African Population and
Health Research Center

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Title of Project: Timeliness of administering birth dose vaccines in Nairobi slums

1.0 Activities

1.1 Summary

This report outlines the findings and lessons from a pilot project that sought to improve the timeliness of administering birth dose vaccines using a digital platform in Nairobi slums in Kenya. The project involved an interaction between community health volunteers (CHVs), pregnant women and healthcare workers using a mobile phone application linked to a central registry. CHVs registered pregnant women at home and entered the information on a mobile phone application which relayed the information to a central server. From the central server pregnant women received text messages encouraging timely vaccination uptake and the server distributed the list of pregnant women to health centers of their choice. The results show that the digital platform is feasible to implement by CHVs and was effective in increasing the probability of administering BCG or oral polio vaccines timely by 63% and 60%, respectively. The lessons learnt in designing and implementing the digital platform and the challenges experienced will inform a larger trial that will inform further scale up of this model.

1.2 Introduction

Vaccine preventable diseases still contribute substantially to child mortality in sub-Saharan Africa [1]. A delay in administering vaccines within the recommended age group increases the risk of infection because of a prolonged potential exposure to vaccine-preventable diseases [2]. Birth dose vaccines are administered late, due to fragmented systems of delivery, poor recording and communication between maternal health and child health services[3] . Understanding these challenges presents opportunities for improving timely vaccinations at birth. The design of most vaccination programs in low and middle income countries (LMICs) is not informed by accurate data and therefore lacks focus. For example in the slums of Nairobi, Kenya, only 22% of vaccinations are administered timely [4] because there is lack of coordination between antenatal services, which usually identify eligible infants before birth and childhood vaccination services that administer the vaccine after birth. Furthermore, providers' immunization data are not linked and health managers lack data to accurately estimate appropriate denominator populations for planning services. This study sought to assess the effectiveness of community health volunteers (CHVs) and healthcare workers using an electronic immunization registry consisting of a digital platform, web-based database and health text messages to improve timeliness of administering birth dose vaccines such as Bacille Chalmette Guerin (BCG) and Oral Polio Vaccine (OPV).

1.3 Methods

1.3.1 Research setting and participants

This study was conducted in Viwandani slum that lies within the Nairobi Urban Health and Demographic Surveillance System (NUHDSS) run by the African Population and Health Research Center (APHRC). We chose this site because the population has been well characterized through serial rounds of data collection on demographics, pregnancies and vaccination that would later enable proper validation of data collected by CHVs. The study participants were pregnant women living in the selected community and their new-born babies. In collaboration with VAL partners, we trained CHVs to prospectively enroll all pregnant women in the 8 villages in Viwandani until the sample size of mother-baby pairs was accrued.

1.3.2 Study design and sample size

We used a cross-sectional stepped wedge design involving a sequential roll-out of the intervention to clusters (defined as a village with one CHV selected for this study). The baseline measurements of timely vaccination were taken in all study villages at month 0 followed by introduction of the intervention sequentially in three time points 2 months apart. Initially three villages received the intervention followed by six after four months and finally all eight villages at six months were included in the intervention. Timeliness of vaccination was estimated at each time point. A total of 479 mother-baby pairs were registered from the 8 villages (clusters): based on the assumption that the timely vaccination of 22% reported from the slums [4] would increase to 45%, intra-cluster correlation 0.04 [5], a fixed cluster size of 12 children, autocorrelation coefficient 0.8, confidence interval 95% with a power of 80% and dropout rate of 20% using a formula by Hooper et al. [6]. Recruitment into the intervention group was done sequentially through a public lottery randomization starting with block 1 (3 villages) then block 2 (3 villages) and lastly block 3 (2 villages) separated by two months. The vaccination data were available from the NUHDSS in all villages including the intervention villages before the start of the intervention. During the intervention in each village, additional data on vaccination was collected through the digital platform.

1.3.3 The intervention activities and operations

Two CHVs were selected from each village and trained to register pregnancies in their second or third trimester using a mobile phone. Demographic variables of women, age of gestation, expected date of birth and the preferred health facility and village of residence were documented at registration and relayed to a central database. This triggered an automated reminder to the CHV about when the woman is due to deliver. Three standardized health messages encouraging women to timely vaccinate their babies at birth were also be automated from the central server and sent to the mother's phone. The first message was delivered at registration, the second message was delivered two weeks from the expected date of delivery and the last message on the date of expected delivery. At delivery, the CHV documented the date of delivery of the child and submitted to the central database. At the vaccination point, immunization status was updated by the CHV or the health facility and relayed to the central server from which a list of unvaccinated children due for vaccination was generated. The CHV and health facility received fortnightly reports with the baby's due for vaccination to plan vaccination services appropriately.

1.3.4 Data collection

Basic maternal and child demographic data, dates, and health facilities of vaccination were collected by the CHV through the digital platform during registration of the pregnant mother, at birth and follow up. We extracted data on household characteristics including socio-economic status and childhood vaccinations collected through the NUHDSS and merged with data collected through the digital platform using the household identification number captured in both datasets. Cost data on implementation of the project was collected from project managers, health facilities, the VAL partners who developed and managed the digital platform.

1.3.4 Data analysis

Birth dose vaccines (BCG and OPV) timeliness was defined as a dose given within the recommended period of seven days after birth. Any dose given after the seven days was considered as late vaccination. Proportions were used to assess the level of timeliness for BCG and OPV vaccines respectively. An econometric model built on the repeated cross-section stepped-wedge cluster randomized trials was used to assess the effect of the intervention. The causal impact is estimated by regressing the outcome variable over the treatment variable (it takes the value 1 if the village had received the experimental treatment at time *t* and 0 if the village had was control arm at time *t*), and time variable (four time points). Multivariate logistic regression models with standard errors clustered at the level of the village were fitted to estimate the causal impact of the intervention. The adjusted odds ratios and 95 % confidence intervals were used to interpret the causal impact of the intervention. All analyses were performed in Stata 15. We converted the odds into probability by using the following formula: $proability = \frac{odds}{1+odds}$.

1.4 Results

1.4.1 Descriptive statistics

The study was powered to yield a total sample size of 479 pregnant mother-baby pairs with an attrition of 20% at each time. We over recruited in some blocks to compensate for the lower numbers of mother-baby pairs in the other blocks. Table 1 shows that the total number of pregnant mother-baby pairs recruited per block and at each time point with those receiving the intervention included in the shaded area. In total we included 412 mother baby-pairs who had received the intervention at various time points and also had complete data.

Table 1: Number of respondents registered and included in the analysis by block.

	Time points				
	Month 0	Month-2	Month-4	Month-6	Total
Block 1	49	32	82	112	**275**
Block 2	34	23	66	82	**205**
Block 3	18	14	16	38	**86**
Total	**101**	**69**	**164**	**232**	**566**

Notes: The shaded area means that mothers in the block have crossed and received the intervention.

1.4.2 Timeliness of vaccinations

Table 2 summarizes the prevalence of timely vaccinations by blocks and time of enrollment between the intervention and control groups, together with their 95% confidence intervals. There was gradual increase the proportion of infants receiving OPV vaccinations on time at the introduction of the intervention in each block. . For BCG the same trend was observed except for block 2 where there was a negligible decline. The between and within-comparisons were later assessed using the econometric model.

Table 2: Proportion of infants receiving OPV and BCG vaccinations on time

	OPV vaccine							
Group (clusters)	Month 0		Month-2		Month-4		Month-6	
	n	% [95% CI]	N	% [95% CI]	n	% [95% CI]	n	% [95% CI]
Block 1	32	65.3 [50.9,77.3]	28	87.5 [70.2,95.4]	74	90.2 [81.6,95.1]	107	95.5 [89.7,98.1]
Block 2	32	94.1 [79,98.5]	22	95.7 [73.4,99.4]	60	90.9 [81.1,95.9]	76	92.7 [84.6,96.7]
Block 3	16	88.9 [64.4,97.3]	12	85.7 [56,96.6]	11	68.8 [41.1,87.4]	37	97.4 [83.4,99.6]
	BCG vaccine							
Group (clusters)	Month 0		Month-2		Month-4		Month-6	
	n	% [95% CI]	N	% [95% CI]	n	% [95% CI]	n	% [95% CI]
Block 1	35	71.4 [57.2,82.4]	29	90.6 [73.7,97.1]	74	90.2 [81.6,95.1]	107	95.5 [89.7,98.1]
Block 2	32	94.1 [79,98.5]	22	95.7 [73.4,99.4]	61	92.4 [83,96.8]	75	91.5 [83.1,95.9]
Block 3	15	83.3 [58.8,94.6]	12	85.7 [56,96.6]	11	68.8 [41.1,87.4]	37	97.4 [83.4,99.6]

Notes: The shaded area means that mothers in the block have crossed and received the intervention

1.4.3 Treatment effect

The odds of receiving BCG vaccinations on time was significantly higher in the intervention group compared to the control (OR1.7; p<0.05; 95% CI 1.0 to 2.5). Results of the study therefore indicate that being exposed to the intervention significantly increases the probability of receiving BCG vaccinations on time by 63%. With regards to the OPV vaccinations, results of the study suggest that the treatment effect is of borderline significance at 10%: exposure to the intervention increased the probability of receiving OPV vaccinations timely by 60% (table 3).

Table 3: Treatment effect

Variables	Adjusted odds ratio	[95% CI]
Treatment effect (BCG)	1.7**	1.26, 2.5
Treatment effect (OPV)	1.5*	0.97, 2.41

Notes: *significant at p<0.1, **significant at p<0.05 and ***significant at p<0.001. We control for the time period. Standard errors are clustered at the village level.

1.5 Conclusions and recommendations

This study provides useful insights into how a digital platform consisting of an electronic community immunization registry, web-based database and indeed shows that the digital platform is feasible to implement by CHVs and effective in improving the timeliness of administering birth dose vaccines in Nairobi slums in Kenya. Results of the study suggest that the intervention was successful in increasing the probability of receiving BCG and polio vaccines timely in the Nairobi slum by 63%, 60%, respectively. The findings from this study are important but before any further scale-up, we propose to undertake a large scale randomized cluster controlled trial, that will use parameters from this study such as the effect size of the intervention now known to be about 63% for BCG vaccines , increase the cluster size to a community unit other than a village to obtain an adequate number of babies per cluster and also ensure that non-contiguous clusters separated by a reasonable geographical distance to avoid contamination. We recommend the larger trial to be conducted first in slums similar to those in our pilot and then consider scale up to rural communities later, since rural communities may not have adequate internet connectivity to implement the digital platform. A longer follow-up period (at least to 6 months after delivery) to measure the impact of the intervention on infant survival will also be needed. Lastly, qualitative interviews (key informant interviews, focus group discussions, in-depth interviews) will be needed to understand the perception of the intervention by pregnant women, CHVs, health workers at primary healthcare facilities and the county health managers.

2.0 Challenges

This study faced a few challenges during the initial stages of its implementation. Some of the CHVs experienced difficulties in enrolling pregnant mothers on the digital platform due to technical hitches and poor internet connectivity. However, following a series of refresher trainings and continuous support by VAL partners, most of the CHVs exhibited a positive outlook and confidence in learning and properly using electronic devices to enroll pregnant mothers on the digital platform. Future larger trials aimed at improving the timeliness of administering birth dose vaccines using a digital platform should consider using USSD technology that does not require a smartphone or internet connectivity to work especially when implementation is undertaken in rural communities. In some cases, the number of households contacted per day was insufficient to reach all assigned households within the study period as required and the brief time spent with households limited the quality of engagement. A few mothers refused the intervention. However, prompt and continuous support through supervision of CHVs' routine activities played an important role in helping the CHV identify and manage complex situations. Some pregnant women who were initially reluctant to enroll on the digital platform were later persuaded by the CHVs and accepted to volunteer in the study. Despite these challenges, the findings of this study provide useful insights for more rigorous investigations in other urban slum settings in Kenya and Sub-Saharan Africa.

3.0 Other Sources of Support

This study did not receive any additional sources of support for during any stage of its implementation.

References

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Phase I Financial Report (Maximum 1 page)

Organization Name	African Population and Health Research Center
Project Title	Timeliness of administering birth dose vaccines in Nairobi slums
Report Type	Final
Reporting Period	May 1 2018 to October 31 2019

Project Expenses by Type	***Actual Expenses (USD)***	***Actual Expenses (USD)***	***Actual Expenses (USD)***	**TOTAL EXPENSES (USD)**
	[Enter FYE]	**[Enter FYE]**	**[Enter FYE]**	**[Reporting Period]**
Personnel	40,921.87			40,921.87
Equipment*				
Travel				
Consultants				
Supplies	19,078.13			19,078.13
Subcontracts	40,000.00			40,000.00
TOTAL EXPENSES	**100,000.00**			**$100,000****

** If equipment expenditures total over $5,000, please list each item separately*

***** We encourage spending all grant funds for the charitable purpose of your grant. If total project expenses are less than $100,000 please email GCE@gatesfoundation.org for further guidance.***