# Engagement of Community Health Workers to Improve Immunization Coverage Through Addressing Inequities and Enhancing Data Quality and Use is a Feasible and Effective Approach: A Case of Uganda

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# Abstract

**Background**: The availability, reliability and quality of immunization data is critical to the success of any immunization program. Poor quality data result into unreliable projections, planning, and programmatic implementation, which ultimately undermine immunization investments. Uganda, like many other developing countries, faces challenges of unreliable estimates for her immunization target population. Strengthening immunization data quality and use for improving immunization program performance are critical steps towards improving coverage and equity of immunization programs.

The goal of this study was to determine the effectiveness of using community health workers (CHWs) to obtain quality and reliable data that can be used for planning and evidence-based response actions.

**Methods:** A three phased cluster randomized trial in which 5 health facilities were randomized in two groups to (i) receive a package of interventions including monthly health unit immunization data audit meetings, and defaulter tracking and linkage through home visits; and (ii) to serve as a control group between July and September 2020 was conducted. Immunization coverage in both arms was determined before and after the interventions. In addition, key informant and in-depth interviews were conducted to explore the feasibility of the interventions.

**Results:** Overall, a total of 2,048 eligible children were registered by CHWs which compares to the district estimated population of 1,889. The study further showed that it is feasible to use CHWs to track and link defaulters to points of services: More than two thirds (68%) of the defaulters were tracked and linked to immunization services. Immunization coverage for specific antigens was significantly higher in the intervention health facilities as compared to that in the control health facilities: DPT3 95.6% vs 88.4% ($p=0.004$); MR 88.9% vs 81.9% ($p=0.048$); BCG 81.4% vs 55.5% ($p<0.001$); OPV3 93.9% vs 87.1% ($p=0.014$); PCV3 95.0% vs 88.4% ($p=0.011$); and Rota2 92.8% vs 84.5% ($p=0.006$).

**Conclusion:** Use of CHWs to obtain reliable population estimates is feasible and can be useful in areas with consistent poor immunization coverage to estimate target population. Facilitating monthly health unit immunization data audit meetings to identify, track and link defaulters to immunization services is effective in increasing immunization coverage and equity.


# Contributions To The Literature

- In developing countries, community health workers have been engaged to improve access to health care. However, few studies have quantitatively assessed their role in immunization.
- There is little evidence in their involvement in use of immunization data to trace and follow up children defaulting at immunization services.
- The findings of this implementation study contribute to the recognized gaps in the literature on how community health workers can be engaged to use immunization data to achieve improved coverage and equity.

# Background

Immunization is a known cost-effective public health intervention that saves millions of lives every year (1). Immunization continues to play a crucial role in the achievement of sustainable development goal (SDG) three, as well other thirteen SDGs directly or indirectly (2). Since the launch of the Expanded Program on Immunization (EPI) in 1974, immunization coverage has exceeded 80% among infants in a number of countries. However, in poor and developing countries, millions of children remain under/un-immunized (3). Sub-Saharan African countries still struggle to reach the Diphtheria-Pertussis-Tetanus third dose ( DPT3) coverage of 90% as well as providing equitable access to life-saving vaccines (4). The National immunisation coverage masks poor sub-national coverage as there is insufficient detail on local populations that are not fully vaccinated (5). Even with strengthened routine immunization programs, the marginalized and vulnerable communities are usually left out. Inequity in uptake of routine vaccines has contributed to accumulation of unimmunized children, and this is closely linked to periodic outbreaks. Understanding who is not immunized can answer why they are not immunized (4, 5). Indeed, one of the goals of the 2030 global immunization agenda is the addressing equity gaps by identification of children that have not received vaccines at all (zero dose) as part of promoting coverage and equity (1). Thus, there is advocacy for country specific pro-equity strategies in order to achieve universal health coverage (2).

One of the pro-equity strategies is a focus on disaggregation of sub-national data which is able to highlight inequitable access and poor utilization of immunization services (2). The availability, reliability and quality immunization data is critical to the success of any immunization program. Poor quality data leads to unreliable projections, planning, and programmatic implementation, which ultimately undermines international and national immunization investments (6). Data remains an underutilized resource in informed and timely decision-making, especially at health facility level despite high investments in national health information systems and advances in information technology to improve data quality (7). A number of developing countries have more than a 10% difference between administrative and survey coverage for year 2011–2015(8). Strengthening immunization data quality and using data for improving immunization program performance are critical steps towards improving coverage and equity in Africa(9).

Ensuring a system of obtaining reliable immunization data remains a challenge. Some of the cited data challenges include an unstable denominator and a transient population (10). Previously conducted studies have revealed inaccurate administrative denominator resulting into vaccine coverage beyond 100% and disease outbreaks in areas of high coverage (11). Uganda, like many other developing countries faces challenges of unreliable and inadequate estimates for her immunization target population (12). The national coverage of DPT3 of 92% masks important differences in performance between districts (12). Most of the immunizable population targets and projections are based on data captured through institutional deliveries. Yet, institutional deliveries are as low as 63% (13) and therefore a number of births in the community go unregistered. Reliance on institutional data underestimates the target population for immunizable eligible children (under one year).

Over the last decade, there has been a growing interest in introduction and re-vitalization of national CHW programs in low-and middle-income countries (14). CHWs consist of paid or volunteer healthcare workers who work in communities outside of healthcare facilities (15). There has been expanding engagement of CHWs to meet population health needs, address health inequities and improve access to health services(14).

In Uganda, CHWs are drawn from and expected to work in their communities(16). In 2002, Uganda began implementing a national CHW program also known as the Village health teams (VHTs). In this model, VHTs are locally elected and are given responsibilities of caring for between 25–30 households(17). Evidence from EPI reviews showed key factors that contribute to a stagnated EPI performance affecting coverage and equity to include; low social community mobilization due to low VHT involvement; social economic factors including religious beliefs, long distances to health facilities and low socio-economic status of parents/caregivers. Equity assessments have revealed underserved communities to include urban poor settlements, fishing communities, refugee settlements, religious sects, remote rural, island and communities in mountainous areas (18). VHTs are not actively involved in the follow up of children defaulting immunization as they lack resources and tools. There is no system in place to trace and refer children for immunization. The tracing of children defaulting is reliant on the health facility staff who are limited in number, time, tools and resources. Districts tend to rely on government national immunization days to provide catch up vaccinations to eligible children including unimmunized children(19).

There are few studies that have quantitatively assessed role of CHWs in immunization (15). There is little evidence of involvement of CHWs in data immunization review meeting so as to promote utilization of data for follow up of children defaulting at their immunization schedules (20). To fill this knowledge gap, we conducted an implementation study to assess the feasibility and use of CHWs in improving use of data, coverage and equity of immunization services in Uganda. This operation research was based on the Ugandan EPI program needs with the aim of scaling up proven best practices to other districts.

This paper presents the use of CHWs to obtain reliable and quality data that can be used for planning as well as use of generated health facility immunization data to increase immunization coverage and equity.

# Methods

### Study setting

The study was conducted in Mayuge district which is located in eastern Uganda. This is a low performing district, with coverage ranging from 70% for Bacillus Calmette–Guérin (BCG) vaccine to 76% for Diphtheria-Pertussis-Tetanus third dose (DPT3) vaccine and Pneumococcal Conjugate Vaccine third dose (PCV3) as of December 2019 (12), and recurrent measles outbreaks each year for the last 5 years. One sub-county (Bukabooli) with one of lowest immunization coverage was purposively selected for the study in consultation with district health authorities. Bukabooli sub-county had a total population of 45,623, with coverage for DPT3 and Measles Rubella (MR) vaccine at 77% and 87%, respectively in the January to March 2020 period.

## Study design

This was a three phased cluster randomized trial with two arms in which 5 health facilities were randomized in two groups of 3 and 2 health facilities each to (i) receive a package of interventions and (ii) to serve as a control group respectively. A cluster design was adopted for the following reasons. First, the study involved evaluation of interventions implemented at health facility level, and cluster randomized trials have been found to be more appropriate for the evaluation of interventions targeted at a group of people rather than individuals (21). Second, this design provided protection against contamination across trial groups when the trial individuals are managed within the same setting (21). In Bukabooli sub-county, health facilities are geographically distanced, which allowed implementation of blinded interventions.

Health facilities were randomized into intervention and control arm respectively, based on the administrative immunization coverage for DPT3 and MR (Figure 1). The stratification ensured a good balance of the health facility characteristics in each arm. The 5 health facility catchment areas had similar characteristics in terms of population size and distribution as well as distances to the health facilities but varied in terms of immunization coverage.

The study was conducted between July and September 2020. A total of 15 health workers and 50 CHWs were oriented in the study protocol and implementation process.

At baseline, house to house registration of eligible children for immunization (0-12months) and identification of unimmunized children (children 12-23 months) who had not received/defaulted on DPT3 and or MR was performed by CHWs in both the intervention and the control arm, using a designed tool. The unimmunized children were advised to go for immunization at the nearest health facility. The collected data was used to update the health facility target population data (denominator). Immunization activities at static and outreaches continued as per the health facility schedule.

In the intervention arm, monthly immunization data audit meetings with health facility staff and CHWs to discuss EPI performance and generate a list of children defaulting immunization services were held for three months. In addition, monthly house to house visits were conducted by CHWs to trace defaulters and link them to health facilities Linkage involved advising caretakers of defaulters to take the children for immunization and subsequent validation of their immunization status during audit meetings. Immunization activities at static and outreaches continued as per the health facility schedule. Please indicate if there was any facilitation given to the CHWs.

**At end line,** the immunization coverage based on updated target population obtained through house-to-house registration in both the intervention and control arms was determined and compared

## Data collection

A structured abstraction tool was used to extract secondary data to measure primary and secondary outcome data as well as data on process indicators at baseline -phase I and at end line -phase III. At both

time points, secondary data was abstracted from health facility records (child immunization registers, tally sheets and health facility based monthly reports and the district health management information system (DHIS). The CHW register was developed and used to collect primary data on the target population (denominator) at baseline and was used to update the health facility target population in both arms.

To assess the feasibility of use of CHWs, 10 Key informant and in-depth interviews using a structured guide were conducted with district health team (DHT) members, health facility staff and CHWs. We interviewed one DHT member in-charge of CHWs; 3 health facility in-charges and 6 leaders of CHWs.

### Data management and analysis

The effectiveness of using CHWs to generate reliable population data (denominator) for tracking and linking immunization eligible children to points of service to expand coverage and equity of immunization services was measured by the proportion of children who were immunized (DPT3 and MR) in both the intervention and control arms.

We assessed the difference between house-to-house registration and Uganda Bureau of Statistics (UBOS) population by using the deviation factor (%). Data was analyzed at health facility level. Data analysis was performed in MS Excel 2013. Data verification was done to ascertain concordance between the reported and verified data. This was done using deviation factor (%) as follows:

$$\frac{(\text{house to house data} - \text{UBOS data}) \times 100}{\text{house to house data}}$$

A deviation factor of 0% implied concordance between the reported and verified data; a negative deviation factor reflects under0 reporting while a positive deviation factor reflects over-reporting. Based on the guidelines which permit a variation of $\pm$ 10%, the data was categorized in three strata: (i) no variation (0-<5%) (ii) acceptable variation (5%-10%); (iii) excess variation (>10%) (11).

A dashboard showing degree of accuracy of data using colour codes based on verification factors was designed as follows: **GREEN** represents acceptable variation ($\pm$5%), **YELLOW** represents moderate variation and needs improvement (-5.1% and -10% or 5.1% to 10%) and **RED** represents excessive variation and requires urgent attention (-10% or above +10%). We assessed the effectiveness of the interventions on the coverage of immunization between the intervention and control arm using the chi-squared test (11).

The key informant interviews (KIIs) were recorded and transcribed in verbatim. The textual data were complemented with additional observational notes. In order to familiarize with the data and immerse in the details, the transcripts were read in their entirety several times. A thematic framework was identifying

by writing memos in form of short phrases, ideas or concepts arising from the data in the margins of the text. These were then organized according to specific categories. This was followed by highlighting and sorting out quotes and making comparisons within and between cases. The quotes were then lifted from their original context and re-arranged under the newly developed themes. Finally, the data was interpreted based on internal consistency, frequency and extensiveness of responses, specificity of responses and trends or concepts that cut across the various discussions. Analyzed data were presented in text form.

# Results

### Feasibility of using CHWs to generate reliable population data

Table 1 compares the data collected by the CHWs and the district population as projected by UBOS(22). Overall, 2,048 children were registered by the CHWs through house-to-house registration as compared to 1,889 according to UBOS estimates. This represents a +7.8% difference. In the intervention facilities, there was a difference of 7.9% between the number of children registered by CHWs and estimated UBOS projections. In the control facilities, there was a difference of 7.5% between the number of children registered by CHWs and estimated UBOS projections.

Based on the analysis of the qualitative data, we assessed and analyzed the experiences, practicability, challenges and suggestions for improvement for house-to-house registration of eligible infants for immunization.

Overall, the health workers reported that the house-to-house registration was a practical and doable exercise which was also accepted by the community. All the in-charges of health facilities who were involved in the study appreciated the engagement of CHWs to collect immunization data at household level and acknowledged this was a feasible intervention as illustrated below;

The Health Workers (HWs) affirmed that it was one of the reliable ways of knowing the accurate target population. They further attested that it was a good experience of knowing the true location of eligible children for further follow up.

The challenges cited by the HWs were that some parents thought the registration of children were for political ambitions and/or financial gains. Indeed, some households were expecting a financial reimbursement for the registration. The registration was conducted during the planting season where a number of families had migrated to the forest reserves for agriculture. Other households thought that their children were going to be recruited into religious cult groups. The known vaccine resistant households refused registration.

The HWs recommended that the house-to-house registration needed to be conducted on a regular basis, at least twice a year. They emphasized the need to plan and facilitate CHWs with logistics to be able to carry out the exercise. They suggested that the community needed to be sensitized on the importance of the house-to-house registration

The CHWs reported that the house-to-house registration was a feasible exercise and highly acceptable by the community.

> *"We discovered children who had only received one antigen like BCG and others had only received up to DPT3. Also, a number of mothers after receiving DPT3, they are told to come back at the health facility when the child is 9 months, but they never turned up. However, house to house registration helped a lot to identify children who had missed some doses like measles. For example, a child was 2 years old but looking at the health card, he had received vaccines up to DPT 3", (IDI with CHW)*

> *"Some children were visitors from another sub-county. Some households were locked and the neighbors told us that they had gone to the forest reserve to plant maize and would return after harvesting," (IDI with CHW)*

> *"Through the registration, I discovered that some children had even died without us knowing at the health facility", (KII with health facility in-charge).*

The CHWs attested that it was an important exercise because it provided an opportunity to identify children who had; missed and or defaulted on their immunization schedules; died; relocated; visitors; migrants; and critically ill. House to house registration presented the opportunity for the CHWs to know their target population for their respective villages including specific location of households for these infants. CHWs were able to know the vaccine hesitant households. They were able to know the visitors and migrants and also locate families that had migrated to other locations. They were able to sensitize the mothers on the importance of immunization and remind some mothers/caregivers on the subsequent vaccination appointments for their children.

The challenges reported by the CHWs were that some villages were big and they had to walk long distances; the vaccine resistant households refused to give information on their children and some would hide the children; it was a rainy season and yet they lacked protective gear such as raincoats, gumboots and umbrellas; public misconception that names of their children were written for financial/political gains; some few households were hostile towards the CHWs; some households demanded for monetary payments for the registration exercise.

The CHWs recommended that they should be provided with protective gear such as umbrella, gumboots, and rain coats to be used during harsh weather. They requested for bicycles to ease their movements and t-shirt for easy identification by the community members. They requested for sufficient logistics to ease their activities while in the field.

### Feasibility of using CHWs to track and link eligible children to points of service

Based on the analysis of the qualitative data, we assessed and analyzed the experiences, data harmonization, practicability and suggestions for improvement for monthly EPI data audit meetings and home visits in order to determine CHWs ability to track and link eligible children to points of service

### Monthly EPI data audit meetings

Overall, there were a total of 9 data audit meetings held from July to September 2020 in the three intervention health facilities. Each facility held 3 monthly audit meetings where children defaulting were identified, listed and given to the CHWs for follow up via home visits in the community. Overall, 531 children were listed as defaulters and later followed up by the CHWs via home visits. Of these 362 (68%) returned for immunization.

> *"I found the monthly meetings very useful. The defaulter tracking register was very important for tracking. Every month, after the meetings I updated the book and noted the children who had returned for immunization after being followed by the community health workers through home visits", (KII with in-charge health facility).*
>
> *"These meetings are important. We need to include these monthly meetings in our annual work-plan so that they can be funded", (KII with in-charge health facility).*

The health workers reported that monthly data audit meetings were important and useful as the monthly EPI performance was shared. They reported that the process for the meetings were that the in charges would identify defaulters from the child register, list them in the defaulter's register and also provide lists to the CHWs for subsequent tracking and linking to the health facility. During the meetings, the defaulter's register would be updated and children returning for immunization identified.

The health workers reported that regular funding was needed to sustain these meetings.

Overall, CHWs reported that the monthly EPI data meetings were beneficial and feasible. They reported that the data audit meetings were very helpful in identifying children who were defaulting and ensuring each CHW obtained the particulars of these children for further follow up. The meetings were useful in updating the health workers on the progress of the work of the CHWs in regards to tracking defaulters via home visits. In these meetings defaulting children who had returned for immunization were also identified and defaulter tracking register was updated. CHWs also reported that they learnt how to approach the community to do home visits and how to conduct health education on immunization during home visits. CHWs reported that they got more involved with immunization activities and realized their role as bridge between the community and the health facility. In addition, they reported that the project tools used for audit meetings and defaulter tracking were helpful.

### Home visits-defaulter tracking

After attending the monthly EPI data audit meetings, the CHWs were given a list of children defaulting in their respective villages and tasked to conduct home visits and subsequent linkage to points of service.

*"Monthly data audit meeting helped to identify the children defaulting for my village catchment area and the list given to me by the in-charge is what I would use to track these children", (IDI with CHW).*

*"From these meetings I learnt a lot of things like how to communicate to the mothers/caregivers; how to deal with hostile families. I learnt a lot about immunization and the schedules and I was able to teach the mothers during the home visits", (IDI with CHW).*

Overall, the CHWs reported that the home visits were feasible and a doable exercise. They reported that good number of mothers were not aware of benefits of immunization. There were some hostile households and vaccine hesitant communities where local leaders and police had to be involved.

Some of the reported challenges faced by the CHWs were that the exercise was conducted during a rainy season and yet they did not have protective gear such as raincoats. Other challenge was hostile families that were suspicious and harsh towards the CHWs. They also complained of long distances they needed to travel to get some distant homes. In addition, they found that some families had migrated to other locations for farming. They reported that some known vaccine hesitant households would intentionally hide their children away and lie about their vaccination status.

*"Through the home visits, I was able to move long distances into hard-to-reach areas such as forest reserves, islands. In one household I visited, the child was disabled and had missed most of the vaccine antigens. The mother was also lame and HIV positive. She complained that she had difficulties accessing health care due to her disabilities," (IDI with CHW)*

*"We have a problem of the religious cults like triple 666, njiri-kalu and tabliqs that do not allow immunization. These cults tell their followers that immunization is bad and against their beliefs. You find that all children from these households are not immunized and even when you go to sensitize them, they hide away, (IDI with CHW).*

*"This COVID has also brought a lot of problems. During the lock down, mothers were fearing to go to the health centers resulting in high numbers of children defaulting," (IDI with CHW)*

*"One of the major reasons for defaulting is migration. When the planting season starts, a number of families due to lack of land migrate to the forest reserves to be able to farm. They go for like four months and yet there are no health facilities in the forest reserves. These children will therefore default," (IDI with CHW).*

The CHWs reported a number of reasons for children missing/defaulting from their immunization schedules. They reported that Some mothers complained about stock out of vaccines discouraging them from returning their children for immunization. Mothers complained that children get a lot of injections and some of them cause swelling of the body parts and hence are hesitant to take them for immunization. Some mothers complained about being victims of domestic violence making them unable to take children for immunization. A number of families migrate for various reasons such as farming for example in forest reserve areas where they're unable to access health services including immunization

services. Some caregivers reported forgetting health cards at their homes when they visit new areas. Some mothers are busy in agricultural activities that they forget about immunization. A number of community members are ignorant about the value of immunization. Lock down due to COVID-19 with restricted movements resulted in defaulting. Some households believe in some religions that forbid immunizations.

The CHWs reported that home visits advanced equity as they were able to reach the hard-to-reach households including vulnerable population:

### Effectiveness of the interventions in increasing immunization coverage

The effectiveness of the interventions in increasing immunization coverage was measured by comparing the coverage of the various antigens between the intervention and the control arm. The coverage at the end line for all antigens was significantly higher in the intervention arm as compared to the control arm (Table 2).

A comparison in the intervention arm before and after the intervention also showed significant increase in the immunization coverage for most of the antigens (Table 3).

The effectiveness of the interventions in increasing immunization coverage was measured by comparing the coverage of the various antigens in the control arm before and after intervention.

A comparison in the control arm before and after the intervention also showed significant increase in the immunization coverage (Table 4).

# Discussion

This is the first implementation science study in Uganda on use of CHWs to obtain population data on eligible children for immunizations. Our findings show the use CHWs can be successfully employed to obtain target population data, track and link defaulters to points of immunization services. The findings further show that holding monthly health facility immunization data audit meetings and defaulter tracking with linkage of defaulters to immunization services are effective in improving immunization coverage. In addition, equity issues were addressed as neglected children living in hard-to-reach areas such as forest reserves were reached through house-to-house registration and or defaulter tracking.

This study found that the collected house-to-house population size was higher than the district estimates by only 7.8% suggesting that UBOS estimates are fairly accurate. Therefore, employing CHWs to conduct house-to-house registration may not be cost-effective at scale. However, house-to-house registration for eligible population may be useful in hard-to-reach areas with poor immunization coverage to address inequities. It is arguable that using the UBOS projections based on the last population census in Uganda conducted in 2014 (23) to estimate target population may give increasingly inaccurate results with each additional year. Evidence from studies suggests that annual changes in number of surviving infants may

vary with the projected national estimates for the target population (24). Therefore, comparison from alternative independent sources such as data from house-to-house registration can be useful in obtaining an accurate denominator. In areas of consistent low immunization coverage, obtaining accurate target population can be useful to further understand extent of missed opportunities for vaccination.

In this study, CHWs were required to attend monthly immunization data audit/review meetings together with the health workers at the respective health facilities. These meetings involved review of immunization coverage, children who had defaulted and their locations. Thereafter, CHWs were tasked to conduct home visits to track and link these children to the respective health facility for catch up immunization. Data monitoring and use through regular meetings coupled with follow up of these partially immunized children through home visits was key improving coverage in our study. Results showed that the review meetings provided an opportunity for health workers to analyze, appreciate and use data to make programmatic improvements. These audit meetings just like evidence from another study presented an excellent platform for sharing best practices, lessons learned, dialoguing and providing feedback on results and indicators (20). Evidence also shows that regular immunization data review meetings have been seen as important means to improving performance especially when conducted among peers with an aim at problem solving. CHWs can learn well from their peers who are at an equivalent level simply because they are able to share their knowledge, ideas and experiences (20).

This study showed that using CHWs to track and link defaulters to points of immunization services was a feasible intervention. In our study, more than two thirds of defaulters returned for catch up immunization. Evidence from a study conducted in Kenya showed that households visited by CHWs were 1.7 times more likely to have fully immunized children than those that were not (25). Another similar study conducted in a hard to reach area in Kenya also showed that home visits were seen to improve immunization coverage and reduce on inequities brought about by differences in geographical location and socio-economic status (26). In addition, it can be argued that home visits present an opportunity for education of caregivers on the importance of immunization.

However, there were a number of reported challenges experienced by CHWs while conducting home visits including lack of protective wear, trekking long distances and lack of financial incentives or remuneration, among others. Similar findings have been reported in studies conducted in Ethiopia (27) and Zimbabwe (28).

Results from our study further elicited various reasons for children defaulting from their immunization schedules. These included religious beliefs prohibiting uptake of vaccination services; restricted movements due to the COVID-19 pandemic; migration of families for economic activities such as farming; fear of multiple injections; domestic violence, and ignorance of the caregivers on the benefits of immunizations. Similar reasons for defaulting have been reported from studies conducted in; Uganda (29); Ethiopia (30) and Kenya (31).

We observed significant differences in the immunization coverage between the health facilities in the intervention and control arms for specific antigens. The differences observed may be attributable to the

monthly health facility immunization data audits and identifying and following up of defaulters through home visits. A number of studies support our results and demonstrate that defaulter tracking of children through home visits increases immunization coverage (32, 33). The ‘fifth child’ project conducted in Ethiopia further demonstrated that use of CHWs to conduct defaulter tracking increased the immunization coverage (34). Our findings are consistent with most studies demonstrating that CHWs contributed to the increase of immunization coverage (25, 35). A study conducted in India showed that CHWs were highly cost-effective where percentage of measles vaccination increased by approximately 10% (15).

CHWs can play an important role in attaining universal health coverage by strengthening health systems to provide people centered care that is equitable and culturally appropriate (14). In our study, CHWs were trained, given specific tasks and regularly supervised. We believe this contributed to their good performance. Evidence from a review of studies further demonstrates that CHWs are likely to perform well if given; appropriate training and skilling; clear limited tasks; supportive supervision; and appropriate remuneration/incentives (14).

# Conclusion

Although it is feasible to use CHWs to obtain accurate population data, it may not be cost-effective to conduct house-to-house registration at full scale since the data obtained was comparable to the district targets which are based on national estimates. In neglected, hard-to-reach populations and other areas with low immunization coverage, house to house registration and home visits by the CHWs may be useful in addressing the immunization inequities.

Facilitating monthly health unit immunization data audit meetings for identifying, tracking and linking defaulters to immunization services are effective in increasing immunization coverage and equity and should therefore be considered for integration into the immunization program.

# Abbreviations

BCG Bacillus Calmette–Guérin vaccine

CHW Community Health Worker

DHIS District Health Management Information System

DPT3 Diphtheria-Pertussis-Tetanus third dose

EPI Expanded Program on Immunization

IDI In-depth Interview

KII Key Informant Interview

MR Measles Rubella vaccine

OPV3 Oral Polio Vaccine third dose

PCV3 Pneumococcal Conjugate Vaccine third dose

Rota2 Rotavirus vaccine second dose

UBOS Uganda Bureau of Statistics

VHT Village Health Team

WHO World Health Organization

# Declarations

### Ethics approval and consent to participate

Ethical clearance for the study was obtained from the Makerere University School of Public Health-Higher Degrees Research and Ethics Committee (MakSPH-HDREC). In addition, permission to conduct the research was sought from the Ministry of Health, the Mayuge District Health Office and management of the selected health facilities. Written consent was obtained from each key informant respondent.

### Consent for publication

This manuscript does not contain individual person's data in any form so the consent to publish is not applicable.

### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. KII guide is available.

### Competing interests

The authors declare that they have no competing interests.

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### Authors' contributions

All authors have made valuable contribution to this work and the development of the manuscript meeting the Implementation Science journal criteria for authorship. Pamela Bakkabulindi (PB), Immaculate Ampeire (IA) and Simon Muhumuza (SM) conceptualized the study. PB and SM coordinated the study and conducted data analysis. PB, SM, IA and Lilian Ayebale (LA) wrote the first draft. Marta Feletto (MF) provided technical guidance to the manuscript development process and review of subsequent drafts. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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# Tables

**Table 1: House to house registration versus the projected district population for under one-year children**

| Health facility | House to House registration for <1 year | UBOS projected target population for <1 year | Variation (%) | Color code for variation |
|---|---|---|---|---|
| **Intervention arm** | | | | |
| Buyugu HC II | 534 | 515 | 3.5 | |
| Busira HC II | 336 | 320 | 4.8 | |
| Nawampongo HC II | 574 | 495 | 13.8 | |
| **Total** | **1,444** | **1,330** | **7.9** | |
| **Control arm** | | | | |
| Mairinya HC II | 197 | 181 | 8.1 | |
| Bugulu HC II | 407 | 378 | 7.1 | |
| **Total** | 599 | 559 | **7.5** | |
| **Overall total** | **2,048** | **1,889** | **7.8** | |

*Green represents acceptable variation of ±5% ; Yellow represents moderate variation of 5.1% and -10% or 5.1% to 10%; Red represents excessive variation of -10% or above +10%.*

Table *2*. Immunization coverage at end line between the intervention and control arm

| No | Antigens | Immunization coverage | | P value |
|---|---|---|---|---|
| | | Intervention arm | Control arm | |
| | | Target N=360 (%) | Target N=155 (%) | |
| **1.** | DPT3 | 344 (95.6) | 137 (88.4) | 0.004 |
| **2.** | MR | 320 (88.9) | 127 (81.9) | 0.048 |
| **3.** | BCG | 293 (81.4) | 86 (55.5) | <0.001 |
| **4.** | OPV3 | 338 (93.9) | 135 (87.1) | 0.014 |
| **5.** | PCV3 | 342 (95.0) | 137 (88.4) | 0.011 |
| **6.** | Rota2 | 334 (92.8) | 131 (84.5) | 0.006 |

**Table *3*. Immunization coverage in the intervention arm (before and after)**

| No | Antigens (N=360) | Immunization coverage | | P value |
|---|---|---|---|---|
| | | Intervention arm | | |
| | | Before | After | |
| | | Target N=360 (%) | Target N=360 (%) | |
| | DPT3 (360) | 325 (90.3) | 344 (95.6) | 0.007 |
| 1. | MR | 248 (68.8) | 320 (88.9) | <0.001 |
| 1. | BCG | 207 (57.5) | 293 (81.4) | <0.001 |
| 1. | OPV3 | 315 (87.5) | 338 (93.9) | 0.005 |
| 1. | PCV3 | 317 (88.1) | 342 (95.0) | 0.001 |
| 1. | Rota2 | 266 (73.9) | 334 (92.8) | <0.001 |

**Table 4. Immunization coverage in the control arm (before and after)**

| No | Antigens (N=360) | Immunization coverage | | P value |
|---|---|---|---|---|
| | | Control arm | | |
| | | Before | After | |
| | | Target N=155 (%) | Target N=155 (%) | |
| | DPT3 (360) | 114 (73.5) | 137 (88.4) | 0.002 |
| 1. | MR | 132 (85.2) | 127 (81.9) | 0.474 |
| 1. | BCG | 137 (88.4) | 86 (55.5) | <0.001 |
| 1. | OPV3 | 114 (73.5) | 135 (87.1) | 0.007 |
| 1. | PCV3 | 114 (73.5) | 137 (88.4) | 0.002 |
| 1. | Rota2 | 134 (86.5) | 131 (84.5) | 0.644 |

# Figures

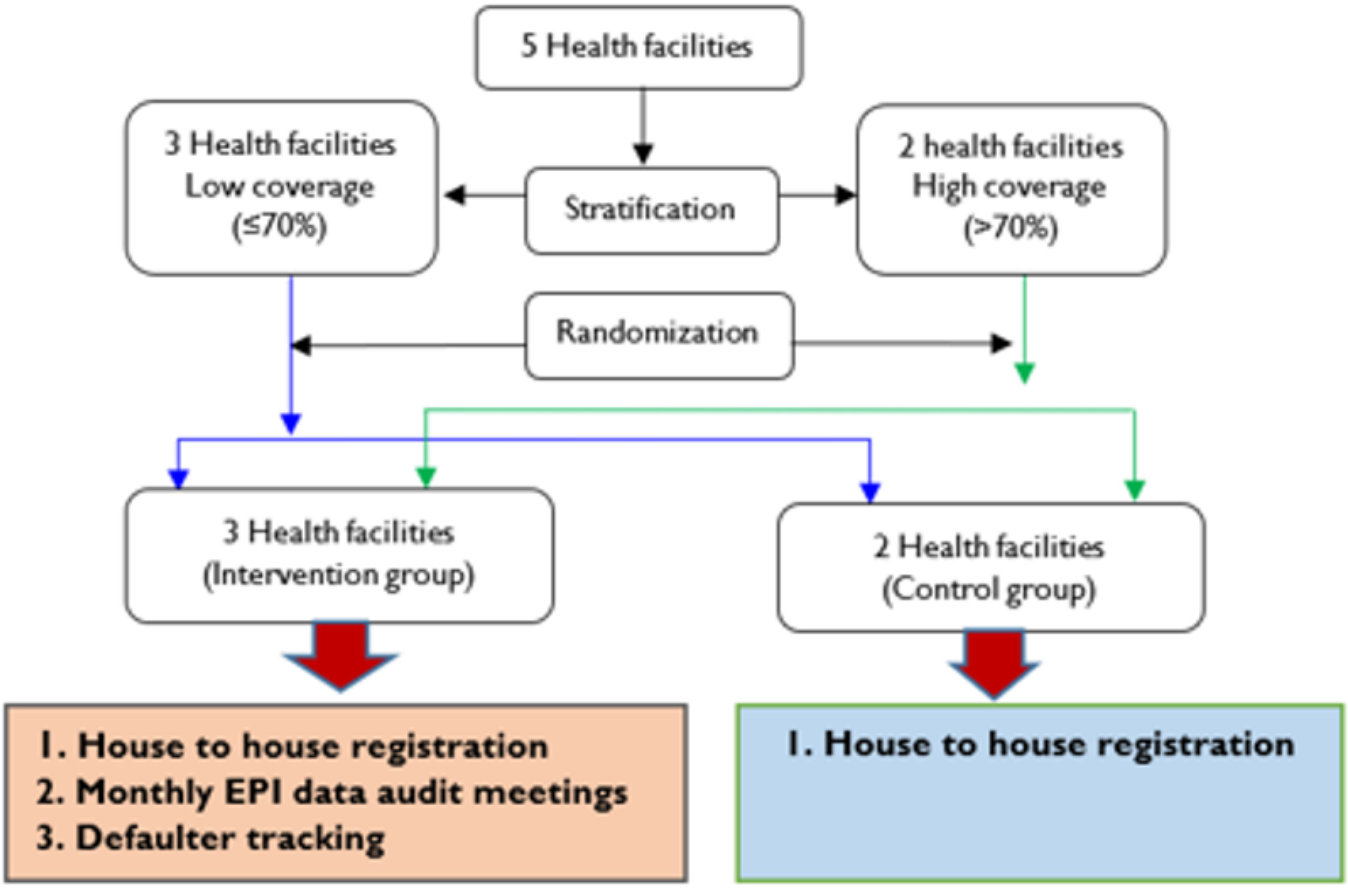


**Figure 1**

Study profile showing stratification and randomization of the Parishes to the intervention and control arms

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- StaRIchecklistPamelaBakkabulindi.docx