (Kuuire et al., 2017; Luginaah et al., 2016). The model

identifies three groups of factors – enabling, predisposing and need factors – influencing uptake of healthcare services. Predisposing factors are exogenous characteristics influencing decision to access health services, which may include demographic factors such as age; social structure factors such as education, occupation and ethnicity; and health beliefs. Enabling factors include availability of health services and means of accessibility, including community resources (health facilities, transportation, and residential capital/rurality), individual and household resources (wealth status, employment status, and social support). Enabling factors together with predisposing factors may not be adequate to trigger healthcare utilization. Need for healthcare service either following ill-health or perceived risk of health complications has been shown to underwrite uptake of health services. We followed other studies that have utilized Andersen's behavioural model and structuration theory in selecting theoretically relevant variables for our analysis.

1.3. Study context

Since the genocide in 1994, Rwanda has made steady progress in all fronts of national life. As at the end of 2016, the World Bank estimated the population of Rwanda at 11.92 million, up from 5.93 million in 1995, even though the growth rate has reduced significantly from 7.92% in 1998 to 2.45% in 2016 (McCarthy et al., 2016). The population is projected to reach 13 million by 2020 at the current growth rate in a country that is only 26,338 km^2 with 30 districts (see Fig. 1). The changing population dynamics together with other factors have created a wide divide between the rich and poor as indicated by the country's deteriorating Gini index from 0.289 in 1984 to 0.504 in 2013, while the poverty gap between the urban rich and the rural poor increased despite a reduction in poverty from 24.4% in 2005 to 14.8% in 2010 (World Bank Group, 2017). This inequality influences health outcomes, especially maternal mortality (Lincetto et al., 2006a; Chukwuma et al., 2017).

On the health front, significant progress has been made. Neonatal death rate declined from 46 per 1000 live births in 1994 to 20 per 1000 live births in 2015. This decline occurred as physician to patient ratio improved from 0.06 in 2011 to 0.09 per 1000 in 2015, while the ratio of nurses and midwives per 1000 of the population within the same period also improved from 0.77 to 0.88, and from 0.01 to 0.25, respectively (NISR et al., 2015). In addition, the number of women receiving antenatal care has remained high, increasing from 92% in 2000 to 99% in 2015 (NISR et al., 2015).

Meanwhile, these modest improvements in maternal health are below the WHO-recommended targets, and reflect marked rural/urban, as well as wealth disparities. The Rwandan Vision 2020 agenda seeks to reduce annual MMR from 1,071 per 100, 000 live births reported in 2000 to 200 per 100,000 live births by 2020 (UNDP & Government of Rwanda, 2007). As of 2015, the ratio had reduced to 210 live births per 100,000, a reduction of 80.4% compared with the 46% average for SSA. The priority of the Rwandan Ministry of Health (RMoH) for 2018 is to increase the uptake of antenatal care and assisted deliveries (RMoH, 2017). One strategy of achieving this is to further increase access to MHS by strengthening implementation of community-based health insurance schemes (*mutuelles*) which have reduced the number of people who use out of pocket expenditure on health from 30.48% in 2009 to 28.13% in 2014 (RMoH, 2017). The implementation of a performance-based financing (PBF) system which ensures the 'transfer of money or material goods conditional on taking a measurable action or achieving a predetermined performance target' (Eichler, 2006) has further resulted in the attainment of higher utilization rates of MHS (Lannes et al., 2016). This is because of its emphasis on the supply side, with aims of

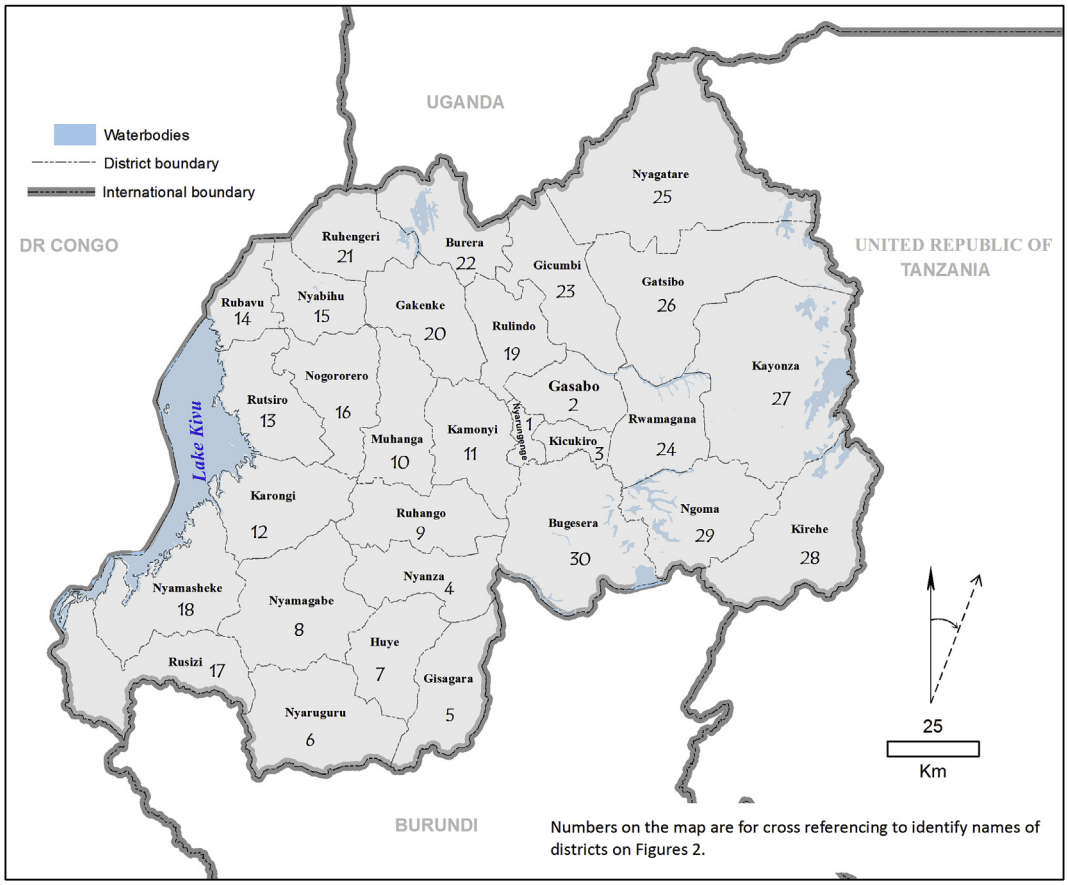

Fig. 1. Map of Rwanda.

improving service delivery by encouraging effort and compliance with recommended clinical practices, culminating in improved access to health services (Eichler, 2006; Soeters et al., 2006; Meessen et al., 2006). In Burundi, PBF increased the probability of institutional deliveries by 39.5 percentage points, even though it did not improve the number of antenatal care (ANC) visits (Rudasingwa et al., 2017). In the case of Rwanda, PBF did not improve equity in access for most health services (Lannes et al., 2016), but achieved efficiency (Lannes et al., 2016; Priedeman et al., 2012), which calls for the need to inquire into possible spatial variations in healthcare delivery.

To understand MHS utilization in Rwanda, it is crucial to examine the contribution of socio-cultural, demographic and geographical disparities in MHS over time. This will reveal the most important factors accounting for disparities in utilization of antenatal and assisted deliveries overtime. In addition, it is necessary to conduct spatial comparison to identify district level variations of MHS utilization for policymakers to target underperforming districts. Studies that have been carried out in this regard have failed to elucidate spatial dimensions to health utilization (Abbott et al., 2017; Logie et al., 2008). This study adopts a spatio-temporal approach to study disparities in access to antenatal services and assisted delivery (as recommended by the WHO) from 2010/11 to 2014/15 in Rwanda. The use of Geographic Information Systems (GIS) to report the study findings will help policymakers understand geographical disparities and assist in location-based resource allocation decision-making.

2. Methods

2.1. Data

Data on utilization of MHS were obtained from the 2010/11 and 2014/15 pooled datasets of the Rwanda Demographic Health Surveys (DHS). The DHS in collaboration with the Rwandan government conducts a nationally representative standardized cross-sectional survey involving women aged 15–49 years, with funding from the United States Agency for International Development (USAID) and other NGOs. Data collection followed a multistage sample design. Districts were selected from administrative regions, which were further divided into Enumeration Areas (EAs) and classified into rural and urban areas. A representative sample of households was drawn from EAs within the rural and urban clusters. The survey captured information on respondents' characteristics (e.g. age, religion, education, literacy, and employment), sexual and reproductive health and maternal health seeking behaviors. We also included data collection points (coordinates) in order to present a spatial dimension of MHS utilization.

2.2. Measures

Four dependent variables, which serve as indicators for MHS utilization both in the MDGs and SGDs, were used in our analysis. The first – timing of first antenatal visit – was derived from a question on the timing of the first antenatal visit during the last pregnancy, the second – 4 + antenatal visits – came from a question on total number of antenatal visits during the last pregnancy, the third – skilled birth assistance (SBA) at delivery – came from a question that asked women who was the person that assisted them during the delivery of their last pregnancy, while the fourth was a composite of the first three variables. Despite the fact that women's utilization of antenatal care and SBA services is impacted by several factors, the WHO recommends that every pregnant woman should attend at least four antenatal care services prior to delivery, the first of which should happen as early as the first trimester of the pregnancy. The WHO further recommends that deliveries should be assisted by professional health workers (a doctor, nurse/midwife or trained community health worker) to reduce delivery related complications and deaths. Informed by these WHO recommendations, we categorized timing of first antenatal visit into early, i.e. antenatal visit in the first trimester, and late with those who never had antenatal service throughout their pregnancy or their first antenatal beyond the first trimester (coded 1 and 0, respectively). Number of antenatal visits was categorized into those that had at least four visits (4 + antenatal visits) and those who had less than four antenatal visits (1 and 0, respectively). Our third dependent variable was also categorized into two – assisted delivery for those delivered by skilled professionals, and those who were not (1 and 0, respectively). We categorized our fourth outcome variable into those who utilized all three services and those who did not (1 and 0, respectively).

In tandem with the main objective of the study, which was to explain spatial disparities in MHS utilization over time in Rwanda, the focal independent variables were survey year and district of residence. Survey year was used as a proxy for the changing policy context over the study period, which could have impacted MHS provision and utilization. Consequently, we selected 2010/2011 as the base year and coded it as '1' while 2014/2015 was coded '2'. District of residence encapsulates a measure of availability of health facilities and services (infrastructure, personnel and logistics), transportation to health facilities, travel and wait times at facilities, which enable or constrain utilization of MHS. District of residence in the survey conformed to the geographical data collection points provided by DHS in the two surveys. In all, 30 districts (see Fig. 1) were identified (coded: 1–30) with Nyarugenge coded as the reference district in our regression analysis. The other enabling factors in our analysis were: place of residence (urban = 1 rural = 2), distance to health facility (small problem = 1 and big problem = 2), household wealth quintile (richest = 1, richer = 2, middle = 3, poor = 4, and poorest = 5), mother's employment status (full time = 1, temporary = 2 and unemployed = 3), and money for healthcare (small problem = 1 and big problem = 2). The predisposing factors were age, mother's educational attainment (secondary and above = 1, primary = 2 and no education = 3), marital status (currently married = 1 and currently not married = 2), birth order (one child = 1, 2–3 children = 2, 4–5 children = 3 and 6 or more = 4), and religion (Christianity = 1, Muslim = 2 and other = 3). We conceptualized in this study that pregnancy, together with other related health conditions were need factors that influence uptake of MHS in Rwanda.

2.3. Analytical strategy

We used three analytical techniques in examining utilization of antenatal services and assisted delivery. First, given that the majority of respondents had early timing of first antenatal visit and assisted delivery (see Table 1), we employed negative log-log regression models to examine the effect of the independent variables on women's early utilization of antenatal care and SBA. Second, we used complementary log-log regressions to estimate utilization of 4 + antenatal visits, as well as utilization of all three MHS as fewer cases were in our categories of interest. These models are built with the assumption of independence of respondents but given that most RDHS surveys follow hierarchical sampling whereby respondents are nested within clusters of enumeration areas, our estimates could potentially be biased. To address this limitation, we conducted random effects models using *meglm* command available in Stata. Sample units in the data were used as the cluster variable. We also adjusted for sample weights (available in the two surveys) to improve proportionality in the samples. Third, we conducted post-estimation probability analysis using the margins command in Stata after building survey-year specific multivariate models, and plotted the results using GIS tools to give spatial dimensions of disparities in MHS utilization in 2010/11 and 2014/15. A total of 12,273 respondents from the two rounds of DHS survey were used as our analytical sample. All analyses were conducted in Stata SE 15.1.

Table 1
Descriptive statistics.

Variables	Frequency (%)	Variables	Frequency (%)
Dependent Variables		***Other Independent Variable***	
Timing of first antenatal visit		**Place of residence**	
Early	6521 (53.13)	Urban	2237 (18.23)
Late	5752 (46.87)	Rural	10036 (81.77)
4 + antenatal visits		**Distance to health facility**	
4 or more visits	4867 (39.66)	Small problem	9269 (75.52)
Less than 4 visits	7406 (60.34)	Big problem	3004 (24.48)
SBA		**Wealth Quintile**	
Yes	9982 (81.33)	Richest	2344 (19.10)
No	2291 (18.67)	Richer	2189 (17.84)
All three maternal health services		Middle	2336 (19.03)
Yes	3485 (28.40)	Poorer	2566 (20.91)
No	8788 (71.60)	Poorest	2838 (23.12)
Key Independent Variables		**Mother's education**	
Year of Survey		Secondary and above	1535 (12.51)
2010/11	6318 (51.48)	Primary	8725 (71.09)
2014/15	5955 (48.52)	No Education	2013 (16.40)
District		**Mother's Employment**	
Nyarugenge	488 (3.98)	Full-time	8055 (65.63)
Gasabo	497 (4.05)	Temporal	3183 (25.93)
Kicukiro	461 (3.76)	Unemployed	1035 (8.43)
Nyanza	362 (2.95)	**Money for healthcare**	
Gisagara	424 (3.45)	Small problem	5648 (46.02)
Nyaruguru	407 (3.32)	Big problem	6625 (53.98)
Huye	389 (3.17)	**Age**[a]	30.51 (6.80)
Nyamagabe	362 (2.95)		Min = 15; Max = 49
Ruhango	357 (2.91)	**Marital status**	
Muhanga	370 (3.01)	Currently married	9964 (81.19)
Kamonyi	391 (3.19)	Currently not married	2309 (18.81)
Karongi	367 (2.99)	**Parity**	
Rutsiro	427 (3.48)	One child	3028 (24.67)
Rubavu	427 (3.48)	2–3 children	4521 (36.84)
Nyabihu	404 (3.29)	4–5 children	2539 (20.69)
Ngororero	408 (3.32)	≤6 children	2185 (17.80)
Rusizi	420 (3.42)	**Religion**	
Nyamasheke	415 (3.38)	Christian	11869 (96.71)
Rulindo	357 (2.91)	Muslim	243 (1.98)
Gakenke	357 (2.91)	Other	161 (1.31)
Musanze	376 (3.06)	**Observations**	**12,273**
Burera	374 (3.05)		
Gicumbi	391 (3.19)		
Rwamagana	414 (3.37)		
Nyagatare	449 (3.66)		
Gatsibo	454 (3.70)		
Kayonza	401 (3.27)		
Kirehe	430 (3.50)		
Ngoma	441 (3.59)		
Bugesera	453 (3.69)		
Observations	**12,273**		

[a] Treated as a continuous variable.

3. Results

3.1. Sample characteristics

The study involved 12,273 women. As shown in Table 1, 81% of Rwandan women utilized skilled birth delivery service, yet 53% of them made their first antenatal visit in the first trimester of their pregnancy, while 40% followed through with 4 + antenatal visits. Approximately 28% of women utilized all three WHO-recommended MHS in 2010/11 and 2014/15.

Geographically, Gasabo District had the highest number of respondents (4%), while about 82% lived in rural localities. Nonetheless, 76% considered distance to health facility as a small problem. With regards to wealth, 23% of all respondents were from households in the poorest wealth quintile. Even though approximately 66% of respondents were fully employed, 46% of them reported money for healthcare as a big problem. Similarly, we observed disparities in predisposing characteristics in the sample. Majority of respondents had attained primary education (84%), married (81%), with 2–3 children (37%), and were affiliated to the Christian religion (97%). On average, respondents were 31 years old.

3.2. Bivariate analysis

Bivariate results are presented in Table 2. Relative to 2010/11, women in 2014/15 were 2.17 times more likely to utilize antenatal services in the first trimester of their pregnancy. We observed geographical disparities in timing of first antenatal visit. Apart from Nyaruguru and Rubavu (OR = 0.585, $p \leq 0.01$; and OR = 0.673, $p \leq 0.05$, respectively), women in most districts were more likely to have early antenatal visit compared with those in Nyarugenge District.

Women residing in rural localities and those who reported that "distance to a health facility" and "money for health care" was problem were less likely to have an antenatal visit in the first trimester (OR = 0.674, $p \leq 0.001$; OR = 0.812, $p \leq 0.001$, and OR = 0.759, $p \leq 0.001$, respectively). Similarly, those in poorer wealth quintiles were less likely to utilize an early antenatal visit. In addition, older women, those with educational attainment lower than secondary, not married, had more than one birth; and were of traditional and other religious affiliation compared to Christianity were less likely to utilize antenatal care during the first trimester of their pregnancy.

The bivariate analysis also showed that women in Rwanda were 35% more likely to have 4 + antenatal visits in 2014/15 compared to 2010/11. In most of the districts, apart from Rubavu (OR = 0.672, $p \leq 0.05$), women were more likely to have 4 + antenatal visits before delivery compared with those in Nyarugenge District. Similar to timing of first antenatal visit, women in rural areas, those who encountered physical and financial barriers to health access, in poorer wealth quintiles, and with educational attainment lower than secondary school were less likely to meet the 4 + recommended antenatal visits. Additionally, older and unmarried women, and those with more than one birth were less likely to have 4 + antenatal visits.

Furthermore, women in 2014/15 were 4.39 times more likely to have been assisted during delivery by a professional health worker compared to 2010/11. Unlike timing of first antenatal and 4 + antenatal visits, women in most districts were less likely to access professional health services at delivery relative to Nyarugenge District. Compared with urban dwellers, women in rural localities were 64% less likely to be assisted during delivery. Distance to health facility and money to pay for health services stood out as barriers to accessing assisted delivery (OR = 0.665, $p \leq 0.001$; and OR = 0.573, $p \leq 0.001$, respectively). Similarly, disparities in household wealth, educational attainment and employment status were also significantly associated with access to assisted delivery. In addition, older women, and those with more than one birth were less likely to utilize assisted delivery. Furthermore, compared to Christian women, Muslim women were more likely to utilize assisted delivery, while traditional believers and women affiliated to other religious groups were less likely to utilize SBA at delivery (OR = 1.569, $p \leq 0.05$; and OR = 0.356, $p \leq 0.001$, respectively).

Taken together, our bivariate results show that Rwandan women had higher odds of utilizing the three MHS in 2014/15 compared to 2010/11 (OR = 1.901, $p \leq 0.001$). With the exception of Nyaruguru and Rubavu districts, which were less likely (OR = 0.653, $p \leq 0.05$; OR = 0.709, $p \leq 0.05$, respectively), women in most of the districts were more likely to utilize all the three MHS compared with

Table 2
Bivariate results of maternal health service utilization in Rwanda (2010–2014/15).

Variables	Timing of 1st ANC	4 + ANC Visits	Assisted delivery	All three
	OR(R. std. err)	OR(R. std. err)	OR(R. std. err)	OR(R. std. err)
Year *(ref: 2010/11)*				
2014/15	2.165(0.083)***	1.348(0.040)***	4.389(0.248)***	1.901(0.068)***
District *(ref: Nyarugenge)*				
Gasabo	1.214(0.191)	1.281(0.174)	0.913(0.253)	1.329(0.197)
Kicukiro	1.226(0.196)	1.389(0.190)*	0.969(0.273)	1.307(0.196)
Nyanza	2.311(0.397)***	2.143(0.298)***	0.382(0.104)***	1.979(0.298)***
Gisagara	1.110(0.183)	1.363(0.192)*	0.389(0.105)***	1.331(0.205)
Nyaruguru	0.585(0.101)**	1.024(0.150)	0.283(0.075)***	0.653(0.115)*
Huye	1.721(0.288)**	1.759(0.245)***	0.606(0.170)	1.857(0.278)***
Nyamagabe	1.736(0.295)**	1.466(0.211)**	0.231(0.061)***	1.317(0.209)
Ruhango	1.736(0.296)**	1.879(0.264)***	0.696(0.201)	1.807(0.275)***
Muhanga	2.684(0.462)***	1.669(0.235)***	0.670(0.192)	1.943(0.292)***
Kamonyi	0.935(0.157)	0.957(0.143)	0.562(0.157)*	0.907(0.151)
Karongi	0.756(0.130)	0.930(0.141)	0.271(0.073)***	0.786(0.136)
Rutsiro	0.870(0.145)	1.014(0.148)	0.485(0.132)**	0.933(0.152)
Rubavu	0.673(0.114)*	0.672(0.105)*	0.464(0.126)**	0.709(0.122)*
Nyabihu	0.783(0.132)	1.031(0.151)	0.312(0.083)***	0.841(0.141)
Ngororero	0.939(0.157)	1.263(0.181)	0.249(0.066)***	0.833(0.140)
Rusizi	2.271(0.379)***	1.912(0.263)***	1.381(0.426)	2.070(0.304)***
Nyamasheke	2.999(0.508)***	2.431(0.329)***	1.432(0.444)	2.713(0.390)***
Rulindo	1.100(0.188)	1.074(0.160)	0.348(0.095)***	0.970(0.162)
Gakenke	1.871(0.319)***	1.774(0.250)***	0.310(0.084)***	1.653(0.255)**
Musanze	1.090(0.184)	1.236(0.180)	0.413(0.113)**	1.158(0.186)
Burera	2.018(0.342)***	1.540(0.219)**	0.411(0.112)**	1.600(0.245)**
Gicumbi	1.096(0.184)	1.336(0.192)*	0.484(0.133)**	1.199(0.190)
Rwamagana	1.551(0.257)**	1.186(0.170)	0.962(0.281)	1.355(0.209)*
Nyagatare	1.470(0.240)*	1.211(0.171)	0.351(0.093)***	1.287(0.197)
Gatsibo	1.308(0.213)	1.151(0.164)	0.357(0.095)***	1.164(0.181)
Kayonza	1.175(0.196)	0.976(0.144)	0.453(0.124)**	0.858(0.143)
Kirehe	0.853(0.142)	0.857(0.128)	0.265(0.070)***	0.965(0.156)
Ngoma	0.956(0.157)	0.893(0.132)	0.419(0.113)**	0.947(0.152)
Bugesera	1.070(0.175)	0.861(0.127)	0.469(0.127)**	0.983(0.156)
Place of resident *(ref: Urban)*				
Rural	0.674(0.044)***	0.819(0.041)***	0.356(0.035)***	0.702(0.040)***
Distance to health facility *(ref: Small problem)*				
Big problem	0.812(0.037)***	0.877(0.032)***	0.665(0.037)***	0.806(0.035)***
Wealth Quintile *(ref: Richest)*				
Richer	0.717(0.048)***	0.852(0.044)**	0.440(0.046)***	0.793(0.047)***
Middle	0.732(0.049)***	0.823(0.043)***	0.370(0.038)***	0.744(0.044)***
Poorer	0.668(0.044)***	0.813(0.042)***	0.312(0.032)***	0.707(0.042)***
Poorest	0.641(0.042)***	0.767(0.039)***	0.254(0.025)***	0.669(0.039)***
Mother's education *(ref: Secondary+)*				
Primary	0.564(0.034)***	0.757(0.033)***	0.302(0.035)***	0.663(0.032)***
No Education	0.416(0.031)***	0.659(0.038)***	0.150(0.019)***	0.477(0.032)***
Mother's employment *(ref: Full-time)*				
Temporal	1.000(0.045)	0.978(0.034)	1.268(0.075)***	1.028(0.042)
Unemployed	0.901(0.065)	0.981(0.056)	1.379(0.144)**	0.916(0.062)
Money for healthcare *(ref: Small problem)*				
Big problem	0.759(0.029)***	0.820(0.023)***	0.573(0.029)***	0.768(0.027)***
Age	0.971(0.003)***	0.991(0.002)***	0.926(0.003)***	0.979(0.003)***
Marital status *(ref: Married)*				
Not currently married	0.785(0.038)***	0.771(0.031)***	0.907(0.056)	0.739(0.035)***
Parity *(ref: One child)*				
2–3 children	0.766(0.038)***	0.828(0.031)***	0.281(0.026)***	0.774(0.032)***
4–5 children	0.537(0.030)***	0.709(0.031)***	0.156(0.015)***	0.610(0.031)***
≤6 children	0.403(0.024)***	0.655(0.031)***	0.104(0.010)***	0.458(0.027)***
Religion *(ref: Christian)*				
Muslim	1.109(0.154)	0.868(0.098)	1.569(0.350)*	0.969(0.122)
Other	0.678(0.116)*	0.770(0.111)	0.356(0.063)***	0.579(0.111)**
Observations	**12,273**	**12,273**	**12,273**	**12,273**

Note: OR = Odds Ratios; R. std. err. = Robust Standard Errors; ***p ≤ 0.001, **p ≤ 0.01, *p ≤ 0.05.

Nyarugenge. Generally, most of the predisposing and enabling factors including demographic, socio-economic and socio-cultural characteristics were statistically significant determinants of antenatal and assisted delivery.

3.3. Multivariate analysis

Table 3 presents multivariate results estimating early antenatal visit (column 2), 4 + antenatal visits (column 3), assisted delivery (column 4), and utilizing all three MHS (column 5).

3.3.1. Meeting the timing for first antenatal visit

Rwandan women in 2014/15 were 2.04 times more likely to have their first antenatal visit in the first trimester of pregnancy compared to 2010/11. However the study found marked variation across geographic districts. In comparison with Nyarugenge, we found that women in

Table 3
Multivariate results of maternal health services utilization in Rwanda (2010–2014/15).

Variables	Timing of 1st ANC	4 + ANC Visits	Assisted delivery	All three
	OR(R. std. err)	OR(R. std. err)	OR(R. std. err)	OR(R. std. err)
Year *(ref: 2010/11)*				
2014/15	2.044(0.082)***	1.293(0.040)***	1.998(0.057)***	1.757(0.064)***
District *(ref: Nyarugenge)*				
Gasabo	1.318(0.211)	1.304(0.178)	1.207(0.161)	1.399(0.206)*
Kicukiro	1.278(0.207)	1.388(0.189)*	1.074(0.141)	1.353(0.201)*
Nyanza	3.965(0.722)***	2.723(0.393)***	1.104(0.156)	2.869(0.445)***
Gisagara	1.949(0.346)***	1.838(0.271)***	1.232(0.172)	2.114(0.338)***
Nyaruguru	0.936(0.172)	1.314(0.202)	1.015(0.143)	0.977(0.177)
Huye	2.668(0.475)***	2.154(0.311)***	1.421(0.202)*	2.592(0.399)***
Nyamagabe	3.126(0.569)***	1.925(0.288)***	0.910(0.129)	2.058(0.337)***
Ruhango	2.773(0.502)***	2.310(0.336)***	1.491(0.214)**	2.455(0.385)***
Muhanga	4.119(0.747)***	1.938(0.281)***	1.361(0.193)*	2.511(0.386)***
Kamonyi	1.346(0.241)	1.122(0.173)	1.318(0.189)	1.177(0.200)
Karongi	1.108(0.203)	1.123(0.177)	0.898(0.127)	1.068(0.190)
Rutsiro	1.433(0.256)*	1.292(0.197)	1.330(0.188)*	1.394(0.235)*
Rubavu	1.105(0.197)	0.862(0.138)	1.258(0.176)	1.067(0.186)
Nyabihu	1.309(0.235)	1.338(0.204)	1.066(0.149)	1.288(0.222)
Ngororero	1.498(0.269)*	1.575(0.236)**	0.835(0.118)	1.194(0.206)
Rusizi	3.92(0.695)5***	2.425(0.344)***	2.118(0.313)***	3.088(0.465)***
Nyamasheke	4.948(0.895)***	3.039(0.432)***	2.129(0.314)***	3.920(0.586)***
Rulindo	1.640(0.299)**	1.278(0.198)	0.986(0.141)	1.289(0.222)
Gakenke	3.143(0.576)***	2.212(0.327)***	1.002(0.144)	2.358(0.378)***
Musanze	1.676(0.300)**	1.506(0.226)**	1.114(0.157)	1.584(0.260)**
Burera	3.277(0.595)***	1.903(0.282)***	1.074(0.153)	2.240(0.356)***
Gicumbi	1.818(0.325)***	1.678(0.249)***	1.357(0.192)*	1.740(0.284)***
Rwamagana	2.281(0.399)***	1.419(0.210)*	1.561(0.223)**	1.797(0.283)***
Nyagatare	2.377(0.414)***	1.497(0.220)**	1.022(0.141)	1.823(0.287)***
Gatsibo	2.111(0.368)***	1.465(0.217)**	1.047(0.145)	1.677(0.268)**
Kayonza	1.871(0.333)***	1.187(0.182)	1.151(0.163)	1.172(0.200)
Kirehe	1.327(0.237)	1.062(0.165)	0.833(0.115)	1.359(0.226)
Ngoma	1.499(0.263)*	1.125(0.171)	1.100(0.152)	1.332(0.220)
Bugesera	1.809(0.316)***	1.116(0.171)	1.356(0.191)*	1.467(0.240)*
Place of resident *(ref: Urban)*				
Rural	0.951(0.071)	0.958(0.055)	0.952(0.054)	0.946(0.060)
Distance to health facility *(ref: Small problem)*				
Big problem	0.903(0.044)*	0.948(0.036)	0.910(0.029)**	0.900(0.041)*
Wealth Quintile *(ref: Richest)*				
Richer	0.779(0.060)**	0.902(0.052)	0.821(0.045)***	0.863(0.057)*
Middle	0.814(0.065)*	0.885(0.053)*	0.756(0.042)***	0.831(0.057)**
Poorer	0.755(0.061)***	0.883(0.054)*	0.694(0.039)***	0.805(0.057)**
Poorest	0.754(0.062)***	0.854(0.053)*	0.614(0.035)***	0.788(0.056)***
Mother's education *(ref: Secondary+)*				
Primary	0.682(0.046)***	0.845(0.041)***	0.809(0.043)***	0.801(0.043)***
No Education	0.631(0.053)***	0.823(0.052)**	0.699(0.043)***	0.707(0.053)***
Mother's employment *(ref: Full-time)*				
Temporal	0.918(0.043)	0.957(0.034)	1.051(0.034)	0.975(0.040)
Unemployed	0.887(0.068)	0.985(0.058)	1.109(0.063)	0.920(0.064)
Money for healthcare *(ref: Small problem)*				
Big problem	0.931(0.041)	0.950(0.032)	0.893(0.027)***	0.927(0.036)
Age	1.006(0.005)	1.013(0.0036)***	0.991(0.0031)**	1.009(0.004)*
Marital status *(ref: Married)*				
Not currently married	0.651(0.034)***	0.699(0.029)***	0.785(0.029)***	0.631(0.032)***
Parity *(ref: One child)*				
2–3 children	0.701(0.039)***	0.741(0.030)***	0.588(0.025)***	0.703(0.033)***
4–5 children	0.499(0.037)***	0.601(0.034)***	0.473(0.025)***	0.547(0.036)***
≤6 children	0.381(0.037)***	0.529(0.039)***	0.410(0.028)***	0.413(0.036)***
Religion *(ref: Christian)*				
Muslim	1.022(0.146)	0.850(0.096)	1.108(0.12)	0.890(0.112)
Other	0.953(0.166)	0.919(0.133)	0.743(0.085)**	0.807(0.155)
Constant	1.403(0.159)**	0.383(0.052)***	49.154(11.201)***	0.277(0.044)***
Observations	12,273	12,273	12,273	12,273

Note: OR = Odds Ratios; R. std. err. = Robust Standard Errors; ***p ≤ 0.001, **p ≤ 0.01, *p ≤ 0.05.

twenty-one of the twenty-nine districts were more likely to have an early antenatal visit with odds ranging from 1.43 in Rutsiro to 4.95 in Nyamasheke. Related to physical barriers, women who reported distance to health facilities as a big problem were 10% less likely to have an early antenatal visit compared with those who considered distance as a small problem. Similarly, women in poorest, poorer, middle and richer household wealth categories compared to their counterparts in the richest category (OR = 0.754 p ≤ 0.001; OR = 0.755, p ≤ 0.001; OR = 0.814, p ≤ 0.05; and OR = 0.779, p ≤ 0.01, respectively), as well as those with primary and no education compared to their colleagues with secondary education or higher (OR = 0.682, p ≤ 0.001; and OR = 0.631, p ≤ 0.001, respectively) were less likely to have early antenatal visit. In addition, women who were not married were less likely to attend an antenatal visit in their first trimester compared to

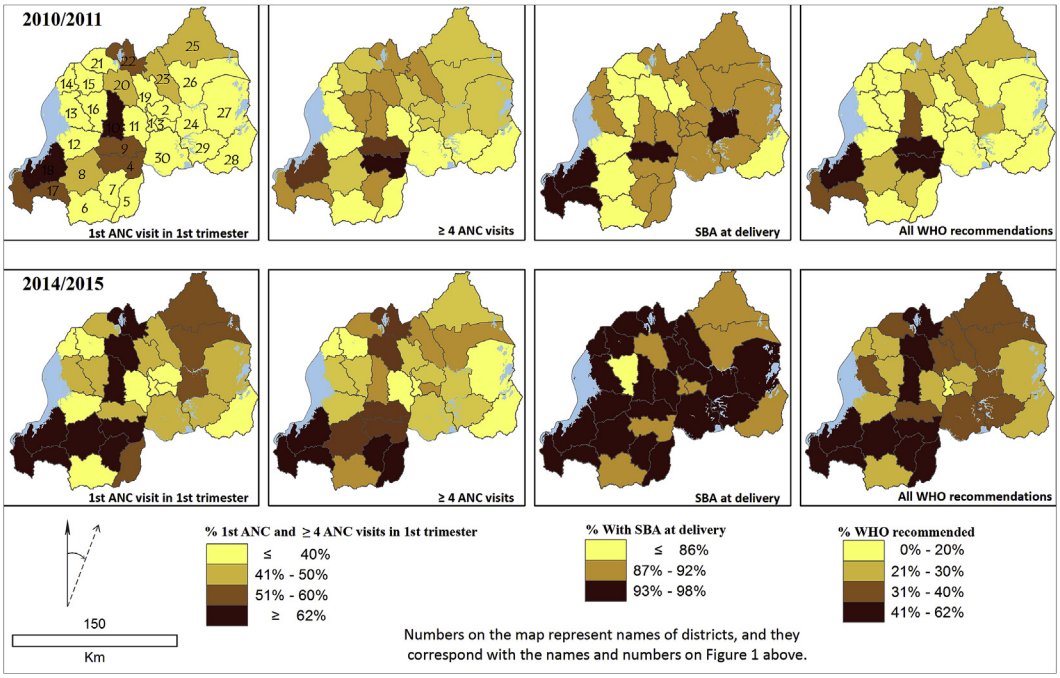

Fig. 2. Spatio-temporal variations in MHS utilization in Rwanda (2010/11 & 2014/15). Cross-reference numbers on the map with numbers on Fig. 1 above to identify names of districts.

married women (OR = 0.651, p ≤ 0.001). Parity was inversely associated with early antenatal visits, whereby women with two or three, four or five, and six or more children (OR = 0.701 p ≤ 0.001; OR = 0.499, p ≤ 0.001; and OR = 0.381, p ≤ 0.001, respectively) were less likely to have early first antenatal visit compared with those with one child.

3.3.2. Utilizing the recommended 4 + antenatal visits

Rwandan women in 2014/15 were 29% more likely to have 4 + antenatal visits than in 2010/11, with disparities across most districts when compared with Nyarugenge. In respect of barriers to MHS utilization, women in the poorest, poorer and middle relative to those in the richest wealth quintile (OR = 0.854, p ≤ 0.05; OR = 0.883, p ≤ 0.05; and OR = 0.885, p ≤ 0.05, respectively), and those with no formal or primary education compared to those with secondary education or higher (OR = 0.823, p ≤ 0.01; and OR = 0.845, p ≤ 0.001, respectively) were less likely to have 4 + antenatal visits. Whereas older women were more likely to have 4 + antenatal visits, women who were not married compared to their married counterparts, and women with two to three, four to five, and six or more children compared to those with one child were less likely to utilize 4 + antenatal visits (OR = 1.013, p ≤ 0.001; OR = 0.699, p ≤ 0.001; OR = 0.741, p ≤ 0.001; OR = 0.601, p ≤ 0.001; and OR = 0.529, p ≤ 0.001, respectively).

3.3.3. Accessing critical assisted delivery services

Accessing professional healthcare during delivery improved markedly over time. We found that women had higher odds of being assisted at delivery in 2014/15 compared to 2010/11 (OR = 1.998, p ≤ 0.001), but with vast disparities across districts. Relative to Nyarugenge, women in nine districts had higher odds of being assisted at delivery (ranging from 1.33 in Rutsiro to 2.13 in Nyamasheke). In addition, women with physical (distance to health facility) and financial (money for health services) barriers were less likely to have assisted delivery (OR = 0.910, p ≤ 0.01; and OR = 0.893, p ≤ 0.001, respectively). Meanwhile, both predisposing and enabling factors in our study were found to be important factors influencing the utilization of assisted delivery. Older women, and those who were not married compared to married women were less likely to utilize assisted delivery (OR = 0.991, p ≤ 0.01; and OR = 0.785, p ≤ 0.001, respectively). Also, women with two to three, four to five, and six or more children relative to those with one, and those of traditional and other religious affiliation compared to Christians were less likely to have assisted delivery (OR = 0.588, p ≤ 0.001; OR = 0.473, p ≤ 0.001; OR = 0.410, p ≤ 0.001; and OR = 0.743, p ≤ 0.01, respectively). Moreover, women in poorest, poorer, middle and richer households compared to those in richest households (OR = 0.614, p ≤ 0.001; OR = 0.694, p ≤ 0.001; OR = 0.756, p ≤ 0.001; and OR = 0.821, p ≤ 0.001, respectively), and those with no and primary education compared with their counterparts with secondary education or higher (OR = 0.699, p ≤ 0.001; and OR = 0.809, p ≤ 0.001, respectively) were less likely to be assisted at delivery.

3.3.4. Utilizing all three recommended MHS

Rwandan women were 76% more likely to utilize all three recommended MHS in 2014/15 compared to 2010/11. With apparent geographic variations, women in most of the geo-political districts were more likely to access all three MHS relative to Nyarugenge. In contrast with women who reported no or small physical barrier to health access, those who reported distance as a big problem were less likely to access all three MHS (OR = 0.900, p ≤ 0.05). Similarly, women from households in poorest, poorer, middle and richer wealth quintiles compared to those in the richest (OR = 0.788, p ≤ 0.001; OR = 0.805, p ≤ 0.01; OR = 0.831, p ≤ 0.01; and OR = 0.863, p ≤ 0.05, respectively), and those with no or primary education compared to women with secondary or higher educational attainment (OR = 0.707, p ≤ 0.001; and OR = 0.801, p ≤ 0.001, respectively) were less likely to utilize all three MHS. Moreover, while unmarried women, and those with higher parity were less likely to utilize all three MHS, older women were rather more likely to have all three MHS.

3.3.5. A closer look at spatial disparities in maternal health service utilization

Results from post-estimation margins are presented in Figs. 2 and 3, and in our supplementary table. Despite our finding that Rwandan women had 38% (average from Supplementary Table) chance of

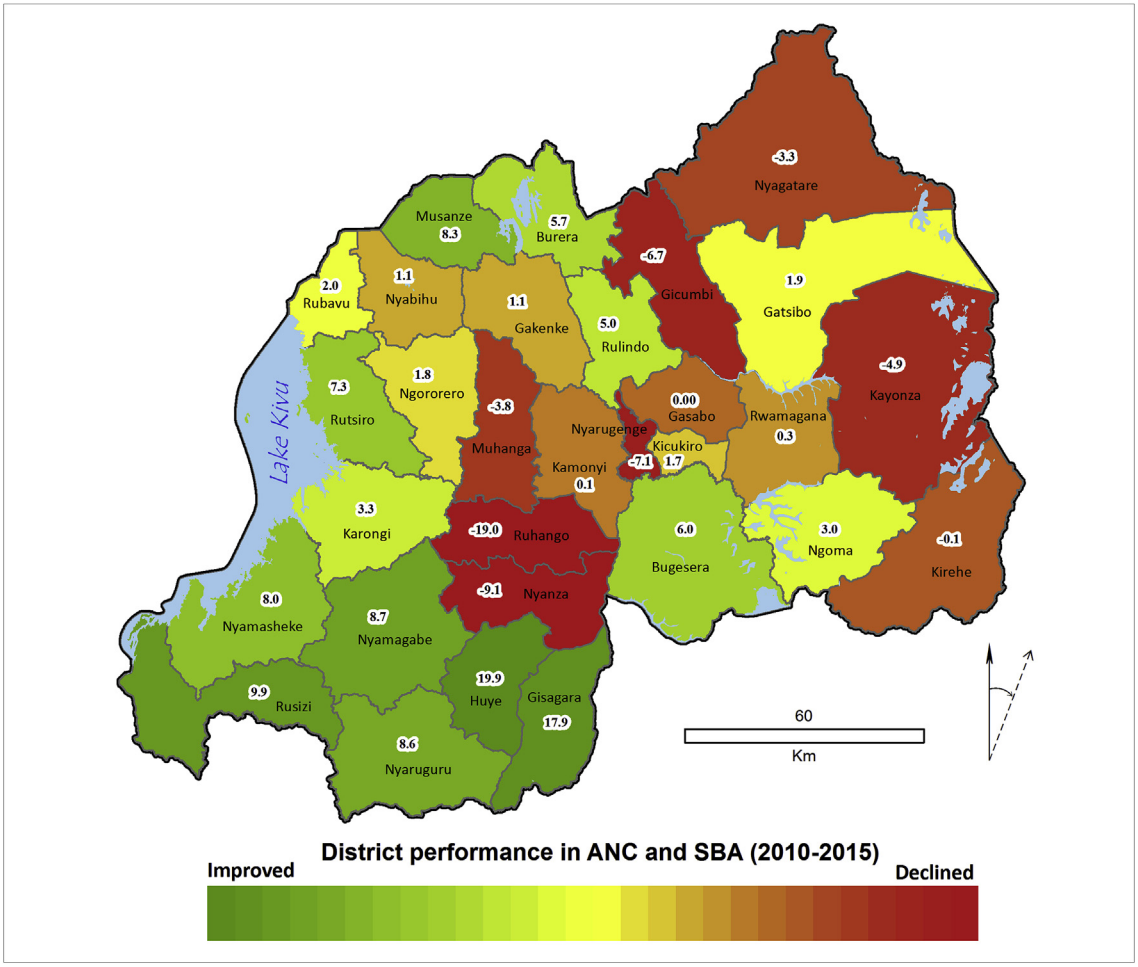

Fig. 3. Spatio-temporal variations of changes in MHS utilization from 2010/11 to 2014/15. The percentages represent predicted probabilities generated from our analysis. The red colors represent areas where there were declines between the two time periods and the greens represents areas of improvements. (For interpretation of the references to color in this figure legend, the reader is referred to the supplementary file.)

utilizing antenatal services in the first trimester of pregnancy in 2010/11, we found marked variation across districts. Women in eight districts (Gisagara, Karongi, Kirehe, Kamonyi, Nyaruguru, Nyarugenge, Rutsiro and Rubavu) had 30% or lower chance of utilizing antenatal services in their first trimester of pregnancy. In contrast, women in Burera, Muhanga, Nyamasheke, Nyanza, Ruhango and Rusizi had more than 50% chance of accessing antenatal services in the first trimester of pregnancy. The lowest chance for accessing ANC in first trimester of pregnancy was 19% in Nyaruguru, while the highest was 62% in Muhanga. In 2014/15, Rwandan women had a higher chance (57%) of accessing antenatal services in the first trimester of their pregnancy relative to 2010/11, with remarkable improvement in all districts, except in Ruhango, which declined from 56% in 2010/11 to 55% in 2014/15. In addition, women in Nyarugenge had the lowest chance (40%) while those in Nyamasheke had the highest chance (76%) of having their first antenatal visit in the first trimester of pregnancy in 2014/15.

Furthermore, on average, women had 36% chance of accessing 4 + antenatal visits before delivery in 2010/11 (see Supplementary Table). While women in Nyanza District had the highest chance (61%), their colleagues in Rubavu had the lowest chance (18%) of meeting 4 + antenatal visits before delivery. Three districts had above 50% chance of meeting 4 + antenatal visits before delivery. There was a slight increase of 9% in the average chance of Rwandan women having 4 + antenatal visits in 2014/15, but with a decline in Nyanza, Ruhango, Muhanga, Nyabihu, Ngororero, Gicumbi and Kayonza (see Fig. 2). Despite reporting a much higher chance of accessing assisted delivery (76% on average in 2010/11 and 94% in 2014/15), there were marked spatial disparities. Unlike antenatal service, all the districts recorded higher chance of a woman being assisted at delivery between 2010/11 and 2041/15, with the highest change (31%) reported in Nyamagabe, and the lowest (5%) in Rusizi.

Overall, the chance of a woman accessing all three recommended MHS was higher in 2014/15 (35%) than in 2010/11 (21%), but with a lower average when compared with the three individual MHS utilization. Spatially, women in Nyaruguru had the lowest chance in 2010/11 while those in Nyarugenge had the lowest in 2014/15. The highest improvement (32%) was reported in Huye while the lowest – a decline from 42% in 2010/11 to 35% in 2014/15 – was reported in Ruhango. Additionally, improvement in access to all three WHO-recommended MHS between 2010/11 and 2014/15 relative to the national average of 13% was spatially differentiated. In eight of the thirty districts, the average change was below the national average. Ruhango had the lowest relative change of 19.0 percentage points below the national average while Huye had the highest relative change of 20 percentage points above the national average over the two time points (see Fig. 3).

4. Discussion

We examined disparities in MHS utilization across geographical districts in Rwanda over time. Overall, our results show a remarkable improvement of 76% in the likelihood of accessing the three WHO-recommended MHS in 2014/15 over 2010/11. The implementation of

multiple health policies and strategies since 2005, such as training and deployment of health personnel, improvement of health infrastructure and implementation of community-based health insurance at a national scale, alongside economic development strategies within Rwanda's Vision 2020 framework likely played a crucial role in improving utilization of MHS. These strategies not only address structural barriers but also influence individuals' socio-cultural and economic contexts known to impede maternal health seeking behaviors (Bucagu et al., 2012; Saksena et al., 2011; Logie et al., 2008).

Despite achieving the MDGs target of reducing MMR by three-quarters (World Health Organization et al., 2015; Abbott et al., 2017), there are marked disparities in MHS utilization across districts over time (see Figs. 2 and 3). For instance, relative to other districts, Ruhango had a lower likelihood of accessing the recommended MHS utilization in 2014/15 than in 2010/11. Further, the utilization of four or more antenatal services declined in six districts between 2010/11 and 2014/15. Meanwhile, access to first antenatal services improved for the same time period. These dynamics suggest a situation whereby women in some districts in Rwanda seem to miss critical services in the course of their pregnancy, with potential risk to safe delivery, and ultimately maternal and child health. These disparities could partly be related to the delivery of antenatal services in the country. For instance, although community health workers in villages are deployed to support health delivery, their mandate in respect of maternal health relates to identifying, registering and sensitizing pregnant women on the need for MHS utilization, and then referring them for antenatal services in health posts at cell level or in health centers and district hospitals (Republic of Rwanda, 2014). Thus, for women to utilize MHS, health professionals should be available at the referral points to deliver the services. In districts where deployment of health professionals results in a stagnation or decline in the availability of health professionals, there is likely to be a decline in utilization of health services including MHS. This is particularly resulting from the fact that health workforce availability has been noted as the biggest driver of change in utilization of health services in Rwanda (Sayinzoga and Bijlmakers, 2016). This probably explains the disparities in MHS utilization in Gisagara, Huye, Nyansa and Ruhango districts which happen to be located in the same geographical zone. Access to doctors for ANC increased from 2.6% to 35.7% in Gisagara, 1.5%–8.5% in Huye, and marginally from 0.0% to 0.6% in Ruhango, but declined from 2.9% to 2.7% in Nyansa when the national average increased from 3.9% to 4.6% between 2010 and 2015 (NISR et al., 2012; NISR et al., 2015). It is therefore not surprising that Gisagara and Huye improved in MHS utilization while women in Nyansa and Ruhango reported below national average MHS utilization.

Consistent with evidence in Ghana, in districts such as Ngororero where referral points are far away, women have to travel long distances to access antenatal services. In addition to the problems of high travel cost and long travel time, the wait times women endure at these referral facilities is also an inhibiting factor (Republic of Rwanda, 2015). It is important to note that improvements in health infrastructure and personnel remain inadequate to support the expanded access created by the community-based health insurance programme (Logie et al., 2008). In this context, pregnant women prioritize how best to utilize their limited resources (including time), and this often influences their ability to go for first antenatal services to know the health status of their pregnancy, as well as assisted delivery. This is highlighted in the 2014 Rwandan Health Sector Report which suggests that improvement in four or more antenatal visits had been gradual compared to utilization of antenatal services in first trimester and assisted deliveries.

Consistent with the literature (Kuuire et al., 2017; Boateng et al., 2014), education and wealth provided the impetus for utilization of all the three WHO-recommended MHS in Rwanda. From an economic standpoint, women with higher educational attainment generally occupy higher paying jobs, and with higher household wealth, are able to afford MHS. Meanwhile, with reduction of financial burden associated with health access in Rwanda (Logie et al., 2008), the impact of education and wealth on MHS utilization could probably relate to disparities in access to information/education. Women with higher educational attainment and in higher wealth households are able to afford and access media tools such as TV, radio and newspapers, often employed to inform the Rwandan people about health policies and programs (NISR et al., 2015). Thus, apart from the fact that rich and educated women are more empowered to autonomously decide on utilization of MHS (Boateng et al., 2014), they are also more informed about availability and need for MHS. Conversely, women with lower educational attainment and from poor households were less likely to access and utilize MHS.

Furthermore, unmarried women were also likely to miss the three antenatal services because of constraining socio-cultural dynamics and limited access to resources for MHS. Pregnancy by nature has a social stimulus for attracting attention (staring), and could lead to women withdrawing into passive roles in their communities (Taylor and Langer, 1977). Pregnancy among unmarried women, that is unwanted/unplanned, is a social taboo in Rwanda and may attract stigmatization (Tuyisenge et al., 2018). For this reason, unmarried pregnant women hide away, and are therefore likely to forego MHS that are provided in health facilities and openly in communities. For young and poor unmarried women who rely on resources of relatives, accessing MHS comes second to nutritional and other material demands of pregnancy. Limited access to MHS among unmarried women is also reported in a study that examined the impact of the recent Ebola outbreak on MHS utilization in Liberia (Luginaah et al., 2016). Also, Levandowski et al. (2012) reported the role of stigma associated with unwanted pregnancy in low utilization of MHS in Malawi.

As suggested in previous studies, women who have acquired experience with pregnancy and delivery are less likely to utilize antenatal services as they consider pregnancy and delivery to be less risky (Fotso et al., 2009; Séraphin et al., 2014). A recent qualitative study in Rwanda found that women with birthing experiences prefer to deliver at home when there are no reported complications with their pregnancy (Tuyisenge et al., 2018). This notwithstanding, older women with higher autonomy who probably have acquired wealth over time were more likely to utilize four or more antenatal services. As found by Ganle (2015b) and Gyimah et al. (2006) in Ghana, religious affiliation plays a major role in discouraging women from accessing formalised health services. Our finding that women of traditional religious affiliation were less likely to utilize assisted delivery is probably explained by anecdotal evidence which suggests that women of traditional religious affiliation in Rwanda perceive MHS in health facilities as enforcing Christian and Muslim religious values. In this regard, they prefer to utilize the services of traditional birth attendants, especially at delivery, which allows for performance of cultural practices associated with birth.

Despite the relevance of our findings, there are potential limitations related to the study design. The cross-sectional nature of the data limits the findings to associations. We are unable to report how a change in any of the determinants would impact on MHS utilization in the SDGs period in Rwanda. Also, as the data used in our study are reported, there is a potential recall bias. Utilization of MHS is influenced by a web of factors, some of which are not part of the current study because of data limitation. For instance, even though we alluded to referral for MHS, and facility level quality of care (Gabrysch and Campbell, 2009; Manzi et al., 2018), these were not examined in our study. Nonetheless, the findings are generally consistent with the literature and provide important imperatives for maternal health policy in the SDGs period in Rwanda and similar contexts.

5. Conclusion

Rwanda has made great strides on MHS utilization in the last decade (Bucagu et al., 2012; Saksena et al., 2011; Abbott et al., 2017; Logie et al., 2008), but this has come with significant geographic variations.

Of particular concern is the fact that some districts saw a relative decline in the access and utilization of MHS at the end of the MDGs period. Although these declines do not immediately point to worsening maternal care provision, there is the need to reassess policies aimed at reducing physical access to MHS in the country. In providing policy suggestions, we turn to the WHO recommendation that MHS in the SDGs period should be decentralised and integrated (World Health Organization, 2017; Moller et al., 2017). Further decentralization of antenatal and assisted delivery services closer to potential mothers should open-up the full benefits of the community-based health insurance, and investments in health personnel and infrastructure made in the country in the MDGs period. Rather than relying on referral for MHS as with the current health structure (Republic of Rwanda, 2015), community health personnel should be trained on antenatal and delivery care to provide these services for mothers in their communities. The CHPS in Ghana has shown that providing MHS in communities not only improve access to critical MHS, it also empowers women and triggers community sustainability (Woods et al., 2018), which is envisaged with the decentralization strategy in the SDGs. Stigmatization of pregnancy among unmarried women and limited health information among women in lower socio-economic status call for urgent need to intensify community level health education and empowerment programs using community centered tools and techniques in the SDGs period. Rwanda should move towards a point where socio-cultural and religious beliefs which tend to be reinforced by lack of access to care due to geographical challenges, play a minimal role in constraining access to maternal health. Overall integration of maternal health and other health policies should reflect in national development policies, which may not only improve the health and wellbeing of women but also reduce inequalities in access to MHS.

Declaration of interest

The authors declare no conflicts of interests for this manuscript.

Acknowledgements

This research was made possible by a grant from the Canadian Department of Foreign Affairs, Trade and Development (Training, Support, and Access Model [TSAM] for Maternal Newborn Child Health in Rwanda). The funder had no role in study design, conduct and analysis, preparation of the manuscript, or decision to submit for publication.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2019.02.040.

References

Abbott, P., Sapsford, R., Binagwaho, A., 2017. Learning from success: how Rwanda achieved the Millennium development Goals for health. World Dev. 92, 103–116.
Alkema, L., Chou, D., Hogan, D., et al., 2016. Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Maternal Mortality Estimation Inter-Agency Group. Lancet 387 (10017), 462–474.
Andersen, R.M., 1995. Revisiting the behavioral model and access to medical care: does it matter? J. Health Soc. Behav. 36 (1), 1–10. https://doi.org/10.2307/2137284.
Atti, E., Gulis, G., 2017. Political determinants of progress in the MDGs in sub-saharan Africa. Glob. Public Health 12 (11), 1351–1368.
Atuoye, K.N., Dixon, J., Rishworth, A., Galaa, S.Z., Boamah, S.A., Luginaah, I., 2015. Can she make it? Transportation barriers to accessing maternal and child health care services in rural Ghana. BMC Health Serv. Res. 15 (1), 333. https://doi.org/10.1186/s12913-015-1005-y.
Boateng, G.O., Kuuire, V., Ung, M., Amoyaw, J.A., Armah, F.A., Luginaah, I., 2014. Women's empowerment in the context of Millennium development goal 3: a case study of married women in Ghana. Soc. Indicat. Res. 115 (1), 137–158. https://doi.org/10.1007/s11205-012-0212-8.
Bucagu, M., Kagubare, J.M., Basinga, P., Ngabo, F., Timmons, B.K., Lee, A.C., 2012. Impact of health systems strengthening on coverage of maternal health services in Rwanda, 2000–2010: a systematic review. Reprod. Health Matters 20 (39), 50–61.
Cha, S., 2017. The impact of the worldwide Millennium Development Goals campaign on maternal and under-five child mortality reduction:'Where did the worldwide campaign work most effectively? Glob. Health Action 10 (1), 1267961.
Chukwuma, A., Wosu, A.C., Mbachu, C., Weze, K., 2017. Quality of antenatal care predicts retention in skilled birth attendance: a multilevel analysis of 28 African countries. BMC Pregnancy Childbirth 17 (1), 152.
Dear, M.J., Wolch, J.R., 1987. Landscapes of Despair: from Deinstitutionalization to Homelessness. Princeton University Press.
Eichler, R., 2006. Can "pay for performance" increase utilization by the poor and improve the quality of health services. Working Group on Performance-Based Incentives. Washington, D.C., United States. (No. 1). .
Fotso, J.-C., Ezeh, A.C., Essendi, H., 2009. Maternal health in resource-poor urban settings: how does women's autonomy influence the utilization of obstetric care services? Reprod. Health 6, 9. https://doi.org/10.1186/1742-4755-6-9.
Gabrysch, S., Campbell, O.M.R., 2009. Still too far to walk: literature review of the determinants of delivery service use. BMC Pregnancy Childbirth 9 (1), 34. https://doi.org/10.1186/1471-2393-9-34.
Ganle, J.K., Dery, I., 2015a. 'What men don't know can hurt women's health': a qualitative study of the barriers to and opportunities for men's involvement in maternal healthcare in Ghana. Reprod. Health 12 (1), 93.
Ganle, J.K., 2015b. Why Muslim women in Northern Ghana do not use skilled maternal healthcare services at health facilities: a qualitative study. BMC Int. Health Hum. Right 15 (1), 10.
Giddens, A., 1984. The Constitution of Society: Outline of the Theory of Structuration. Univ of California Press.
Graham, W.J., Bell, J.S., Bullough, C.H.W., 2001. Can skilled attendance at delivery reduce maternal mortality in developing countries? In: Studies in Health Services, Organisation, and Policy. Prince Leopold Institute of Tropical Medicine, Antwerp, Belgium, pp. 97–129.
Gyimah, S.O., Takyi, B.K., Addai, I., 2006. Challenges to the reproductive-health needs of African women: on religion and maternal health utilization in Ghana. Soc. Sci. Med. 62 (12), 2930–2944.
Hurst, T.E., Semrau, K., Gawande, A., Hirschhorn, L.R., 2015. Demand-side interventions for maternal care: evidence of more use, not better outcomes. BMC Pregnancy Childbirth 15 (1), 297.
International Planned Parenthood Federation, UNFPA, WHO, UNAIDS, 2011. Rapid Assessment of Sexual and Reproductive Health and HIV Linkages: Malawi. Lilongwehttps://doi.org/10.1017/CBO9781107415324.004.
Jones, K., Moon, G., 1993. Medical geography: taking space seriously. Prog. Hum. Geogr. 17 (4), 515–524.
Kearns, R.A., 1991. The place of health in the health of place: the case of the Hokianga special medical area. Soc. Sci. Med. 33 (4), 519–530.
Kumbani, L., Bjune, G., Chirwa, E., Malata, A., JØ, Odland, 2013. Why some women fail to give birth at health facilities: a qualitative study of women's perceptions of perinatal care from rural Southern Malawi. Reprod. Health 10, 9. https://doi.org/10.1186/1742-4755-10-9.
Kuuire, V.Z., Kangmennaang, J., Atuoye, K.N., et al., 2017. Timing and utilisation of antenatal care service in Nigeria and Malawi. Glob. Public Health 12 (6), 711–727.
Lannes, L., Meessen, B., Soucat, A., Basinga, P., 2016. Can performance-based financing help reaching the poor with maternal and child health services? The experience of rural Rwanda. Int. J. Health Plan. Manag. 31 (3), 309–348.
Levandowski, B.A., Kalilani-Phiri, L., Kachale, F., Awah, P., Kangaude, G., Mhango, C., 2012. Investigating social consequences of unwanted pregnancy and unsafe abortion in Malawi: the role of stigma. Int. J. Gynecol. Obstet. 118 (2).
Lieberman, E.S., 2007. Ethnic politics, risk, and policy-making: a cross-national statistical analysis of government responses to HIV/AIDS. Comp. Pol Stud. 40 (12), 1407–1432.
Lincetto, O., Mothebesoane-Anoh, S., Gomez, P., et al., 2006a. Antenatal care. In: Lawn, J., Kerber, K. (Eds.), Oppor Africa's Newborns Pract Data, Policy Program Support Newborn Care Africa, pp. 55–62.
Lincetto, O., Mothebesoane-Anoh, Gomez, P., Munjanja, S., 2006b. Antenatal care. In: Lawn, J., Kerber, K. (Eds.), Pportunities for Africa's Newborns: Practical Data, Policy and Programmatic Support for Newborn Care in Africa. Whorld Health Organisation, Geneva.
Logie, D.E., Rowson, M., Ndagije, F., 2008. Innovations in Rwanda's health system: looking to the future. Lancet 372 (9634), 256–261.
Luginaah, I.N., Kangmennaang, J., Fallah, M., Dahn, B., Kateh, F., Nyenswah, T., 2016. Timing and utilization of antenatal care services in Liberia: understanding the pre-Ebola epidemic context. Soc. Sci. Med. 160, 75–86. https://doi.org/10.1016/j.socscimed.2016.05.019.
Manzi, A., Nyirazinyoye, L., Ntaganira, J., et al., 2018. Beyond coverage: improving the quality of antenatal care delivery through integrated mentorship and quality improvement at health centers in rural Rwanda. BMC Health Serv. Res. 18 (1), 136.
McCarthy, N., Brubaker, J., De La Fuente, A., 2016. Vulnerability to Poverty in Rural Malawi. World Bank.
Meessen, B., Musango, L., Kashala, J.I., Lemlin, J., 2006. Reviewing institutions of rural health centres: the Performance Initiative in Butare, Rwanda. Trop. Med. Int. Health 11 (8), 1303–1317.
Moller, A.-B., Petzold, M., Chou, D., Say, L., 2017. Early antenatal care visit: a systematic analysis of regional and global levels and trends of coverage from 1990 to 2013. Lancet Glob Heal 5 (10), e977–e983.
National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], CF International, 2012. Rwanda Demographic and Health Survey 2010-11. https://doi.org/10.1017/S0266673100000246.
National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH)

[Rwanda], ICF International, 2015. Rwanda Demographic and Health Survey 2014-15. Rockville, Maryland, USA.
Nguyen, P.H., Kim, S.S., Nguyen, T.T., et al., 2016. Supply-and demand-side factors influencing utilization of infant and young child feeding counselling services in Viet Nam. PLoS One 11 (3), e0151358.
Nyonator, F.K., Awoonor-Williams, J.K., Phillips, J.F., Jones, T.C., Miller, R a, 2005. The Ghana community-based health planning and services initiative for scaling up service delivery innovation. Health Policy Plan. 20 (1), 25–34.
Priedeman Skiles, M., Curtis, S.L., Basinga, P., Angeles, G., 2012. An equity analysis of performance-based financing in Rwanda: are services reaching the poorest women? Health Policy Plan. 28 (8), 825–837.
Republic of Rwanda, 2014. Health Sector Annual Report: July 2013 – June 2014. Kigali.
Republic of Rwanda, 2015. Health Sector Annual Report: July 2014 – June 2015. Kigali. http://www.moh.gov.rw/fileadmin/templates/MOH-Reports/Health_20Sector_20Annual_20Report_202015-2016_25082016.pdf.
Republic of Rwanda, Health Sector Policy. Kigali.
Rwanda Ministry of Health, 2017. Minutes of the 2017-2018 Forward Looking Joint Health Sector Review Meeting. Kigali, Rwanda.
Rudasingwa, M., Soeters, R., Basenya, O., 2017. The effect of performance-based financing on maternal healthcare use in Burundi: a two-wave pooled cross-sectional analysis. Glob. Health Action 10 (1), 1327241.
Saksena, P., Antunes, A.F., Xu, K., Musango, L., Carrin, G., 2011. Mutual health insurance in Rwanda: evidence on access to care and financial risk protection. Health Policy 99 (3), 203–209.
Sayinzoga, F., Bijlmakers, L., 2016. Drivers of improved health sector performance in Rwanda: a qualitative view from within. BMC Health Serv. Res. 16 (1), 123.
Séraphin, M.N., Ngnie-Teta, I., Ayoya, M.A., et al., 2014. Determinants of institutional delivery among women of childbearing age in rural Haiti. Matern. Child Health J. https://doi.org/10.1007/s10995-014-1646-1.
Singh, D., Lample, M., Earnest, J., 2014. The involvement of men in maternal health care: cross-sectional, pilot case studies from Maligita and Kibibi, Uganda. Reprod. Health 11 (1), 68.
Soeters, R., Habineza, C., Peerenboom, P.B., 2006. Performance-based financing and changing the district health system: experience from Rwanda. Bull. World Health Organ. 84, 884–889.
Taylor, S.E., Langer, E.J., 1977. Pregnancy: a social stigma? Sex. Roles 3 (1), 27–35.
Tuyisenge, G., Hategeka, C., Kasine, Y., Luginaah, I., Cechetto, D., Rulisa, S., 2018. In: Mothers' Perceptions and Experiences of Using Maternal Health Care Services in Rwanda. Women Health just-accepted.
United Nations Development Programme, Government of Rwanda, 2007. Turning Vision 2020 into Reality. From Recovery to Sustainable Human Development. National Human Development Report. UNDP and Government of Rwanda.
World Health Organization, 2002. Antenatal Care Randomized Trial: Manual for the Implementation of the New Model. Geneva.
World Health Organization, UNICEF, UNFPA, World Bank Group and the United Nations Population Division, 2015. Trends in Maternal Mortality: 1990 to 2015. Geneva.
Woods, H., Haruna, U., Konkor, I., Luginaah, I., 2018. The influence of the community-based health planning and services (CHPS) program on community health sustainability in the upper west region of Ghana. Int. J. Health Plan. Manag. xx, 1–15.
World Bank Group, 2017. World development indicators. World developemnt indicators. https://www.google.ca/publicdata/explore?ds=d5bncppjof8f9_&ctype=l&strail=false&bcs=d&nselm=h&met_y=sp_pop_totl&scale_y=lin&ind_y=false&rdim=region&idim=country:RWA&ifdim=region&hl=en&dl=en&ind=false, Accessed date: 9 November 2017 Published.
World Health Organization, 2017. Progress in Partnership: 2017 Progress Report on the Every Woman Every Child Global Strategy for Women's, Children's and Adolescents' Health. World Health Organization, Geneva. http://apps.who.int/iris/bitstream/10665/258504/1/WHO-FWC-NMC-17.3-eng.pdf.