

The effect of health insurance and health facility-upgrades on hospital deliveries in rural Nigeria: a controlled interrupted time-series study

Daniëlla Brals,^{1,*} Sunday A Aderibigbe,² Ferdinand W Wit,¹ Johannes C M van Ophem,³ Marijn van der List,⁴ Gordon K Osagbemi,² Marleen E Hendriks,¹ Tanimola M Akande,² Michael Boele van Hensbroek^{1,5} and Constance Schultz¹

¹Academic Medical Center, Department of Global Health, University of Amsterdam, Amsterdam Institute for Global Health and Development, Amsterdam, The Netherlands, ²Department of Epidemiology and Community Health, University of Ilorin Teaching Hospital, Ilorin, Nigeria, ³Faculty of Economics and Business, Section Quantitative Economics, University of Amsterdam, Amsterdam, The Netherlands, ⁴Department of Economics, Vrije Universiteit Amsterdam, Amsterdam Institute for International Development, Amsterdam, The Netherlands and ⁵Academic Medical Center, Emma Children's Hospital, Department of Paediatrics, Global Child Health Group, Amsterdam, The Netherlands

*Corresponding author. Academic Medical Center, University of Amsterdam, Amsterdam Institute for Global Health and Development, Trinity Building C, Pietersbergweg 17, 1105 BM Amsterdam, The Netherlands. E-mail: d.bral@amc.uva.nl

Accepted on 2 March 2017

Abstract

Background: Access to quality obstetric care is considered essential to reducing maternal and new-born mortality. We evaluated the effect of the introduction of a multifaceted voluntary health insurance programme on hospital deliveries in rural Nigeria.

Methods: We used an interrupted time-series design, including a control group. The intervention consisted of providing voluntary health insurance covering primary and secondary healthcare, including antenatal and obstetric care, combined with improving the quality of healthcare facilities. We compared changes in hospital deliveries from 1 May 2005 to 30 April 2013 between the programme area and control area in a difference-in-differences analysis with multiple time periods, adjusting for observed confounders. Data were collected through household surveys. Eligible households ($n = 1500$) were selected from a stratified probability sample of enumeration areas. All deliveries during the 4-year baseline period ($n = 460$) and 4-year follow-up period ($n = 380$) were included.

Findings: Insurance coverage increased from 0% before the insurance was introduced to 70.2% in April 2013 in the programme area. In the control area insurance coverage remained 0% between May 2005 and April 2013. Although hospital deliveries followed a common stable trend over the 4 pre-programme years ($P = 0.89$), the increase in hospital deliveries during the 4-year follow-up period in the programme area was 29.3 percentage points (95% CI: 16.1 to 42.6; $P < 0.001$) greater than the change in the control area (intention-to-treat impact), corresponding to a relative increase in hospital deliveries of 62%. Women who did not enroll in health insurance but who could make use of the upgraded care delivered significantly more often in a hospital during the follow-up period than women living in the control area ($P = 0.04$).

Conclusions: Voluntary health insurance combined with quality healthcare services is highly effective in increasing hospital deliveries in rural Nigeria, by improving access to healthcare for insured and uninsured women in the programme area.

Key words: Access to care, global health, health insurance, health system strengthening, hospital delivery, impact evaluation, maternal and new-born health and survival, Nigeria, public health, quality of care, sub-Saharan Africa

Key Messages

- Provision of a combination of voluntary health insurance and quality healthcare increased hospital deliveries by 29 percentage points (62%) among both insured and uninsured women in the intervention area in rural Nigeria.
- Insurance enrollment increased from 0% to 70% after the intervention.
- The findings provide important evidence that a health system intervention can be effective and cost-effective in delivering maternal healthcare services, providing an alternative to vertical programmes that solely focus on maternal and new-born health.
- Distance to a programme hospital was both an independent determinant of hospital delivery and of insurance enrollment. The distance to programme hospitals should therefore be included in the programme design of voluntary health insurance programmes.

Introduction

Although progress has been made globally since the United Nations Millennium Development Goals were defined in 2001, maternal and new-born mortality remain high in most sub-Saharan African countries, including Nigeria (Bhutta and Black 2013; Kassebaum *et al.* 2014; Wang *et al.* 2014). Easily accessible hospital delivery care, including emergency obstetric care, is generally recognized as the best way to lower high maternal and new-born mortality (Bulatao and Ross 2003; Campbell *et al.* 2006; Bhutta *et al.* 2008). An estimated 39% of maternal deaths could be averted if all women had access to emergency obstetric care (Wagstaff 2004). Moreover, new-born mortality could decrease by 82% if mothers would switch from delivering in a low-quality facility to delivering in a facility providing emergency obstetric care (Leslie *et al.* 2016).

In a public–private partnership, the Kwara State Government, Hygeia Community Health Care, the Health Insurance Fund and PharmAccess Foundation introduced the Kwara State Health Insurance (KSHI) programme to improve access to affordable and quality healthcare for the population of rural Kwara State. The programme combines improvement of quality of care offered by hospitals (supply side) with provision of subsidized low-cost private health insurance (demand side).

The KSHI programme provides a unique opportunity to assess the impact of a health system intervention to improving access to and utilization of maternal healthcare services. Whereas previously the cost-effectiveness of this intervention was established (Gomez *et al.* 2015), with this study we have evaluated whether the KSHI programme—addressing the demand and supply sides simultaneously—has increased hospital deliveries in rural Kwara State, Nigeria.

Methods

Study setting, study area, and the KSHI programme

Kwara State is part of the north central region of Nigeria with a total population of ~2.5 million based on the 2006 National Population Census. The 2013 Nigerian demographic health survey reported that, in Kwara State, 76.7% of women delivered in primary health centres or hospitals (National Population Commission (NPC) [Nigeria] 2014).

The KSHI programme began providing health insurance to households in the Asa Local Government Area in Kwara State,

Nigeria (the programme area) in July 2009. In the 2 months before the insurance was introduced (May–June 2009), the programme facilitated quality improvements in the participating hospitals. The Ifelodun Local Government Area in Kwara State was chosen as the control area, as it was comparable to the programme area in terms of socio-demographic and socio-economic characteristics. The quality and services provided in the healthcare facilities in the two areas were also similar before the introduction of the programme (see the Supplementary Materials for a figure of the study area).

Enrolment in the health insurance scheme was voluntary and on an individual basis. At the time of this study, the annual insurance premium was ~2.4 USD per person per year, which corresponded to ~0.5% of average yearly per capita consumption among the 1500 surveyed households in 2009. The insurance package provided coverage for consultations, diagnostic tests and medication for all diseases that could be managed at a primary care level, as well as limited coverage of secondary care services. Secondary care services provided included antenatal care, vaginal and caesarean delivery, neonatal care, immunizations, radiological and more complex laboratory diagnostic tests, hospital admissions for various diseases, minor and intermediate surgery and annual check-ups. Excluded from the programme were high technology investigations (computed tomography and magnetic resonance imaging), major surgeries and complex eye surgeries, family planning commodities, treatment for substance abuse/addiction, cancer treatment requiring chemotherapy and radiation therapy, provision of spectacles, contact lenses and hearing aids, dental care, intensive care treatment and dialyses (Hendriks *et al.* 2014).

Quality and efficiency of healthcare were monitored through independent audits by an international quality improvement and assessment body called SafeCare, a partnership between the PharmAccess Foundation, the American Joint Commission International and the South-African Council for Health Services Accreditation of Southern Africa. Prior to enrolment in the KSHI programme, a baseline assessment of the clinic or hospital was conducted by SafeCare and a quality improvement plan was formulated. The provider specific improvement plans consisted of specific targets in 13 different domains, including management and leadership, human resource management, patients' rights and access to care, management of information, risk management, primary healthcare services, inpatient care, operating theatre, laboratory, diagnostic imaging, medication management, facility management

and support services. The improvement plans were implemented by the healthcare providers with technical and financial support from Hygeia Community healthcare. SafeCare monitored the progress on quality improvement through annual follow-up assessments with the SafeCare Quality Standards. Examples of quality improvement interventions included implementation of treatment guidelines and protocols for waste management and hospital infection control, training of staff in guideline-based care and adequate medical file keeping, hospital renovation, upgrading of laboratory equipment and training of laboratory staff in basic laboratory testing and assurance of continuous essential drug supplies (Hendriks *et al.* 2014) (see the Supplementary Materials for additional information on the KSHI programme).

Study design and participants

We applied a controlled interrupted time-series design to measure the impact of the KSHI programme 4 years after its introduction.

We used stratified two-stage cluster sampling, with stratification by area of residence (programme or control) and distance to the nearest (potential) programme hospital (within 5 km or within 5–15 km) resulting in four subareas. Based on the 2006 National Population Census those four subareas were divided into 300 enumeration areas, of which a random sample of 100 enumeration areas was drawn. Subsequently a random sample of 1500 households [900 (60%) households in the programme area and 600 (40%) households in the control area] was drawn from those 100 enumeration areas, such that the resulting sample was representative of the Asa and Ifelodun areas. As a 50–60% uptake of insurance among households was expected, households in the programme area were over-sampled compared with the control area. The target sample size of 1500 households was based on sample size estimates required to study the effect of the programme on healthcare utilization and financial protection in the overall population. Therefore, no formal sample size calculations were performed using hospital deliveries changes as a main outcome measure. However, a fixed sample size of 1500 households would allow us to measure a minimum impact of a 21.2 percentage points increase in hospital deliveries, with a power of 80% using a two-tailed test and a 0.05 level of significance.

Data were collected in three consecutive population-based household surveys that were simultaneously conducted in the programme area and control area. A baseline survey was carried out in May 2009, shortly before the introduction of the programme, and two follow-up surveys were carried out among the same households in June 2011 and 2013, respectively. Households were included in the surveys after written informed consent was obtained from adult household members. Consent was obtained from the head of household for those under 18. All respondents (including the respondents under 18) were explicitly asked to assent to respond to the pregnancy questionnaire within the household surveys.

All deliveries during the 4-year baseline period (1 May 2005–30 April 2009) or 4-year follow-up period (1 May 2009–30 April 2013) from women aged 15–45 years at the time of delivery were eligible for this study (see the Supplementary Materials for more information on the survey questions, potential recall bias and data construction).

Ethical clearance

The study protocol was approved by the Ethical Review Committee of the University of Ilorin Teaching Hospital in Nigeria (04/08/2008, UITH/CAT/189/11/782).

Outcome

Hospital delivery was defined as delivery in any hospital or clinic where skilled delivery care was provided and where caesarean sections were possible, as opposed to at home or in a primary healthcare centre, as reported by the women during the household survey. Primary healthcare centres in rural Kwara State did not provide skilled delivery services and were therefore not included in the definition of hospital delivery.

Analysis

We measured the intention-to-treat effect of the KSHI programme by using a difference-in-differences method. All women living in the programme area had access to improved quality maternal and child healthcare services in the upgraded programme hospitals, with or without being enrolled in the health insurance, although uninsured women had to pay for these services. Therefore, all women in the programme area were considered to be in the intervention group irrespective of whether they were actually insured. Such an intention-to-treat approach avoids the bias introduced by self-selection into (or out of) the health insurance and incorporates the independent effect of the quality improvements in the programme hospitals on uninsured women in the programme area.

In difference-in-differences analysis the intention-to-treat effect (or impact) was estimated as the increase in percentage of hospital deliveries from the pooled 4-year baseline period to the pooled 4-year follow-up period in the programme area, controlled for the change in percentage of hospital deliveries in the control area (Lee and Kang 2006; Blundell and Dias 2009; Wooldridge 2010). The key identifying assumption behind the difference-in-differences method is that hospital deliveries in the programme and control area followed a common constant pre-intervention trend (the common trend assumption).

Let y_i be a dummy variable that equals 1 if woman i delivered in a hospital. The intention-to-treat programme effect on hospital deliveries was estimated by the following linear probability multivariable difference-in-differences model (Blundell and Dias 2009):

$$y_i = \alpha + \vartheta \text{Programme}_i + \delta \text{Post}_t + \gamma \text{Programme}_i \cdot \text{Post}_t + \mathbf{X}'_i \beta + \varepsilon_i, \quad (1)$$

where Programme_i is the treatment indicator that equals 1 if woman i was living in the programme area, and 0 otherwise. The treatment indicator captured possible differences between the programme and control area prior to the introduction of the programme (measured by ϑ). Post_t is a dummy variable equal to 1 for the pooled 4-year follow-up period, which captured aggregate factors that would cause changes in hospital deliveries in the absence of the programme (measured by δ). The interaction term $\text{Programme}_i \cdot \text{Post}_t$ equals 1 if woman i was living in the programme area during the pooled 4-year follow-up period, and 0 otherwise. The interaction term measured the intention-to-treat programme effect, which is identified by γ under the common trend assumption. The vector \mathbf{X}_i captured the effects of the observed confounders on hospital delivery (measured by the β 's) and the error-term ε_i captured unobserved factors affecting hospital delivery.

The common trend assumption was assessed in the controlled interrupted time series analysis, where we estimated a fully flexible difference-in-differences model. This model compared changes in hospital deliveries from the 4 pre-programme years to hospital deliveries in the 4 years after the introduction of the programme, allowing for fully flexible pre- and post-programme trends in the programme and control area. The following fully flexible

multivariable difference-in-differences model was estimated by including the separate 4 pre- and 4 post-programme years (Mora and Reggio 2012):

$$y_i = \alpha + \sum_{t=1}^4 \theta_t \text{Pre}_t + \sum_{t=1}^4 \rho_t \text{Programme}_i \cdot \text{Pre}_t + \vartheta \text{Programme}_i + \sum_{t=1}^4 \delta_t \text{Post}_t + \sum_{t=1}^4 \gamma_t \text{Programme}_i \cdot \text{Post}_t + X_i' \beta + \varepsilon_i, \quad (2)$$

where Pre_t is a dummy variable equal to 1 for the t th pre-programme year and Post_t is a dummy variable equal to 1 for the t th post-programme year. The interaction term $\text{Programme}_i \cdot \text{Pre}_t$ equals 1 if woman i was living in the programme area during the t th pre-programme year and the interaction term $\text{Programme}_i \cdot \text{Post}_t$ equals 1 if woman i was living in the programme area in the t th post-programme year. The common trend assumption was assessed by testing the $H_0: \rho_1 = \rho_2 = \rho_3 = \rho_4$, which would suggest that indeed the difference-in-differences model in equation (1) is appropriate (Mora and Reggio 2014). In addition, we assessed whether the intention-to-treat effect was constant in the follow-up period by testing the $H_0: \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4$, which would suggest that the programme reached its maximal impact in the first post-intervention year already and remained stable at its maximum in the years that followed (Mora and Reggio 2014).

In pre-specified heterogeneity analysis we assessed whether the programme's impact varied with distance to the nearest (potential) programme hospital (within 5 km vs within 5–15 km). Hereto, we augmented the difference-in-differences model in equation (1) by including interactions with distance to the nearest (potential) programme hospital:

$$y_i = \alpha + \vartheta \text{Programme}_i + \delta \text{Post}_t + \pi \text{Distance}_i + \omega \text{Programme}_i \cdot \text{Distance}_i + \phi \text{Post}_t \cdot \text{Distance}_i + \gamma_1 \text{Programme}_i \cdot \text{Post}_t + \gamma_2 \text{Programme}_i \cdot \text{Post}_t \cdot \text{Distance}_i + X_i' \beta \pm \varepsilon_i, \quad (3)$$

where Distance_i is a dummy variable, which was equal to 1 for women living more than 5 km away of a (potential) programme hospital. The intention-to-treat programme effect is measured by γ_1 for women living within 5 km of a programme hospital and by $\gamma_1 + \gamma_2$ for women living more than 5 km away, where we expect γ_2 to have a negative sign. The 95% CI and P -value of the programme's impact among women living more than 5 km away of a programme hospital were calculated by employing the delta method after estimation.

In sensitivity analysis using the subsample of women who delivered in both periods, the multivariable difference-in-differences model was estimated with individual fixed-effects to control for the effect of unobserved time-constant confounders as well (Wooldridge 2010):

$$y_{it} = \alpha_i + \delta_t + \gamma \text{Programme}_i \cdot \text{Post}_t + \beta X_{it} + \varepsilon_{it}, \quad (4)$$

where α_i is the individual fixed-effect representing unobserved time-constant characteristics of the women and δ_t is the time fixed-effect representing the trend in the control group. The vector X_{it} captured the effects of the observed time-varying confounders on hospital delivery. Observed time-constant confounders were not included in this model.

Since hospital delivery is a variable taking only values 0 and 1 one might assume that a non-linear difference-in-differences method would be preferable to linear difference-in-differences (linear probability model) but Blundell and Dias (2009) showed the opposite. They showed that difference-in-differences loses much of its simplicity even

under a very simple non-linear specification and requires additional strong assumptions which are often not met. Moreover, Angrist and Pischke (2008) showed that in practice the results of the linear probability model are just as good as those of non-linear models. To verify this, in a sensitivity analysis the results of the linear difference-in-differences model were compared with the results of the logistic difference-in-differences model (noting that this logistic difference-in-differences model is not favourable).

If the programme affected the odds of getting pregnant (or not getting pregnant) then this would bias the difference-in-differences results. Therefore we additionally estimated whether the probability of pregnancy during the follow-up period was significantly different between women of reproductive age with access to the programme and women in the control area without access to the programme, by using multivariable logistic regression analysis. Finally, deaths could be pregnancy related which can bias the programme's impact, as well. Therefore we assessed whether the number of deaths among women of reproductive age were similar over time in both study areas.

Confounders were selected based on Gabrysch and Campbell's (2009) conceptual framework. This framework distinguishes four sets of variables related to hospital delivery, namely (i) perceived needs [age, parity, complications during (previous) delivery and desire to become pregnant], (ii) socio-demographic factors (religion and ethnicity), (iii) socio-economic factors (marital status, female head of household, educational level head of household, and household wealth) and (iv) physical accessibility [distance to nearest health facility and distance to nearest (programme) hospital]. In addition, a context specific factor was added, namely whether the delivery date coincided with one of two public sector health worker strikes in Kwara State (a 40-day strike in May–June 2011 and 3-week strike in December 2011–January 2012). Household wealth was estimated by an asset index derived using principal component analysis. In the multivariable models all a-priori selected confounders were included, irrespective of whether they were statistically significant. Age, parity, complications during (previous) delivery, marital status, female head of household, distance to nearest health facility, distance to nearest (potential) programme hospital, and the strike variable were included as time-varying variables and desire to become pregnant, religion, ethnicity, educational level of the head of household, and household wealth were included as time-constant variables, measured at baseline. Educational level of the head of household and household wealth were measured at follow-up as well, but included at their baseline value to avoid endogeneity problems. In a sensitivity analysis the strike variable was removed from the list of confounders to assess the estimation bias of not controlling for the effect of the strikes.

Finally, we provided an estimate of the independent effect of the quality improvements in the programme hospitals on uninsured women in the programme area by estimating the increase in hospital deliveries from the baseline period to the follow-up period among uninsured women in the programme area who delivered in both periods, by using multivariable logistic regression analysis.

In all analyses we corrected for clustering within enumeration area, household, and individual. Data were analysed using STATA, version 12.1 (StataCorp LP, TX, USA).

Results

Participants

Within the surveyed households, 40.7% of 1131 women of reproductive age delivered during the baseline period [42.2% ($n = 664$) in

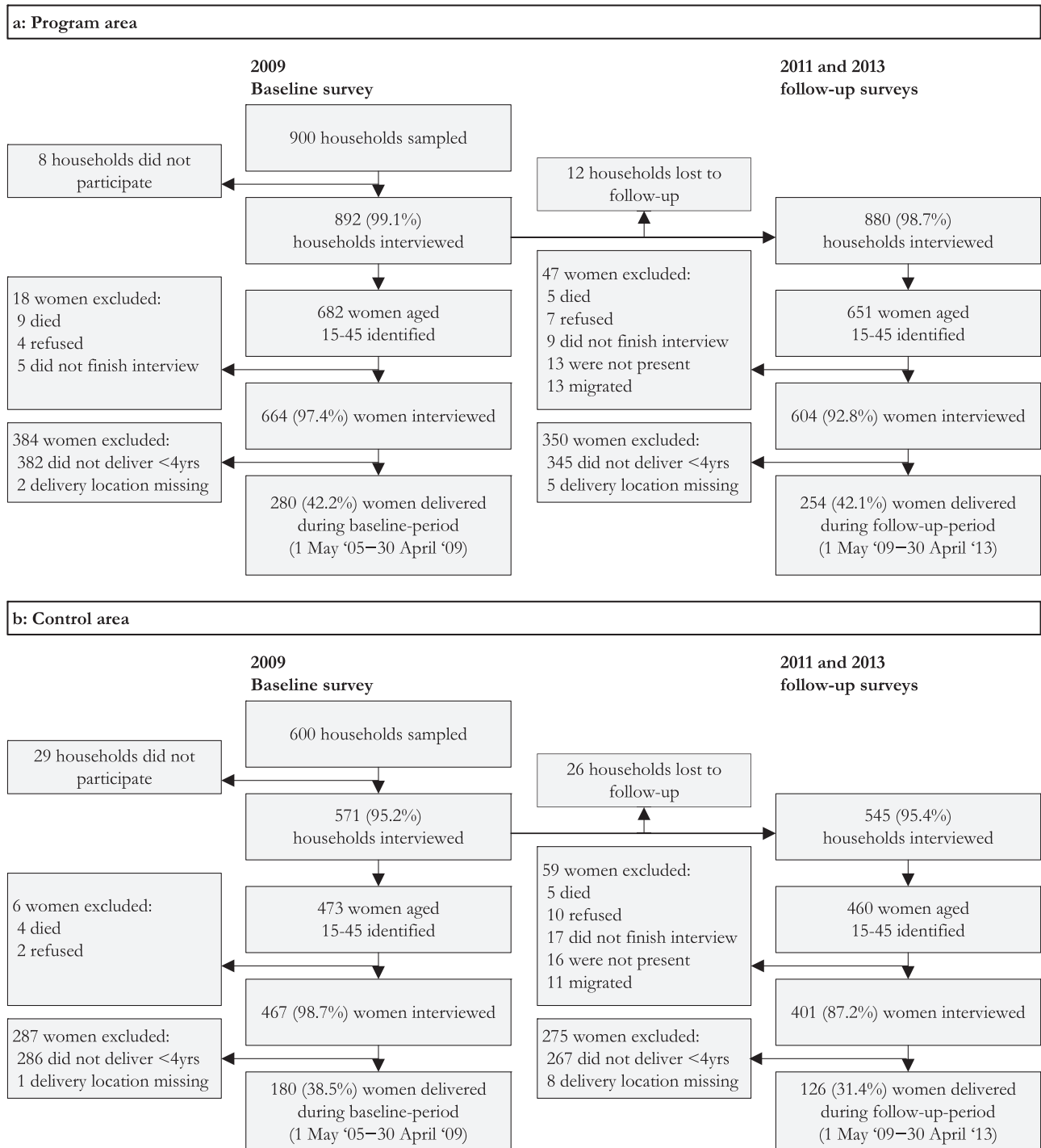


Figure 1. Study flowchart. Source: 2009, 2011 and 2013 household surveys

the programme area and 38.5% ($n = 467$) in the control area] and 37.8% of 1005 women of reproductive age delivered during the follow-up period [42.1% ($n = 604$) in the programme area and 31.4% ($n = 401$) in the control area] (Figure 1). Of these women who delivered, 239 delivered in both study periods (162 in the programme area and 77 in the control area).

After adjusting for observed confounders, we found that the odds of pregnancy among all women of reproductive age were similar in the programme and control area during the follow-up period ($P = 0.20$ —see Supplementary Table S1).

In total 13 women of reproductive age died in the 12 months prior to the baseline survey (9 women in the programme area and 4 in the control area) and 10 women of reproductive age died in the 12 months prior to the follow-up surveys (5 women in the programme area and 5 in the control area) (Figure 1), as reported by the head of household during the household surveys. The percentages of women of reproductive age who died were similar over time in both study areas ($P = 0.22$).

At baseline, non-response rates (due to death, absence or refusal to reply) among women of reproductive age were similar in the

Table 1. Characteristics of women who reported a delivery in the 4 years prior to the baseline (2009) or second follow-up (2013) surveys

	Baseline-period (1 May 2005–30 April 2009)			Follow-up-period (1 May 2009–30 April 2013)		
	Programme area (<i>n</i> = 280)	Control area (<i>n</i> = 180)	<i>P</i>	Programme area (<i>n</i> = 254)	Control area (<i>n</i> = 126)	<i>P</i>
Outcome						
Hospital delivery	133 (47.5)	85 (47.2)	0.96	181 (71.3)	47 (37.3)	<0.001
Perceived needs						
Age (mean [SD])	30.18 [7.09]	31.18 [6.43]	0.16	30.24 [6.38]	30.37 [6.73]	0.87
Parity						
first pregnancy	49 (17.5)	28 (15.6)	0.58	25 (9.8)	13 (10.3)	0.89
second–third pregnancy	107 (38.2)	67 (37.2)	0.83	98 (38.6)	54 (42.9)	0.43
≥fourth pregnancy	124 (44.3)	85 (47.2)	0.57	131 (51.6)	59 (46.8)	0.46
Complications ^a	18 (6.4)	9 (5.0)	0.51	20 (7.9)	10 (7.9)	0.98
Desire to become pregnant	205 (73.2)	118 (65.6)	0.17	156 (61.4)	87 (69.0)	0.15
Socio-demographic						
Islam	252 (90.0)	99 (55.0)	<0.001	235 (92.5)	77 (61.1)	<0.001
Yoruba	237 (84.6)	112 (62.2)	<0.001	218 (85.8)	82 (65.1)	0.002
Socio-economic						
Married	266 (95.0)	166 (92.2)	0.25	241 (94.9)	120 (95.2)	0.87
Female household head	32 (11.4)	40 (22.2)	0.008	32 (12.6)	22 (17.5)	0.21
Educational level household head						
None	105 (37.5)	62 (34.4)	0.61	86 (33.9)	38 (30.2)	0.50
Primary	82 (29.3)	39 (21.7)	0.12	84 (33.1)	32 (25.4)	0.14
Secondary	52 (18.6)	49 (27.2)	0.06	44 (17.3)	40 (31.7)	0.004
Tertiary	41 (14.6)	30 (16.7)	0.69	40 (15.7)	16 (12.7)	0.48
Household wealth quintile						
First	58 (20.7)	27 (15.0)	0.24	47 (18.5)	13 (10.3)	0.09
Second	50 (17.9)	37 (20.6)	0.52	47 (18.5)	30 (23.8)	0.39
Third	67 (23.9)	38 (21.1)	0.52	56 (22.0)	30 (23.8)	0.72
Fourth	54 (19.3)	53 (29.4)	0.06	47 (18.5)	36 (28.6)	0.056
Fifth	51 (18.2)	25 (13.9)	0.33	57 (22.4)	17 (13.5)	0.10
Insured at the time of delivery	0 (0.0)	0 (0.0)	1.00	156 (61.4)	0 (0.0)	<0.001
Physical accessibility						
Nearest health facility (km) (mean [SD])	1.14 [1.14]	1.35 [1.40]	0.53	1.16 [1.37]	1.41 [1.50]	0.41
Nearest (potential) programme hospital <5km ^b	159 (56.8)	93 (51.7)	0.67	156 (61.4)	63 (50.0)	0.37
Context specific						
Strike	0 (0.0)	0 (0.0)	1.00	3 (1.2)	26 (20.6)	<0.001

Source/Notes: 2009, 2011 and 2013 household surveys. Data are number (%) of women or mean [SD] (for age and distance to nearest health facility).

^aComplications during the most recent delivery.

^bDistance to nearest programme hospital in the programme area and distance to nearest potential programme hospital in the control area.

P-values were adjusted for clustering within enumeration area and household.

programme and the control area (2.6% [$\frac{18}{682}$] versus 1.3% [$\frac{6}{473}$], respectively, $P = 0.10$). However, during the follow-up surveys, the non-response rate was significantly higher in the control area than in the programme area (12.8% [$\frac{59}{460}$] vs 7.2% [$\frac{47}{651}$], $P = 0.007$) (Figure 1). Nevertheless, women of reproductive age who took part in the initial survey but were not interviewed during the follow-up surveys were similar to the women interviewed in terms of observed characteristics at baseline (see Supplementary Table S2).

Population characteristics

At baseline women in both study areas who delivered a child were well balanced in terms of most observed characteristics, but significant differences were observed with respect to the distribution of religion, ethnicity and female head of household (Table 1). Women in the programme area were significantly more often of Islamic religion ($P < 0.001$), more often ethnically Yoruba ($P = 0.002$), and less often living in a household with a female household head ($P = 0.008$).

Insurance enrolment

None of the women who delivered a child were enrolled in any health insurance scheme during the baseline period. Women in the control area remained uninsured during the follow-up period. In the programme area 61.4% of 254 women who delivered during the follow-up period were insured at the time of delivery (Table 1). Within the follow-up period enrolment rates increased from 0% before the insurance was introduced to 50.0% in May 2010, 64.1% in May 2011, 70.6% in May 2012 and 70.2% in May 2013 (Figure 2).

Within the programme area, women living within 5 km of a programme hospital had significantly higher insurance coverage than women living more than 5 km away [70.5% ($n = 156$) vs 46.9% ($n = 98$), respectively, $P = 0.005$].

Hospital deliveries

The average percentage of deliveries that were reported to have taken place in a hospital were similar in the programme and control area during the 4-year baseline period [47.5% ($n = 280$) vs 47.2% ($n = 180$), respectively, $P = 0.96$] (Table 1 and Figure 3).

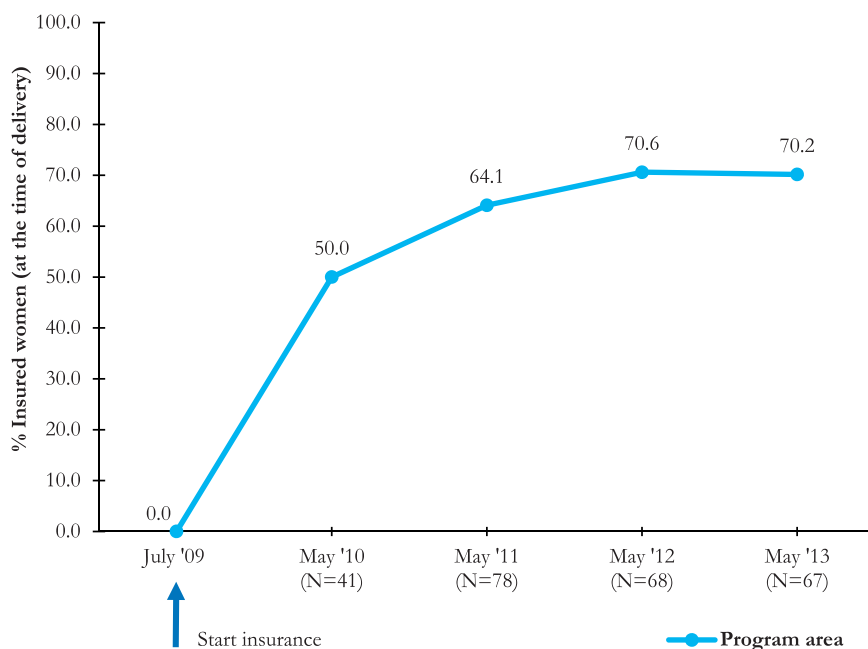


Figure 2. Percentage of insured women at the time of delivery in the programme area, by year. Source/Notes: 2009, 2011 and 2013 household surveys. Data are percentage of women insured at the time of delivery out of all women who delivered a child in the months between the given data points. For example, 70.2% of all women who delivered between 1 May 2012 and 30 April 2013 in the programme area were insured at the time of delivery

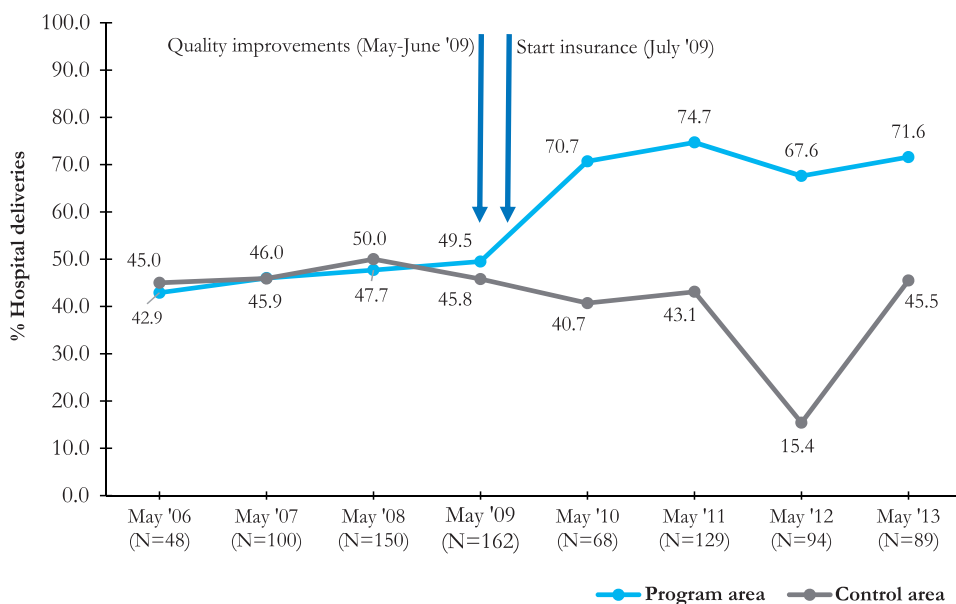


Figure 3. Percentage of deliveries that were reported to have taken place in a hospital, by year. Source/Notes: 2009, 2011 and 2013 household surveys. Data are percentage of hospital deliveries in the 12 months prior to the given month

Hospital deliveries in the programme area significantly increased from 47.5% ($n = 280$) during the baseline period to 71.3% ($n = 254$) during the follow-up period ($P < 0.001$). In the control area hospital deliveries decreased non-significantly from 47.2% ($n = 180$) during the baseline period to 37.3% ($n = 126$) during the follow-up period ($P = 0.10$). A significant drop in hospital deliveries occurred in the control area between May 2011 and 2012 ($P = 0.001$), when two health worker strikes took place in the public sector (Figure 3).

Within the programme area, hospital deliveries were also similar among women living within 5 km of a programme hospital and women living more than 5 km away during the baseline period

[49.1% ($n = 159$) vs 45.5% ($n = 121$), respectively, $P = 0.66$]. However, women living within 5 km of a programme hospital delivered significantly more often in a hospital during the follow-up period than women living more than 5 km away [82.7% ($n = 156$) vs 53.1% ($N = 98$), respectively, $P < 0.001$].

Women who were enrolled in health insurance at the time of delivery, delivered significantly more often in a hospital than women who were not enrolled at the time of delivery in the programme area during the follow-up period [80.8% ($n = 156$) vs 56.1% ($n = 98$), respectively, $P = 0.001$ —Figure 4a]. However, women who did not enroll in health insurance but who could make use of the upgraded care

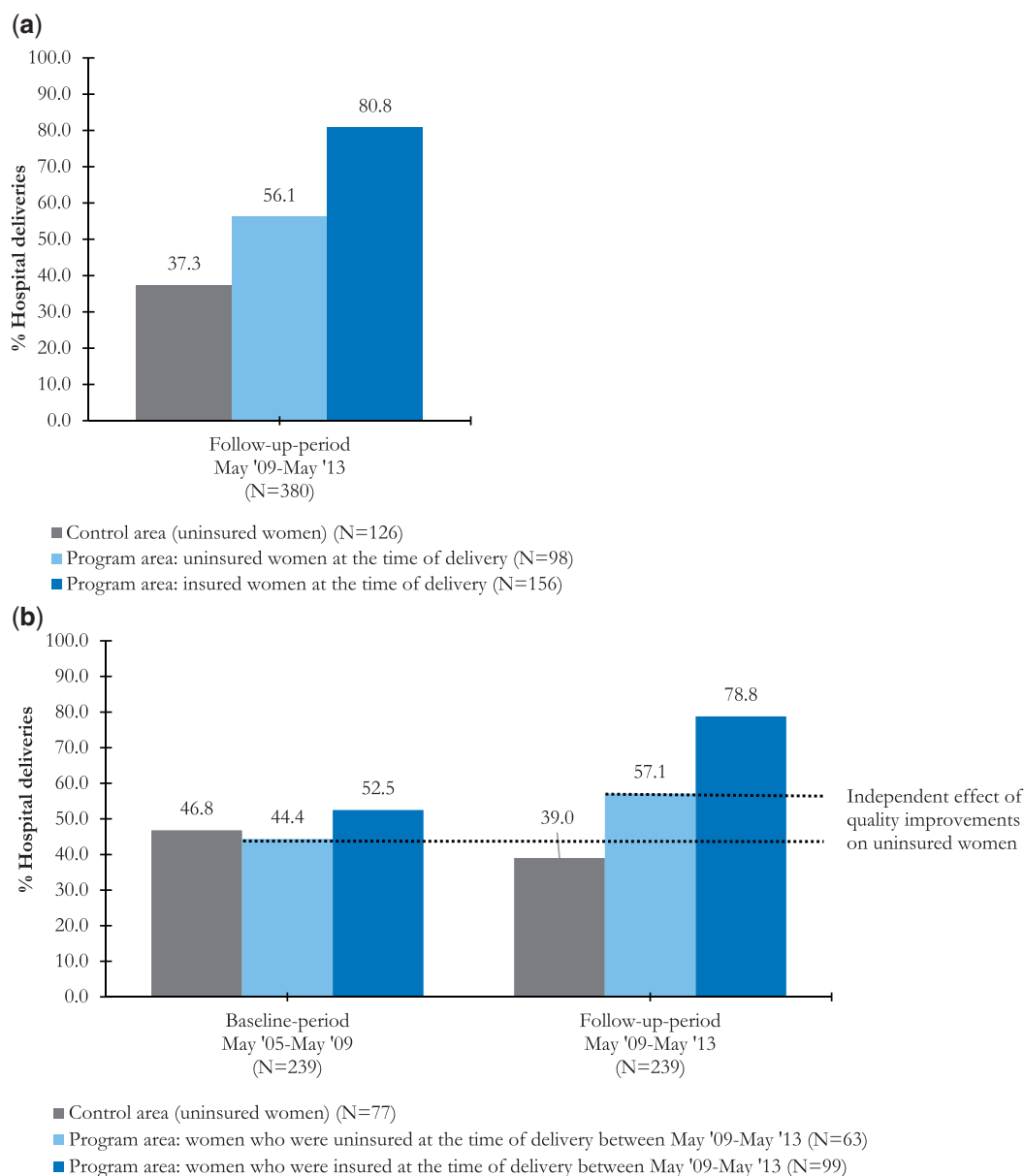


Figure 4. (a) Percentage of deliveries that were reported to have taken place in a hospital, by insurance status. Source/Notes: 2009, 2011 and 2013 household surveys. Data are percentage of hospital deliveries during the follow-up period, by insurance status at the time of delivery. **(b)** Percentage of deliveries that were reported to have taken place in a hospital among women with a delivery in both periods, by insurance status during the follow-up period. Source/Notes: 2009, 2011 and 2013 household surveys. Data are percentage of hospital deliveries among women with a delivery in both periods ($n = 239$) during the baseline and follow-up period, by insurance status at the time of delivery during the follow-up period

delivered significantly more often in a hospital during the follow-up period than women living in the control area [56.1% ($n = 98$) vs 37.3% ($n = 126$), respectively, $P = 0.02$ —Figure 4a]. Moreover, using the subsample of women in the programme area who delivered in both periods and who did not enroll in the health insurance during the follow-up period ($n = 63$ —see Figure 4b) and after adjusting for observed confounders, hospital deliveries increased by 15.1 percentage points (95% CI: 1.1–29.1; $P = 0.04$ —see Supplementary Table S3) from the baseline period to the follow-up period (independent effect of quality improvements on uninsured women).

Intention-to-treat effect of the KSHI programme

After adjusting for observed confounders, the increase in hospital deliveries in the first, second and fourth post-programme years was

respectively 26.6% points [95% CI: 4.3–48.9; $P = 0.02$; Table 2, column(3)], 30.3 percentage points [95% CI: 14.2–46.5; $P < 0.001$; Table 2, column (4)] and 36.6 percentage points [95% CI: 13.6–59.7; $P = 0.002$; Table 2, column (6)] greater than the change in the control area. In the third post-programme year—the year of the strikes—the programme impact was highest [49.2 percentage points increase; 95% CI: 25.8–72.7; $P < 0.001$; Table 2, column (5)]. However, a test on equal programme impacts in the 4 post-programme years did not reject equal intention-to-treat effects in these 4 years ($P = 0.44$). Furthermore, hospital deliveries in the programme and control areas followed a common stable pre-intervention trend in the 4 pre-programme years ($P = 0.89$).

After adjusting for observed confounders, the increase in hospital deliveries from the pooled 4 pre-programme years to the

Table 2. Estimated intention-to-treat effect of the KSHI programme on hospital deliveries

Outcome: hospital delivery	Difference-in-differences		Fully flexible difference-in-differences			
	[1]	[2]	[3]	[4]	[5]	[6]
	1 May 2009–30 April 2013 (pooled)		1 May 2009–30 April 2010	1 May 2010–30 April 2011	1 May 2011–30 April 2012	1 May 2012–30 April 2013
	Unadjusted	Adjusted	Adjusted	Adjusted	Adjusted	Adjusted
Impact programme	33.7	29.3	26.6	30.3	49.2	36.6
(95% CI)	(18.9–48.5)	(16.1–42.6)	(4.3–48.9)	(14.2–46.5)	(25.8–72.7)	(13.6–59.7)
<i>P</i>	<0.001	<0.001	0.02	<0.001	<0.001	0.002
Observations	840	840	840	840	840	840
Estimated equation	(1)	(1)	(2)	(2)	(2)	(2)

Source/Notes: 2009, 2011 and 2013 household surveys. In all difference-in-differences analysis the 4-year baseline period was used. Adjusted for the following observed confounders: age, parity, complications during (previous) delivery, desire to become pregnant at baseline, Islam, Yoruba, married, female household head, educational level household head at baseline, household wealth at baseline, distance to nearest health facility, distance to nearest (potential) programme hospital and whether the delivery date coincided with a health workers strike in the public sector. S.E.s and *P*-values were adjusted for clustering within enumeration area, household and individual (woman).

Table 3. Estimated intention-to-treat effect of the KSHI programme on hospital deliveries in sensitivity and heterogeneity analyses

Outcome: hospital delivery	Difference-in-differences 1 May 2009–30 April 2013		Sensitivity analysis		Heterogeneity analysis	
	[1]	[2]	[3]	[4]	[5]	[6]
	Preferred model	Without controlling for strikes	Logistic difference-in-differences	Difference-in-differences with fixed effects ^a (women with longitudinal data)	Women living within 5 km of nearest (potential) programme hospital	Women living within 5 to 15 km of nearest (potential) programme hospital
	Adjusted	Adjusted	Adjusted	Adjusted	Adjusted	Adjusted
Impact programme	29.3	34.0	32.0 ^b	30.3	36.3	18.0
(95% CI)	(16.1–42.6)	(20.5–47.4)	(19.0–45.0)	(13.3–47.2)	(18.2–54.3)	(–0.1–37.0)
<i>P</i>	<0.001	<0.001	<0.001	0.001	≤0.001	0.06
Observations	840	840	840	478	840	840
Estimated equation	(1)	(1)	(1)	(4)	(3)	(3)

Source/Notes: 2009, 2011 and 2013 household surveys. In all difference-in-differences analysis the 4-year baseline period was used. Adjusted for the following observed confounders: age, parity, complications during (previous) delivery, desire to become pregnant at baseline, Islam, Yoruba, married, female household head, educational level household head at baseline, household wealth at baseline, distance to nearest health facility, distance to nearest (potential) programme hospital and whether the delivery date coincided with a health workers strike in the public sector. S.E.s and *P*-values were adjusted for clustering within enumeration area, household and individual (woman).

^aObserved time-constant confounders were not included in this model.

^bMarginal effect, evaluated at the mean values of the observed confounders.

pooled 4 post-programme years in the programme area was 29.3 percentage points (95% CI: 16.1–42.6; *P* < 0.001) greater than the change in the control area [Table 2, column (2) and Table 3, column (1)].

Removing the strike variable from the list of confounders in a sensitivity analysis amplified the results to a 34.0 percentage points increase [95% CI: 20.5–47.4; *P* < 0.001—Table 3, column (2)], which demonstrated that not controlling for the effect of the strikes results in an overestimated impact of 4.7 percentage points [Table 3, impact column (2) minus impact column(1)]. In further sensitivity analysis, the multivariable logistic difference-in-differences model yielded consistent results with an estimated 32.0 percentage points increase (95% CI: 19.0–45.0; *P* < 0.001) in hospital deliveries [Table 3, column (3)]. Finally, using the subsample

of women who delivered in both periods and adjusting for observed time-varying and unobserved time-constant confounders (using individual fixed effects) also did not change the programme's impact [30.3 percentage points increase; 95% CI: 13.3–47.2; *P* = 0.001—Table 3, column (4)].

Pre-specified heterogeneity analysis indicated that women living within 5 km of a programme hospital benefitted substantially more from the programme [36.3 percentage points increase; 95% CI: 18.2–54.3; *P* < 0.001—Table 3, column (5)] than women living more than 5 km away [18.0 percentage points increase; 95% CI: –0.1–37.0; *P* = 0.06, respectively—Table 3, column (6)]. However, the difference between the impact among women living within 5 km of a programme hospital and the impact among women living more than 5 km away was not significant (*P* = 0.16).

Discussion

Provision of a combination of health insurance and quality antenatal and obstetric care was associated with a significant increase in hospital deliveries in rural Kwara State, Nigeria. In the 4 years after the introduction of the KSHI programme, hospital delivery care utilization among all women who delivered a child in the programme area, whether enrolled in the health insurance or not, was 29.3 percentage points (or 62%) higher than the change in the control area. In addition, a recent study showed that maternal healthcare services within the KSHI programme were cost-effective at a one GDP per capita threshold, compared with the current practice of care in Nigeria (Gomez *et al.* 2015). These findings provide important evidence that a health system intervention can be effective and cost-effective in delivering maternal healthcare services, providing an alternative to vertical programmes that solely focus on maternal and new-born health.

Easily accessible hospital delivery care, including emergency obstetric care, is generally recognized as the best way to reduce high maternal and new-born mortality (Bulatao and Ross 2003; Campbell *et al.* 2006; Bhutta *et al.* 2008). Estimates of maternal mortality in developing countries suggest that, in particular, access to hospital delivery care, including caesarean delivery when indicated, leads to major health and survival benefits (Bulatao and Ross 2003). An estimated 3 out of 4 maternal deaths could be averted if all women had access to emergency obstetric care (Wagstaff 2004).

There is relatively consistent evidence that health insurance is positively correlated with health facility delivery (Criel *et al.* 1999; Schneider and Diop 2001; Smith and Sulzbach 2008; Adinma *et al.* 2009, 2011; Chankova *et al.* 2010; Mensah *et al.* 2010; Sekabaraga *et al.* 2011), but only one study—in Ghana—used methods that can establish this as a causal relationship (Mensah *et al.* 2010). None of the health insurance schemes that were analysed in these studies targeted both demand and supply sides simultaneously, and the authors of one study noted explicitly that in their expectation complementary supply side interventions would be critical to improving maternal health and the health of newborns (Smith and Sulzbach 2008). Moreover, common sense and a recent study indicate that health insurance programmes aimed exclusively at the demand side are likely to have a lower impact, compared with combined supply and demand side programmes (De Brouwere *et al.* 2010). Additionally, it is not evident that health insurance increases hospital deliveries in the presence of barriers to hospital delivery such as distance to clinic, fear of hospital, and stigma of an ‘abnormal birth’, which are particularly common in rural settings and are not overcome by enrollment in a health insurance scheme (Afsana and Rashid 2001; Moyer and Mustafa 2013). The strength of our study is that it quantified the impact of a health insurance programme—addressing both the supply and demand side of healthcare simultaneously—on hospital deliveries in a rural setting in Nigeria, where potential sources of selection bias (into the programme) were avoided by estimating the programme effect on the whole programme area (insured and uninsured women).

The main limitation of our study is its inability to disentangle the insurance effect from the effect of the hospital-upgrades. However, hospital deliveries among women who were uninsured at the time of delivery in the programme area significantly increased after the introduction of the programme, suggesting that improved quality of maternal and child healthcare services in the upgraded programme hospitals attracted them. Hence our intention-to-treat impact reflects a real-world situation in which not all eligible subjects choose

to enroll in a health insurance programme but can make use of the upgraded care. This renders our analysis very useful to policy-makers, funders and healthcare staff with an interest in improving maternal and new-born health outcomes in developing countries.

Another limitation of this study was the non-randomized rollout of the insurance programme. Because of their complexity and multi-stakeholder nature, as well as for ethical considerations, health insurance programmes can be rolled out in a (cluster) randomized fashion in very few settings. We used an alternative approach to eliminating selection bias by including a control group similar to the intervention group and by analysing the data using difference-in-differences with multiple time periods. We demonstrated that hospital deliveries in the programme and control areas followed a common pre-intervention trend in the 4 pre-programme years, making this controlled interrupted time-series design a strong alternative to a randomized-controlled trial (Shadish *et al.* 2002; Fretheim *et al.* 2015).

Insurance coverage during the follow-up period was high among women who delivered a child but enrolment in health insurance was substantially lower among men, non-pregnant women, and children (within the 1500 households). For example, 70.2% of women who delivered a child between 1 May 2012 and 30 April 2013 were insured at the time of delivery, whereas 31.6% of men, non-pregnant women and children were insured at least 1 month in the same time period. This demonstrates that the programme is able to reach a group that can benefit from health insurance immediately.

In line with findings of other studies from sub-Saharan Africa, we found that distance to the nearest hospital was an obstacle for hospital deliveries (Gage 2007; Mwaliko *et al.* 2014), as women living within 5 km of a programme hospital benefitted more from the programme than women living more than 5 km away, though this additional benefit was not statistically significant. In addition other studies found that the negative effect of distance on hospital delivery is less pronounced if the reputation of the provider is good (Thaddeus and Maine 1994; Gabrysch and Campbell 2009). In the impact analyses we did observe an 18.0 percentage points increase in hospital deliveries among women living more than 5 km away from a programme hospital. Although this increase was not statistically significant, this was likely a sample size problem as our sample was too small to measure impacts below a 21.2 percentage points increase.

The observed decrease in hospital deliveries in the control area between May 2011 and 2012 is plausibly the result of two health workers’ strikes in the public sector employment of Kwara State in the same period. In the control area the main hospital was a public hospital, whereas in the programme area only the public programme hospital (and not the private programme hospital) was affected by these strikes. In the programme area 3 deliveries were during these strikes, compared with 26 deliveries in the control area. In addition, these 3 deliveries in the programme area were in the private hospital, whereas these 26 deliveries in the control area were indeed at home. This suggests that the control area was more affected by the strikes, which was confirmed by an overestimated intention-to-treat effect when we did not control for the strikes.

Conclusion

This study demonstrates that provision of a combination of health insurance and higher quality health facilities has been effective and cost-effective in delivering maternal healthcare services in Nigeria, providing an alternative to vertical programmes that solely focus on

maternal and new-born health. These findings provide evidence justifying the introduction and expansion of health system interventions state or countrywide. This is expected to contribute to improving maternal and new-born health and survival and assist Nigeria in meeting its sustainable development goals for reducing maternal mortality and ending preventable deaths of newborns by 2030.

Supplementary Data

Supplementary data are available at *HEAPOL* online

Acknowledgements

We thank all members of the Household Survey Study Group for their contribution to the study. The following persons of the study group contributed to data collection: Hannah Olawumi, MD, Abiodun Oladipo, MD and Kabir Durowade, MD, Department of Epidemiology and Community Health, University of Ilorin Teaching Hospital; Aina Olufemi Odusola, MD, Mark te Pas, MSc, Inge Brouwer, MD, Florise Lambrechtsen, MD and Alexander Boers, MSc, Amsterdam Institute for Global Health and Development; Marijke Roos, PhD and Marissa Popma, MSc, PharmAccess Foundation; Berber Kramer, PhD, Jos Rooijackers, BSc, Anne Duynhouwer, MSc, Judith Lammers, PhD, Daan Willebrands, MSc, Tobias Lechtenfeld, PhD, David Pap, MSc, Lene Böhnke, MSc, Marc Fabel, BSc and Gosia Poplowska, MSc, Amsterdam Institute for International Development; and all interviewers, data entrants and other field workers from the University of Ilorin Teaching Hospital. Jacques van der Gaag, PhD and Jeroen van Spijk, MSc, Amsterdam Institute for International Development; and Michiel Heidenrijk, BSc, Amsterdam Institute for Global Health and Development, contributed to the design of the study. We thank Catherine Hankins, Menno Pradhan, Igna Bonfrer, Melvin Schut, Gabriela Gomez and Zlata Tanović for critical reviewing the draft article and useful comments. We thank Shade Alli, MD, for her contribution to the training of doctors in the programme clinics. We thank PharmAccess Foundation and Hygeia Nigeria limited for their support of the study. We dedicate this work to the memory of Joep Lange, MD, PhD, who passed away on 17 July 2014.

Funding

The study was funded by the Health Insurance Fund (<http://www.hifund.org/>), through a grant from the Dutch Ministry of Foreign Affairs.

Conflict of interest statement. None declared.

Ethics

The study protocol was approved by the Ethical Review Committee of the University of Ilorin Teaching Hospital in Nigeria. Households were included in the surveys after written informed consent was obtained from adult household members. Consent was obtained from the head of household for those under 18.

References

Adinma ED, Adinma JB-D, Obionu CC, Asuzu MC. 2011. Effect of government-community healthcare co-financing on maternal and child healthcare in Nigeria. *West African Journal of Medicine* 30: 35–41.

Adinma ED, Nwakoby BA, Adinma BD. 2009. Integrating maternal health services into a health insurance scheme: effect on healthcare delivery. *Nigerian Quarterly Journal of Hospital Medicine* 20: 86–93.

Afsana K, Rashid SF. 2001. The challenges of meeting rural Bangladeshi women's needs in delivery care. *Reproductive Health Matters* 9: 79–89.

Angrist JD, Pischke J-S. 2008. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton: Princeton University Press.

Bhutta ZA, Black RE. 2013. Global maternal, newborn, and child health — so near and yet so far. *New England Journal of Medicine* 369: 2226–35.

Bhutta ZA, Ali S, Cousens S *et al.* 2008. Interventions to address maternal, newborn, and child survival: what difference can integrated primary health care strategies make? *The Lancet* 372: 972–89.

Blundell R, Dias MC. 2009. Alternative approaches to evaluation in empirical microeconomics. *Journal of Human Resources* 44: 565–640.

Bulatao RA, Ross JA. 2003. Which health services reduce maternal mortality? Evidence from ratings of maternal health services. *Tropical Medicine and International Health* 8: 710–21.

Campbell OMR, Graham WJ. Lancet Maternal Survival Series steering group. 2006. Strategies for reducing maternal mortality: getting on with what works. *Lancet* 368: 1284–99.

Chankova S, Atim C, Hatt L. 2010. Ghana's National Health Insurance Scheme. *Impact of Health Insurance in Low-and Middle-Income Countries*.

Criel B, Van der Stuyft P, Van Lerberghe W. 1999. The Bwamanda hospital insurance scheme: effective for whom? A study of its impact on hospital utilization patterns. *Social Science and Medicine* 48: 897–911.

De Brouwere V, Richard F, Witter S. 2010. Access to maternal and perinatal health services: lessons from successful and less successful examples of improving access to safe delivery and care of the newborn. *Tropical Medicine and International Health* 15: 901–9.

Fretheim A, Zhang F, Ross-Degnan D *et al.* 2015. A reanalysis of cluster randomized trials showed interrupted time-series studies were valuable in health system evaluation. *Journal of Clinical Epidemiology* 68: 324–33.

Gabrysch S, Campbell OM. 2009. Still too far to walk: Literature review of the determinants of delivery service use. *BMC Pregnancy and Childbirth* 9: 34.

Gage AJ. 2007. Barriers to the utilization of maternal health care in rural Mali. *Social Science and Medicine* 65: 1666–82.

Gomez GB, Foster N, Brals D *et al.* 2015. Improving maternal care through a state-wide health insurance program: a cost and cost-effectiveness study in Rural Nigeria. *PLoS One* 10: e0139048.

Hendriks ME, Wit FW, Akande TM *et al.* 2014. Effect of health insurance and facility quality improvement on blood pressure in adults with hypertension in Nigeria: a population-based study. *JAMA Internal Medicine* 174: 555–63.

Kassebaum NJ, Bertozzi-Villa A, Coggeshall MS *et al.* 2014. Global, regional, and national levels and causes of maternal mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet* 384: 980–1004.

Lee M, Kang C. 2006. Identification for difference in differences with cross-section and panel data. *Economics Letters* 92: 270–6.

Leslie HH, Fink G, Nsona H, Kruk ME. 2016. Obstetric facility quality and newborn mortality in Malawi: a cross-sectional study. *PLoS Medicine* 13: e1002151.

Mensah J, Oppong JR, Schmidt CM. 2010. Ghana's National Health Insurance Scheme in the context of the health MDGs: An empirical evaluation using propensity score matching. *Health Economics* 19: 95–106.

Mora R, Reggion I. 2012. Treatment effect identification using alternative parallel assumptions.

Mora R, Reggion I. 2014. *dq*: A command for treatment effect estimation under alternative assumptions. (working paper).

Moyer CA, Mustafa A. 2013. Drivers and deterrents of facility delivery in sub-Saharan Africa: a systematic review. *Reproductive Health* 10: 1.

Mwaliko E, Downing R, O'Meara W *et al.* 2014. 'Not too far to walk': the influence of distance on place of delivery in a western Kenya health demographic surveillance system. *BMC Health Services Research* 14: 1.

National Population Commission (NPC) [Nigeria]. 2014. *Nigeria Demographic and Health Survey 2013*. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF International.

Schneider P, Diop FP. 2001. *Impact of prepayment pilot on health care utilization and financing in Rwanda: findings from final household survey*. Bethesda, MD: Partners for Health Reformplus, Abt Associates.

Sekabaraga C, Diop F, Soucat A. 2011. Can innovative health financing policies increase access to MDG-related services? Evidence from Rwanda. *Health Policy and Planning* 26: ii52–62.

Shadish WR, Cook TD, Campbell DT. 2002. *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Houghton: Mifflin and Company.

- Smith KV, Sulzbach S. 2008. Community-based health insurance and access to maternal health services: evidence from three West African countries. *Social Science and Medicine* 66: 2460–73.
- Thaddeus S, Maine D. 1994. Too far to walk: maternal mortality in context. *Social Science and Medicine* 38: 1091–110.
- United Nations. *Transforming Our World: the 2030 Agenda for Sustainable Development* [Internet]. Sustainable development, Knowledge platform.
- Wagstaff A. 2004. *The Millennium Development Goals for Health: Rising to the Challenges*. Washington, DC: World Bank Publications.
- Wang H, Liddell CA, Coates MM *et al.* 2014. Global, regional, and national levels of neonatal, infant, and under-5 mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet* 384: 957–79.
- Wooldridge JM. 2010. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.