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Immediate and sustained effects of user fee exemption on healthcare utilization among children under five in Burkina Faso: A controlled interrupted time-series analysis

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A R T I C L E I N F O

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A B S T R A C T

Background: Little is known about the long-term effects of user fee exemption policies on health care use in developing countries. We examined the association between user fee exemption and health care use among children under five in Burkina Faso. We also examined how factors related to characteristics of health facilities and their environment moderate this association.
Method: We used a multilevel controlled interrupted time-series design to examine the strength of effect and long term effects of user fee exemption policy on the rate of health service utilization in children under five between January 2004 and December 2014.
Results: The initiation of the intervention more than doubled the utilization rate with an immediate 132.596% increase in intervention facilities (IRR: 2.326; 95% CI: 1.980 to 2.672). The effect of the intervention was 32.766% higher in facilities with higher workforce density (IRR: 1.328; 95% CI (1.209–1.446)) and during the rainy season (IRR:1.2001; 95% CI: 1.0953–1.3149), but not significant in facilities with higher dispersed populations (IRR: 1.075; 95% CI: (0.942–1.207)). Although the intervention effect was substantially significant immediately following its inception, the pace of growth, while positive over a first phase, decelerated to stabilize itself three years and 7 months later before starting to decrease slowly towards the end of the study period.
Conclusion: This study provides additional evidence to support user fee exemption policies complemented by improvements in health care quality. Future work should include an assessment of the impact of user fee exemption on infant morbidity and mortality and better discuss factors that could explain the slowdown in this upward trend of utilization rates three and a half years after the intervention onset.

1. Introduction

Population-based studies suggest that improved access to health care has the potential to produce a significant reduction in under-five morbidity in developing countries (Rutherford et al., 2010), but this improvement can only occur when children actively (Yates, 2009) and promptly use health facilities. A wide range of factors affect access to health care in low-middle income countries (LMICs), with user fee identified as one of the greatest obstacles (Ridde, 2015). In Burkina Faso, over half of the population lives on less than 1 US dollar per day with a national average of 54–56% of children under five reported to use health services when ill (INSD & Macro, 2012), compared to 32% in the most deprived areas of the country (Ridde, Haddad and Heinmuller, 2013). Inequalities in morbidity and use of services according to socioeconomic status and place of residence persist across the country (INSD & Macro, 2012).

In an effort by the World Health Organization and the African Union to achieve the provision of universal coverage of primary health care (Yates, 2009), many African countries are attempting to remove financial obstacles to health services access (Ridde, 2015).

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The government of Burkina Faso has experimented with user fee exemption for women and children under-five since September 2008 (Ridde et al., 2013a,b). This pilot intervention was delivered within the context of a population health intervention research study; whereby complete user fee exemption was implemented in two out of four districts in the Sahel region.

Studies across several low-income countries have shown that, globally, user fee exemption is typically associated with an immediate increase in the use of maternal and child health care services (Bassani et al., 2013; Lagarde and Palmer, 2011; Ridde and Morestin, 2011). Most studies have analyzed the effect of free care policies on maternal outcomes such as assisted deliveries and caesarian sections. In particular, McKinnon et al. (2014) showed that user fee exemption was consistent with an increase of 3.1 facility-based deliveries per 100 live births and an estimated reduction of 2.9 neonatal deaths per 1000 births (McKinnon et al., 2014). In Ghana, following user fee exemption policies from 2005 to 2008 and a policy exempting pregnant women from paying the national Health insurance registration and premium fees, facility deliveries increased significantly over time (Dzakpasu et al., 2012). In Addition, Fournier et al. (2014) showed that the implementation of a free caesarian section policy increased the rate of caesarian section deliveries from 1.7 to 5.7% for Malian women living in cities without any significant change in trends among women living in villages (Fournier et al., 2014). With regard to children under five more specifically, free care was associated with an immediate increase of service use among children under five in Mali, with user attendance multiplied by 1.5 during the rainy season (Heinmüller et al., 2013). The effect was maintained in all facilities up to three years after the intervention onset (Heinmüller et al., 2013). In the case of Burkina Faso, two studies that have analyzed the effect of user fee exemption policy reported an increase in the use of health services among children under five (Druetz et al., 2015; Ridde et al., 2013a,b).

Given that most evaluations were conducted early, within three years after the policy change (Hatt et al., 2014; Lagarde and Palmer, 2011), the important research question regarding the long-term effect of this intervention on access to health services and on health outcomes among children under five remains relatively unexplored (Bassani et al., 2013). Indeed, the lack of appropriate data and weaknesses of research designs have led most studies to be limited to the analysis of linear short-term effects (Ridde and Morestin, 2011; Yates, 2009) and few have accounted for long-term trends and confounding factors (Dzakpasu et al., 2013; Lagarde and Palmer, 2008) or effect modifiers, which mainly include factors related to characteristics of health facilities and their environment that may interact with and alter the effect of the intervention (Hatt et al., 2014; Victora et al., 2005). In the context of Africa and particularly in Burkina Faso, the need for strong evidence supporting the scaling up of pilot exemption policies through the formulation of public policies is urgent (Ridde, 2015), especially considering the Government of Burkina Faso has decided to implement a nationwide exemption policy starting April 2016.

This study examines the strength of effect and long term effects of user fee exemption policy on the rate of health service utilization by children under five years of age in rural health facilities in Burkina Faso. In addition, it explores whether contextual and health service factors moderate the association between user fee exemption and health service utilization for children under five.

2. Methods

2.1. Study settings

The study was conducted in the northern region of Burkina Faso, where two out of four rural districts (Fig. 1) began to implement user fee exemption in 2008. The region has 1,160,000 inhabitants, mostly consisting of herders and farmers, with similar demographics among the districts (Ridde et al., 2013a,b). Starting in September 2008, regional health authorities from districts of Dori (313,497 inhabitants, 23 primary health care facilities (PHC)) and Sebba (191,810 inhabitants, 13 PHC) abolished user fees and implemented a user fee abolition policy for child health services. In contrast, districts of Gorom (237,000 inhabitants, 18 PHC) and Djibo (415,776 inhabitants, 32 PHC) maintained standard user fees where patients had to pay $0.20 for consultations, treatments (drug costs were determined according to prescriptions), and a daily fee of US$0.60 in case of hospitalization within the health facility.

2.2. Intervention (user fee exemption policy)

The intervention aimed to improve access to health care for children under five by removing any direct payment at point of service for consultations, medications and hospitalizations for children under five, indigents, and pregnant women (Ridde et al., 2013a,b). Concurrently, quality of service delivery was improved through training, endowments of medical equipment, and permanent staff support. The intervention was funded by the Humanitarian Aid Service of the European Commission and implemented by the NGO Help (Ridde et al., 2013a,b). Health facilities offered free care and were reimbursed monthly by the Ministry of Health depending on their activity level. The intervention was integrated within the health system. Therefore, in our study, we assessed the effect of the overall policy and programmatic changes that combine user fee exemption with quality of care improvement, rather than the single effect of user fee exemption.

2.3. Study design

This evaluation builds upon an initial study performed in one intervention district (Dori) and in a neighboring non-intervention district (Djibo) with an observation window covering a 56-month pre-intervention period and a 12-month intervention period (Ridde et al., 2013a,b). Our study extends this prior work to include two additional districts, one intervention and one non-intervention district, along with 6 additional years of observation. This permitted the assessment of both immediate and sustained effects up to 6-year (75 months) post-implementation in all intervention facilities ($n = 34$) compared to the facilities without intervention ($n = 51$), as well as potential effect modification from health services and contextual factors. We used a multilevel controlled interrupted time-series design to examine the monthly level and overall trend in the rate of health service utilization in children under five between January 2004 and December 2014. All facilities from the two neighboring districts not targeted by the intervention were included as the comparison group.

2.4. Data sources

Our study relied on two data sources:

2.4.1. National health information system (NHIS) data

We collected retrospective (from January 2004 to August 2008) and prospective data (from September 2008 to December 2014) from NHIS to form a reliable continuous time-series. This included for facilities in the study both data on monthly counts of curative consultations for children under five and estimates of the relevant population (children under five) in the respective catchment area. Data quality and completeness were assessed through each district office the first week of each month and audited by the Direction of Health Statistics at the Ministry of Health. 17 facilities that were

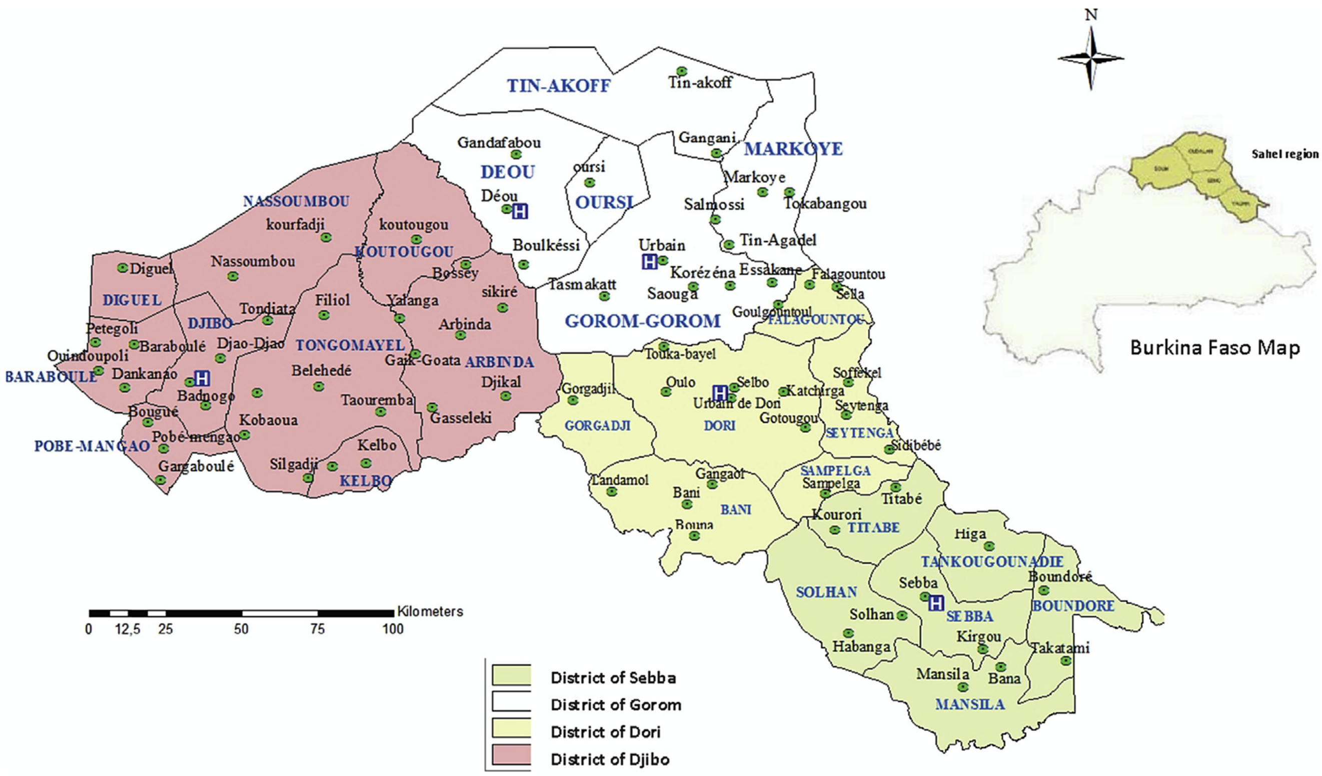

Fig. 1. Location of the 4 districts with their primary health care facilities.

opened within 12 months of the intervention inception (either before or after) were removed from the analysis. The reliability and validity of NHIS data in the context of Burkina Faso have already been demonstrated in prior studies (Druetz et al., 2015; Johri et al., 2014; Ridde et al., 2013a,b).

2.4.2. Facility-based survey

We carried out a retrospective facility-based survey to supplement NHIS data with data on health service and contextual factors. Within the framework of this facility-based survey, all 85 PHC facilities of comparison and intervention districts were surveyed for: 1) Population density of the catchment areas of health facilities; 2) Staff type and quantity; and 3) Presence of other health interventions. The survey was administered to health centers staff between January 2015 to May 2015 by 16 interviewers, who received two days of training. One of the authors was responsible for coordinating the collection and validation of all data.

2.5. Study variables

2.5.1. Outcome variable

We defined the outcome as the monthly rate of health facility utilization per 1000 children under-five within each facility catchment area. We expressed the outcome variable as an incidence density rate, defined as the number of consultations among children under five per month divided by the total number of children under five years in the catchment population.

2.5.2. Interrupted time series components

We included the three usual interrupted time series components related to the pre-intervention slope, the level of change, and the change in slope in the post-intervention period (Lagarde, 2012) and their interaction with the group variable (equal to 1 for intervention facilities and 0 for comparison facilities). Time was defined as a continuous variable from January 2004 to December 2014 and was included in the model to capture long-term trends in utilization rate over time. We used a dichotomous variable to describe pre- and post intervention (=1 for post-intervention and 0 for pre-intervention).

2.5.3. Effect modifiers and seasonal components

In line with our wish to explore intervention effect modification due to health service and contextual factors (Anand and Bärnighausen, 2004; Rutherford et al., 2010; Victora et al., 2005), we included 2 time-invariant effect modifier variables in the model. The first variable described accessibility to services defined as the proportion of the population that lived within more than 10 km away from each health center. This variable was equal to 1 for facilities with a more highly dispersed populations, where more than half of the target population lived further than 10 km from the facility and equal to 0 otherwise. The second variable measured health workforce density defined as the number of health workers (nurses, midwives and other health professionals) per 1000 children under five (WHO, 2015). To better investigate the effect of health worker density availability, we categorize this variable to form facilities with higher health worker density with more than 0.45 health workers per 1000 people as equal to 1 and 0 otherwise. This threshold represents the average number of health workers per 1000 people in Burkina over the period before intervention onset, 2004–2008 (WHO, 2015). Because our two presumed effects modifiers do not vary monthly, they have been dichotomized to better explain their effects. Finally, to account for confounding by season, we treated each month as a separate category with a fixed dummy parameter to capture the magnitudes of seasonality and to control for seasonal patterns (Barnett and Dobson, 2010).

3. Statistical analysis

We plotted all the variables over time to allow for the visual identification of trend and seasonality as well as outliers and the functional forms of variables. We used two-level mixed-effects negative binomial modeling to account not only for overdispersion but also for the hierarchical structure of data, i.e. the repeated measure of monthly utilization rate (level 1) within the single facility (level 2).

We tested linear, linear spline, logarithmic and quadratic functional form for the post-intervention trend and use the Akaike information criterion (AIC) to determine the best-fitting multilevel model among our non-nested models (Steele, 2013).

The basic multilevel model was expressed as follows:

$$log(U_{it}) = log(P_{it}) + \varphi_i + \beta_1 Time + \beta_2 Group_{it} + \beta_3 Intervention + \beta_4 Group^* time + \beta_5 Intervention^* Time + \beta_6 Intervention^* Group + \beta_7 Intervention^* Time^* Group + \beta_8 Intervention^* Group^* HWds_i + \beta_9 Intervention^* Group^* Popds_{i_t} + \beta_{10}\delta_{m(t)} + \beta_{11}\delta_{m(t)}{}^* Intervention + \beta_{12}\delta_{m(t)}{}^* Intervention^* Group + \beta_{11}{}^* Time^x + \beta_{12} Group^* Time^x + \nu_{0i} + \nu_{1i} + e_{it}$$

Where U_{it} denotes the number of visits from children under five expected in the health facility *i* in month *t*. This value is assumed to follow a negative binomial distribution for each *t* month. Since the number of consultations in a given facility depends on the size of the target population, we included the natural logarithm of population $\log(P_{it})$ as an offset. $Time^x$ defines the functional form of the post intervention trend. $Time^x$ equals to 0 for simple linear form. $Time^x$ for linear spline form is defined with x denoting a knot at x-month post intervention. $Time^x$ equals $Time^2$ for quadratic form and $Time^x$ equals to ln*(T)* for logarithmic form. For linear spline models, we performed sensibility analysis by varying the knots over 12 time points in the year 2012.

There are two random facility effects to allow facilities to vary in their intercept (ν_{0i}), and intervention effect (ν_{1i}). From this model, some key informational elements were essential to our analysis and were reported in the results table: (1) initial rate of health service utilization per 1000 children under five in comparison with PHC facilities, $Exp(\varphi_i)$; 2) baseline rate of health service utilization per 1000 children under five in intervention facilities, $Exp(\varphi_i + \beta_2)$; (3) trend in the rate of health service utilization in intervention facilities, $Exp(\beta_1 + \beta_4)$; 4) trend in comparison facilities prior to the intervention, $Exp(\beta_1)$; (5) immediate intervention effect, $Exp(\beta_6)$, which captures the difference between the intervention and comparison group in utilization rates during the month immediately following the implementation of the intervention; (6) change in pre and post-intervention trends after user fee exemption, $Exp(\beta_7)$; 7) effect modification due to health-workforce density, β_8 ; and 8) dispersion of the population, β_9. Since our outcome variable follows negative binomial distribution, we use non-linear combination of regression parameters to derive the effect of the intervention that is to say the absolute and relative change 1-year, 3-year, 5-year and 6-year post intervention (with 95% confidence intervals). This enables to better highlight the sustainability of the intervention effects by comparing overall changes in outcome attributable to the intervention with counterfactual estimates of what would have happened without the intervention. This is allowed by *nlcom* command of Stata which computes standard errors and confidence intervals for nonlinear combinations of estimate parameters using the delta method (Feiveson, 1999).

To assess variability of the intervention effect over health centers, we performed a likelihood ratio test to compare the model without random intervention effect to the model with random intervention effect. We report all fixed effects as incidence rate ratios (IRR) with 95% confidence intervals. To highlight the impact of the intervention on the amplitude of seasonal variations we analyzed the IRR associated with the interaction between seasonal parameters for the months of June to October and the intervention group during the postintervention period. All statistical analyses were performed with Stata 13 using the command *menbreg* for mixed effect negative binomial models. Incidence rate ratios and their confidence intervals were obtained using the command *nlcom*. We report below results from best-fitting model.

4. Ethics approval

The research was accepted by the Ministry of Health and ethics committees in Burkina Faso and Canada (CRCHUM).

5. Results

5.1. Descriptive statistics and trends

Table 1 presents descriptive statistics related to the crude rate of health service utilization among children under five before and after the implementation of the intervention in comparison and intervention facilities. We included 40 comparison health centers and 28 intervention health centers.

As shown in Fig. 2, which presents the monthly average rates per group over time, there was an almost linear and relatively stable trend in the use of health services by children under five in both districts before the implementation of the intervention with seasonal variation that showed higher utilization rates between June and October of each year. After the implementation of the intervention, there was a change in the level of service use in intervention facilities, while the level and trend of service use remained unchanged in the comparison facilities. In addition, seasonal variation was amplified during the post-intervention period in the intervention group and the trend appears to exhibit linear growth followed by a certain peak around 3 and a half years after intervention onset. The pace of growth then begins declining slowly towards the end of the study period. Aside from the intervention effect we didn't observe any other sudden breaks of level nor changes in slopes in the trend of health service use in both groups post-intervention.

When comparing the values of the AIC statistics (Table 2), results from the multilevel regression models show that the quadratic model with squared post-intervention trend term fits better than simple linear, linear spline or logarithmic model (see details on regression model at Appendix 3.

Our quadratic model results showed that at the beginning of the observation period in comparison facilities, the average initial rate of health service utilization was 12.815 per 1000 children under

Table 1
Descriptive statistics of the comparison and intervention group.

	Number of facilities	Number of observations	Facilities with higher workforce density	Facilities with higher dispersed populations	Crude mean of monthly rate of use per 1000 children under 5	
					Pre-intervention	Post-intervention
Comparison Group	40	3527	64.79%	43.2%	29.33	57.89
Intervention Group	28	5155	74.23%	35.61%	47.39	249.03

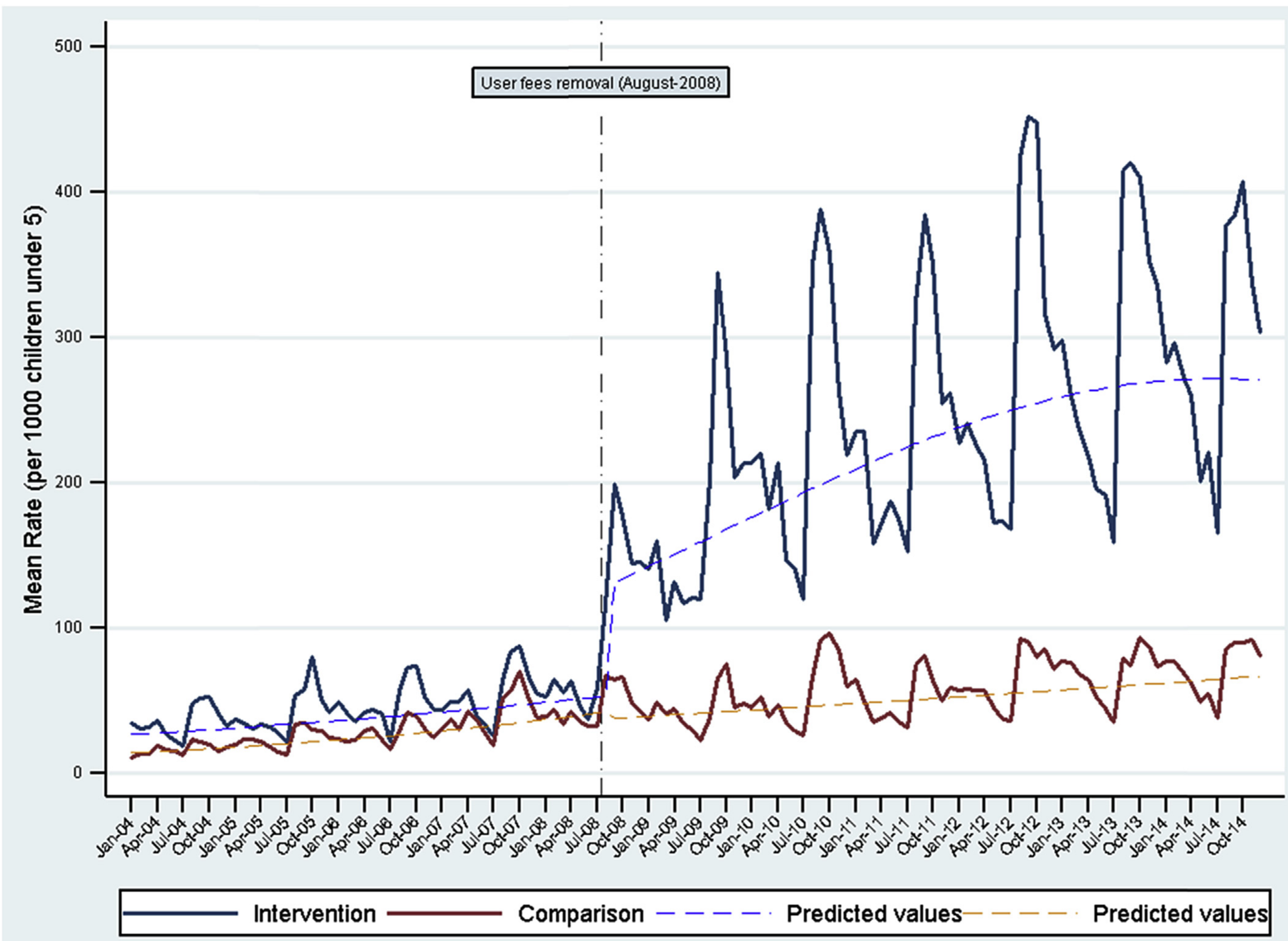

Fig. 2. Evolution of the mean rate of health service utilization among children under five in comparison and intervention districts, 2004–2014. Note: Model with Quadratic postintervention trends.

Table 2
Results comparing fitting of model using different kind of postintervention trend.

	Quadratic Model	Linear Model	Logarithm model	Linear spline with Knot at 3 year 7 month	Linear spline with Knot a mid-2012
Intervention effect, IRRs (se)	2.326*** (0.177)	2.619*** (0.191)	1.848*** (0.157)	2.465** *(0.183)	2.486 (0.184)
AIC	92,968.924	93,102.876	92,980.218	93,003.667	93,000.31
BIC	93,308.237	93,428.051	93,319.531	93,342.979	93,339.62

Table 3
Parameter estimates, 95% confidence intervals and p-values from the most parsimonious segmented regression models.

	Estimates (95% CI)	exp (Estimates) (95% CI)	p_value
Initial rate			
Intervention group	3.189 (2.969–3.407)	24.237 (18.922–29.552)	P < 0.001
Comparison group	2.551 (2.376–2.725)	12.815 (10.582–15.049)	P < 0.001
Pre-intervention trend			P < 0.001
Intervention group	0.013 (0.012–0.014)	1.013 (1.012–1.014)	P < 0.001
Comparison group	0.020 (0.019–0.021)	1.020 (1.019–1.021)	P < 0.001
Immediate intervention effect	0.844 (0.695–0.993)	2.326 (1.98–2.672)	P < 0.001
Intervention effects modification			P < 0.001
Distance effect modification	0.072 (−0.051–0.195)	1.075 (0.942–1.207)	P < 0.258
Health worker density effect modification	0.283 (0.194–0.373)	1.328 (1.209–1.446)	P < 0.001

five (95% CI: 10.582–15.049). This was 1.891 lower than the rate in facilities in intervention districts, which at baseline was 24.237 per 1000 children under five (95% CI: 18.922–29.552). Utilization rates increased during the pre-intervention period in intervention facilities by 1.3% (IRR = 1.013, 95% CI: 1.012–1.014) and by 2.0% (IRR:1.020 95% CI: 1.019–1.021) in comparison facilities. This differential trend remained nearly constant over the pre-intervention period.

5.2. Effect of the intervention

The initiation of the intervention more than doubled the utilization rate with an immediate 132.596% increase in intervention facilities (IRR: 2.326; 95% CI: 1.980 to 2.672), whereas the rate of health service utilization remained unchanged in the comparison group. In addition, the examination of the random part of our model (Appendix 2) shows that the estimated variance for the random effect of the intervention was significant (chi-square statistic = 659.930; p < 0.001), denoting heterogeneity in the effects of the intervention across intervention health facilities.

5.3. Contextual factors effect modification

The effect of the intervention was 32.766% higher in facilities with higher workforce density (IRR: 1.328; 95% CI (1.209–1.446)). Furthermore, the effect of the intervention increased the amplitude of seasonal variations coinciding with the rainy season. Therefore, the IRR of the interaction between intervention and month in the post-intervention period in intervention group showed a significant increase in the rate of utilization, ranging from 8.276% (IRR: 1.083; 95% CI:0.992–1.181) to 20.009% (IRR: 1.200; 95% CI: 1.095–1.315) during the rainy season, particularly between the months of June and October over the post-intervention period, compared to the same timeframe during the pre-intervention period. The amplitude was particularly higher during August, which corresponded to the peak of malaria transmission. Finally, the effect of the intervention was 7.5% higher in PHC facilities with a more highly dispersed populations (IRR: 1.075; 95% CI: (0.942–1.207)), but this finding was not statistically significant (see Table 3).

5.4. Sustainability of the intervention effects

The examination of the quadratic post-intervention trend in Fig. 2 and mainly the results of our quadratic model show that in addition to the substantial increase in the level of the use of health services, the utilization rate increased instantaneously by 1.8% (IR: 1.018; 95% CI: 1.014–1.023) in intervention facilities in the first month following the implementation of the intervention. Because of the negative curvature associated with the coefficient of quadratic term (-0.0001246; 95% CI: -0.000175 -.0000742), the trajectory initially rises with an increase of 1.8% in monthly post intervention rate but does not persist over time. Results reported in Table 4 showed that in the first three, five and six years following intervention onset, relative changes in health service among children under five were respectively 30.542% [95% CI: 23.773–37.31]; 35.258% [95% CI: 27.062–43.454]; 31.945% [95% CI: (22.536–41.353)] and 27.711 95% CI: 17.953–37.468]. These relative changes in utilization growth during the post-intervention period reflected absolute significant increase of 22.956, 45.050, 62.922, 42.154, respectively. The pace of growth seems to have reached a plateau around the third year after implementation, because the slope reverses direction from this point. This is precisely at 43.08 months, namely 3 years and 7 months after the intervention onset, when dividing the coefficient associated to the post intervention trend in the intervention group over the sum of quadratic terms in compliance with the formula from Singer et al. (Singer and Willett, 2003). This coincided with April 2012. Therefore, if the effect was significantly immediate and substantial, it is clear that in the post-intervention period, the slope, while positive, decelerated to stabilize in April 2012 before displaying a slightly downward trend.

6. Discussion

This is the first study to use a controlled interrupted time-series design to assess the long-term effects of user fee exemption policy on health service utilization for children under five. The results show a substantial and immediate increase in the rate of service utilization in intervention facilities during the month following the implementation of the intervention. Our findings also indicate that, although the intervention effect was substantially significant

Table 4
Absolute and relative effects of the user fees exemption policy on the use of health service among children under five (one to six years post-policy).

	Counterfactual	Predicted	Absolute Change (95% CI)	Relative Change (%) (95% CI)
1 Year Effect	111.481	134.437	22.956 (17.001–28.916)	30.542 (23.773–37.31)
2 year Effect	122.177	167.227	45.05 (32.502–57.597)	33.954 (26.509–41.401)
3 year Effect	133.900	195.784	61.884 (42.750–81.019)	35.258 (27.062–43.454)
4 year Effect	146.747	215.739	114.915 (90.710–139.118)	34.535 (25.657–43.412)
5 year Effect	160.827	223.749	62.922 (14.480–111.364)	31.945 (22.536–41.353)
6 year Effect	176.258	218.412	42.154 (−17.690–101.996)	27.711 (17.953–37.468)

immediately in the first month following its inception, the pace of growth, while positive over a first phase, decelerated to stabilize three years and 7 months later before starting to decrease slowly. We also found a greater increase in service utilization for facilities with higher workforce density and during the rainy season (June to October).

The observed immediate increase in health service utilization among children under five, following the abolition of user fees, is consistent with a previous study conducted in Burkina Faso (Ridde et al., 2013a,b) and also with studies in other African countries (Deininger and Mpuga, 2004; Lagarde et al., 2012; Masiye et al., 2010; Ponsar et al., 2011a,b). This immediate and ample rise in the rate of children health services use could be first explained by the efficacy of media campaigns and social mobilization initiated in communities to inform the population of free healthcare during the month before its implementation.

This large increase in utilization rate also confirms how user fees have long represented the most important barrier access to care in this specific context. Moreover, this may have been explained by unmet needs as also reported in the Malian context where a study indicates that the elimination of financial barriers was effective in addressing previously unmet needs (Heinmüller et al., 2012).

Different effects could have been observed in different settings, such as Ghana, where financial barriers do not represent the primary obstacle to healthcare access (Buor, 2003). Furthermore, by targeting both financial and quality barriers to healthcare access at once, the intervention we observed is likely to have produced changes of a larger magnitude than those possible with an intervention which simply removes user fees. Quality of service delivery has in fact long been recognized as an equally important deterrent of service use (Yates, 2009).

Nevertheless, despite using a single group interrupted time series design, the estimated magnitude of the intervention effect reported by these prior studies (Deininger and Mpuga, 2004; Lagarde et al., 2012; Masiye et al., 2010; Ponsar et al., 2011a,b) was lower than what was observed in our study. This difference could be attributed to study design and methods of analysis, the intervention implementation condition (absence of mass media campaign to inform population before implementation), or possibly the intervention effect was delayed in these studies. Whether based on household surveys (Deininger and Mpuga, 2004; Ponsar et al., 2011a,b) or NHIS data (Lagarde et al., 2012), data used in previous studies covered a shorter time period (Lagarde et al., 2012; Ridde et al., 2013a,b). In addition, prior studies did not account for the hierarchical structure of time-series data and did not control for potentially relevant confounding factors (Lagarde and Palmer, 2008), which could lead to biased effect estimates.

Our analysis also detected high levels of variation in effect estimation across facilities in which facilities with higher health worker density experienced the largest increase in service use after the onset of the intervention. This finding is aligned with prior evidence from longitudinal (Fernandes et al., 2014) and cross-sectional studies (Anand and Bärnighausen, 2004; Muldoon et al., 2011) suggesting that higher health workforce density is related to the improved health outcomes in children under five. In our study, the availability of health workers at the time of intervention and during the following months is likely to have enabled facilities to cope with increased workload, while at the same time reducing waiting times. This was not the case in Niger where the number of staff was insufficient to manage the higher utilization resulting from the abolition of user fees (Antarou et al., 2013).

The policy change did not appear to increase the rate of utilization in facilities with higher geographically-dispersed populations compared to other facilities. Our finding corroborates the results of others studies in Mali, which reported that the proportion of target population living more than 5 km away from the health center was not associated with an increase of service use compared to proportion of people living within 5 km from the health center (Heinmüller et al., 2012). However, since we use facility-level data, we use dispersion of population as a proxy of distance in line with an approach previously suggested by Heinmuller et al. (Heinmüller et al., 2013), making inference at the individual level inappropriate. On the other hand, two studies, also from Burkina Faso using household level data (Druetz et al., 2015; Ridde et al., 2013a,b), found no significant association between distance to health facility and service use. Our results and the result of these two previous studies (Druetz et al., 2015; Ridde et al., 2013a,b) suggest that user fee exemption improves equity of health care access both in population and at the individual level. While few previous studies have evaluated the influence of user fee exemption on the seasonal variation in the use of services, our results showed that the intervention increased the amplitude of seasonal variation in the use of services. This effect was greater during the rainy season, which coincides with higher rates of malaria transmission among children and adults (Ouédraogo et al., 2013). In our setting, during the rainy season, the accessibility of facilities was limited or impossible because several roads often become inaccessible (Schoeps et al., 2011). Moreover, in the rainy season, health needs are higher because of malaria. Thus, the intervention has managed to reverse a trend that has long been documented (Sauerborn et al., 1996). During the rainy season, there is more malaria, but less money available and, as a consequence, access to healthcare is limited. Removing fees makes access to healthcare possible at critical moments, potentially yielding an important effect on mortality as this is likely the season during which most children die of malaria.

In regards to the sustainability of the intervention effect over time, the results from previous studies were scarce and showed mixed results (Lagarde et al., 2012; Lagarde and Palmer, 2008; Wilkinson et al., 2001). Our results showed that user fee exemption policies can result in a sustained effect over a first phase during a relatively long period of time before decelerating and thus declining. In South Africa, the number of visits by children increased rapidly at the time of user fee abolition and was followed by a sustained reduction during the first quarter post-intervention (Wilkinson et al., 2001). Similarly, in Zambia and in Niger, the initial increase in the level of health care utilization was not sustained after 18 months (Lagarde et al., 2012). One hypothesis of the non-sustained effect is that the initial increase in health service utilization may adversely impact quality of care, leading to a deterioration of the intervention effects in the longer term (Gilson and McIntyre, 2005). In our setting, however, this early deterioration as reported in previous studies was most likely counteracted in first by the explicit availability of financial resources, since the intervention is financed by the European Union and implemented by an NGO. In addition, user fee removal was accompanied by permanent investments in quality of services, including permanent staff training and support, provisions of medical equipment, and drug supply monitoring. The joint role of these actors suggests that implementation conditions can be determinants of the intervention effect. But the declining pace of growth of the utilization rate followed by a reversing direction observed three years after the intervention could be attributed more to demand-side factors rather than to the deterioration of the quality of care as observed in previous studies. Indeed, a study conducted in an intervention context shows that the exemption of payments did not cause a deterioration of quality of care (Atchessi et al., 2013). Moreover, the intervention has created a lot of interest by removing the financial barrier to healthcare access which represented the largest barrier to healthcare in the country. Some important unmet needs that were not filled due to financial constraints have certainly been widely met within a period of three years. Furthermore, growing interest in health promotion initiatives for a rational use of health services, in the fact that service use could have reduced morbidity among children under five, are among the main factors that could explain the change in health services utilization. Finally, other barriers may explain the decrease in the pace of growth in the use of health services and would deserve qualitative investigation.

6.1. Methodological considerations

Our study has methodological strengths as well as several limitations. First, our study demonstrates the value of using routine NHIS data for complex health program evaluations (Wagenaar et al., 2015). Our analytical approach makes an important contribution to the methodology of intervention evaluation and also to the understanding of the long-term effect of user fee exemption. We have shown that selecting an appropriate functional form of time representation, such as an interrupted time series design, is essential to better understand and assess long-term effects of public health interventions. Our design allows for the control of temporal trends before, during, and after the intervention and to assess the reversing direction in the trend after the intervention. That would not be possible with other approaches, including linear interrupted time series design or before-after design.

Our sample consisted of 57 pre-intervention and 75 post-intervention repeated measures nested in several facilities, providing sufficient power to assess immediate and long-term effects of the intervention as well as to assess the effect of seasonality (Wagner et al., 2002) and other potential effect modifiers. We also increased statistical power by using non-equivalent controls (Cook et al., 1979). This strategy aimed to better discern effects of the intervention while addressing challenges to internal validity related to historical bias (Cook et al., 1979). We also relied on a sample size of at least 50 facilities at level two to allow unbiased estimates of second-level standard errors and coefficients (Maas and Hox, 2005). To increase the scope of our findings, we included contextual factors to investigate the effect modification of the association between user fee exemption and PHC utilization.

Contamination of the intervention is a legitimate problem that can arise when evaluating health interventions with neighboring interventions and comparison units. In our case, contamination has been minimized by the fact that the data collected exclusively concerned the use of services by populations from each health center's respective area. Moreover, our results show that separation between both groups over the month following the intervention remains constant over time and that there has been no declining trend in the comparison group. This comforts us in the idea that contamination has been minimized. Finally, we implicitly modelled dependencies over time by allowing a random coefficient for time to vary across PHC facilities.

With regards to possible instrumentation bias, our presence on the ground several times and for long periods allowed us to realize that methods of collection and collection tools have not changed before and during the intervention period in both groups and has reinforced our belief that the intervention did not influence the quality of data reported, which would have explained a part or all of the increase in use.

Despite these strengths, some limitations of the study should be taken into account when interpreting results. One limitation to our quasi-experimental analytical approach is that the intervention and control facilities were not randomly selected. This may have led to residual confounding and biased intervention effect estimates (Brookhart et al., 2010), although we attempted to control for confounding factors using the best available comparison facilities. Furthermore, we did not have information on individual socio-economics and clinical characteristics to allow us to determine individual-level effects, such as whether observed increases in utilization rates occurred preferentially among the poor or among the severely ill. In addition, measurement error was likely present in our study, specifically in our covariates and outcomes, but we assume that this type of error would have a non-differential impact on the results. Our study was able to obtain routine data on health service utilization that did not allow us to prospectively collect all potential factors related to the use of health services. If present, some potentially omitted variables or unmeasured confounding could introduce bias in the estimation of the intervention (Brookhart et al., 2010; Shadish et al., 2002) and this needs to be considered when interpreting the results of our study. Lastly, several factors other than health worker density and the dispersion of population could also explain the heterogeneity of the intervention effects but could not be taken in account in this study.

7. Conclusion

Our results provide additional evidence to support the view that user fee exemption coupled with improvements in quality of care can result in both an immediate and a sustained increase in service utilization for children under five. While the intervention effect was higher in facilities with higher health worker density, reducing inequalities in health worker allocation and improving health workforce capabilities and public financing are needed to maintain a long-term intervention impact. Our findings also add important information to the ongoing debate on the long-term effects of user fee exemption policies on children under five. So far, the potential improvement of health outcomes in children under five has been demonstrated only in a simulation study showing that the nationwide elimination of user fees could reduce under-five mortality by 17% during the first year of the user-fee elimination program (Johri et al., 2014). Future studies should include the assessment of the impact of user fee elimination on infant morbidity and mortality over differing time periods to investigate whether the general improvement in morbidity among children under five could be one of the explanatory factors for the reduction of growth followed by a slow decrease in the use of health services three years after the intervention onset.

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Competing interests

We declare that we have no competing interests.

Authors' contributions

VR and DZ designed the study. DZ acquire data, led the analyses and drafted the manuscript in consultation with other authors. All authors interpreted the results, reviewed the article. VR and MA critically reviewed improved and approved the final version of the manuscript.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.socscimed.2017.02.027.

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