The cost of identifying and reaching zero dose children in Uganda:

A case study of house-to-house registration and targeted immunisation outreaches

Uganda Zero Dose Learning Hub

Report

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Executive summary

Background

Despite notable progress in vaccination coverage in Uganda, critical gaps persist, resulting in 109,338 zero-dose (ZD) children and 313,467 under-immunised (UI) children estimated in 2024. ZD children are those who have not received the first dose of the Diphtheria, Tetanus, and Pertussis (DPT)-containing vaccine, while under-immunised children are those who have not completed the third dose of DPT. Many interventions have been implemented to reach Zero Dose Children (ZDC) in resource-constrained settings, including Uganda. However, there is a paucity of data on the costs associated with identifying and reaching ZD and UI children, especially in resource-constrained settings like Uganda. Previous costing exercises or studies in Uganda mainly focused on estimating the costs of routine immunisation and mapping financing flows for routine immunisation.

This study estimated the cost of identifying and reaching a ZD and UI child through selected interventions implemented during the 'big catch-up' campaign conducted in Uganda.

Methodology

In November 2024, Uganda's National Expanded Program on Immunisation (UNEPI) launched the Big Catch-Up Campaign, a nationwide effort to identify and vaccinate ZD and under-immunised children under five. The campaign used house-to-house registration by Village Health Teams (VHTs), followed by static and outreach vaccination.

A costing study was conducted in three high-priority districts Kasese, Mubende, and Wakiso selected for their high burden of zero-dose children. Using a retrospective cross-sectional design, the study applied a combination of a bottom-up ingredient and activity-based costing from a government perspective. Data were collected at the district, sub-county, health facility, and community levels.

Health facilities served as the primary units of analysis, selected based on their, geographic diversity, and facility level. Although costs were incurred at multiple levels, including district, sub-county, health facility, and community, all expenditures were ultimately attributed to the health facility level. A stepwise allocation approach was employed, whereby costs were first distributed from the district to sub-counties, and subsequently from sub-counties to individual health facilities. The study distinguished between financial (actual expenditures) and economic (including donated resources and opportunity costs) costs. The total costs included both financial and economic components and were further categorised based on the nature of the activity—either identification (registration) or vaccination. The main outcome measured was the cost per zero-dose child vaccinated and the cost per child identified.

The number of children registered during the campaign was extracted from the VHT registers that been distributed to VHTs to conduct registration. The registers reflected under-five children and the antigens that they had missed yet were due. The number of vaccinated children for each antigen (for each health facility) was extracted from the immunization records for the campaign period. The records were accessed at the health facility and additional information from the district biostatistician. To determine the 'incremental performance' of the campaign, an assumption was made that even without the campaign, some children would still be vaccinated through routine immunization. We therefore estimated this benchmark vaccination and subtracted it from the number of children vaccinated during the campaign to obtain vaccination attributed to the campaign.

The main study outcomes were the cost per zero-dose child vaccinated and cost per zero-dose child identified – were estimated by dividing the total incremental costs by the number of zero-dose children vaccinated during the campaign.

Results

Number of zero-dose and under-immunised children identified and reached.

In the Big Catch-Up Campaign conducted across Kasese, Mubende, and Wakiso districts, a total of 119,156 children under five were registered through house-to-house efforts led by Village Health Teams. Of these, 12.1% (14,425 children) were identified as zero-dose, having never received the first dose of the DPT vaccine (DPT1). Mubende had the highest proportion of zero-dose children at 15%, followed by Wakiso at 13% and Kasese at 10%. Identification efforts at the selected health facilities registered in 587 zero-dose children in Mubende, 312 in Kasese, and 413 in Wakiso.

Targeted outreach activities resulted in 23,716 children receiving DPT1, with Wakiso accounting for 15,881 vaccinations, Mubende 4,132, and Kasese 3,703. Within selected health facilities, Mubende registered 3,336 children (18% zero-dose), Kasese 2,790 (19% zero-dose), and Wakiso 11,780 (9% zero-dose). Vaccination efforts at these health facilities resulted in 966 zero-dose children receiving DPT1 in Mubende, 124 in Kasese, and 889 in Wakiso.

Using a previous month (before the campaign) to understand the vaccination performance for a typical six-day of routine vaccination (equivalent of the 6-day period of the campaign), we observed that the selected study facilities in Kasese would have ordinarily vaccinated averagely 24 children for DPT1 in 6-days, 72 children for DPT1 in Mubende district, and 71 children for DPT1 in Wakiso District (even without the Big Catch-up campaign).

The incremental vaccination for DPT1 (zero-dose) resulting from the campaign was 1,813 children vaccinated for DPT1 (1979 – 166), with 894 children for Mubende (966 – 72), 100 children for Kasese (124 – 24), and 818 children for Wakiso District (889 – 71).

Costs of implementation

Registration-related costs. The total costs attributable to registration (identification) related activities for the selected study health facilities were estimated at $41,545, with Kasese recording the highest costs at $15,132, followed by Wakiso at $14,578, and Mubende district at $10,466. For all districts, personnel expenses—particularly allowances to VHTs to undertake mobilization and house-to-house registration – were the main cost driver.

Vaccination-related costs were divided into vaccine delivery costs and vaccine/supply costs. The total vaccine delivery costs attributed to DPT1 were $3,634 in Mubende, $7,549 in Kasese, and $4,251 in Wakiso. Relatedly, the total vaccine and supply costs were $3,591 (Mubende), $605 (Kasese), and $3,573 (Wakiso) respectively. The overall vaccination-related costs (vaccine delivery + vaccine & supply costs) attributable to DPT1 vaccination for the study health facilities in the three districts were $24,816, with Mubende district contributing$8,031, Kasese $8,518, and Wakiso $8,267.

Unit costs

Cost per zero dose child identified/registered.

The cost per zero-dose child identified was calculated by dividing the total incremental identification costs by the number of zero-dose children reached during the campaign. The number of zero dose children identified were as follows: 587 in Mubende, 515 in Kasese, and 1,053 in Wakiso. Corresponding unit costs were $3.85 for Mubende, $5.75 for Kasese, and $1.33 for Wakiso. The overall average cost across the three districts was $3.07. Notably, the number of children identified had a significant influence on the unit cost in each district

Cost per zero-dose child vaccinated.

This was estimated by dividing the total vaccination (vaccine delivery costs + vaccines & supplies) costs with the incremental number of zero-dose children vaccinated (reached) across selected study health facilities in the three districts. This resulted in an overall average of $14.0 per zero-dose child vaccinated/reached. The unit cost varied across the districts, with Kasese accounting for $85.18, Mubende with $8.98, and Wakiso with $10.1. A key factor in the estimation of per unit cost was the number of children vaccinated, for example, Kasese district, with the highest total costs, had the lowest number of zero-dose children vaccinated, and this explains the highest per unit costs being associated with Kasese district compared to other districts

Conclusion

The cost per zero dose child identified was $3.07 (range:$1.33 to $5.75). The cost per zero dose child vaccinated with DPT1 in the three selected districts was $14.0 (range: $8.98 to $85.18) and varied by district, with Kasese district posting the highest unit cost ($85.18 and Mubende district having the lowest ($8.98). The unit costs were driven by the variations in coverages (number of children reached during BCU) and the unique district characteristics such as number of administrative units (sub-counties).

These estimates highlight the considerable financial investment required to locate and immunise ZD children, with even higher costs associated with completing the full immunisation schedule. However, when large numbers of children are reached, significant cost savings can be achieved through economies of scale. While campaigns and supplementary immunisation activities can generate economies of scale—such as lower per-child costs when large populations are reached—these efficiencies tend to diminish as coverage increases. The marginal cost often rises due to the need for more targeted, resource-intensive approaches. Thus, although scaling up may enhance overall efficiency, it also demands disproportionate investments to ensure that all ZD children are reached.

Additionally, the long-term sustainability of the targeted outreach campaigns remains uncertain due to resource challenges, and this uncertainty is exacerbated by the global budget cuts. To improve efficiency and reduce implementation costs in future campaigns, it is essential to leverage localised data and triangulate multiple sources—such as DHIS2, house-to-house registration data, census estimates, and IHME projections—to better identify better areas with high concentrations of ZD or under-immunised children. Strategic and data-driven targeting will be critical to ensure optimal effectiveness of immunization strategies.

Recommendations

Short term

1. **Immunisation programs, including UNEPI, should ensure efficient, adequate, and context-sensitive allocation of resources.** Budgeting should consider district-specific challenges—such as geographic barriers and high travel costs—rather than applying uniform rates that may not reflect actual needs. Hard-to-reach areas, including islands, mountainous regions, and underserved communities, often require additional financial and human resources to ensure timely and effective implementation. Furthermore, planning and budgeting processes should actively involve lower-level stakeholders and remain flexible to adapt to the local context.

   However, before institutionalising house-to-house registration as a routine strategy, UNEPI/MoH should conduct a comprehensive evaluation of its effectiveness and cost-effectiveness to ensure optimal resource allocation and impact.

Medium term

2. **To sustain the identification of zero-dose children, Immunisation programs including UNEPI should strengthen community-based registration by improving planning, training, and resource allocation.** This effort can be further enhanced by engaging trusted community actors, such as Village Health Teams, local leaders, religious figures, and peer mothers, who can significantly improve data accuracy and broaden the reach of registration efforts. These combined strategies will not only enhance the identification and targeting of ZD children but may also contribute to reducing overall program costs by minimising inefficiencies and missed cases. Updating immunisation registers at least quarterly will enable more targeted and efficient outreach efforts, ultimately improving coverage and reducing missed vaccination opportunities.

3. **Immunisation programs including UNEPI should consider using digital platforms to capture immunisation and registration data at both community and health facility levels.** This transition has the potential to significantly reduce data processing costs and improve data quality and timeliness. The electronic Community Health Information System (eCHIS), currently being piloted in selected districts, presents a promising solution for digitising house-to-house registration. However, national rollout will require upfront investment in digital infrastructure, including mobile devices and training for frontline health workers.

Long term

4. **Integration:** To maximise impact and efficiency, immunisation programmes, including UNEPI, should strategically leverage and, where feasible, integrate Zero-Dose (ZD) efforts into existing and planned health interventions. This includes platforms such as Integrated Child Health Days, routine immunisation outreach, and immunisation campaigns, as well as broader health initiatives targeting malaria, HIV, TB, nutrition and others. At the heart of these efforts is a single caregiver—often a mother—interacting with the health system. By aligning ZD identification and outreach with services she already accesses, we not only improve coverage but also reduce the marginal cost of reaching zero-dose children. Integration ensures that ZD efforts are not siloed but embedded within the broader health system, enhancing sustainability, efficiency, and equity.

Other considerations

5. **Sustainability** must be a central criterion in the selection and implementation of Zero-Dose (ZD) interventions. As donor funding becomes increasingly constrained—evident in recent funding reductions—countries must prioritise approaches that can be maintained and scaled through domestic resources and systems.

   ZD strategies should be designed with long-term viability in mind, integrating into existing health infrastructure, leveraging community ownership, and aligning with national health priorities. This ensures that progress made in reaching zero-dose children is not only impactful in the short term but also resilient and enduring beyond the lifecycle of external funding.

6. **Capturing the Patient Perspective.** To design equitable and responsive immunisation strategies, future studies must incorporate the patient perspective, particularly the direct and indirect costs faced by caregivers. These include transportation expenses, time away from work, and income loss, which can vary significantly across different geographic and socio-economic settings. Special attention should be given to underserved and high-risk populations such as pastoralist communities, refugees, border populations, and mining communities. Understanding these barriers is essential to tailoring interventions that are both accessible and equitable.

7. **Evaluating the Cost-Effectiveness of Identification and Reach Strategies.** Further research is also necessary to assess the cost-effectiveness of registration systems and targeted outreach strategies aimed at identifying and reaching zero-dose children. Evidence from such studies will be crucial for informing budgeting decisions and guiding efficient resource allocation, ensuring that investments produce maximum impact in reducing immunisation inequities.

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Abbreviations

DHT	District Health Team
DPT	Diphtheria, Tetanus, and Pertussis vaccine
EPIVAC	Expanded Programme for Immunisation Vaccination
HPV	Human Papilloma Virus Vaccine
LH	Learning Hub
MoH	Ministry of Health
UI	Under Immunised
UIC	Under Immunised Child
UNEPI	Uganda National Expanded Program on Immunisation
UNICEF	United Nations International Children's Emergency Fund
VHTs	Village Health Teams
ZDC	Zero Dose Children

1.0 Introduction

Great strides have been made in improving immunisation coverage globally, with more than 300 million children vaccinated in 2020, preventing about seven million future deaths [1]. Despite this achievement, about 25 million children were unvaccinated or under-vaccinated in 2021, including 18 million children who did not receive any vaccine [2, 3]. Zero-dose children (ZDC) have not received a single dose of Diphtheria, Tetanus, and Pertussis-containing vaccine (DPT) by 12 months of age. Under-immunised (UI) children have missed the third dose of diphtheria, tetanus, and pertussis-containing vaccine (DTP3). Under-immunised children have had contact with the health system, and ZDC often lacks access to essential health services, which include immunisation. Nearly half of the child deaths caused by vaccine-preventable diseases occur among ZDC4.

Uganda has made significant progress in improving immunisation coverage through the efforts of the Uganda National Expanded Programme on Immunisation (UNEPI), achieving an estimated coverage of over 90% for most antigens in the routine schedule. Despite this success, the country has continued to experience outbreaks, mainly of measles and polio, especially since 2020. Additionally, data from the Ministry of Health reveals that in 2023, there were 109,338 ZDC and 313,467 Under-Immunised (UI) children. Earlier projections for 2024 showed a concerning increase, with approximately 188,349 ZD children and 363,245 UI children.

In response, the Ministry of Health/UNEPI in Uganda implemented the "Big Catch-Up" campaign nationwide in November 2024. The campaign aimed to identify and reach 297,687 ZD and 676,712 UI children. It also aimed to deliver the second dose of measles-rubella (MR) to 3 million children, provide HPV vaccinations to 600,000 girls, and reach 4,389,835 women of childbearing age.

1.2 Rationale

Many interventions have been implemented to reach ZDC in resource-constrained settings. However, there is a paucity of data on the costs associated with identifying and reaching ZD and UI children, yet this is key to optimal resource deployment and use in resource-constrained settings like Uganda. Previous costing exercises or studies in Uganda1–3 mainly focused on estimating the costs of routine immunisation and mapping financing flows for routine immunisation. This costing study specifically focuses on estimating the costs of identifying and reaching ZD and UI children through selected interventions implemented during the "Big Catch-up" campaign, to inform country- and global-level planning, budgeting, and resource mobilisation to address the burden of ZD and UI in Uganda.

1.3 Objective

To estimate the **incremental cost of identifying and reaching the zero-dose and under-immunised child** through selected interventions implemented during the 'big catch-up' campaign conducted in November 2024 in Uganda.

2.0 Methods

2.1 Study design and context

This was a retrospective costing study conducted from February 2025 to April 2025 from a payer/government perspective (Ministry of Health/UNEPI). This costing exercise estimated the resources utilised to implement interventions and activities that aimed to reach the zero dose and under-immunized children during the 'big catch-up' campaign.

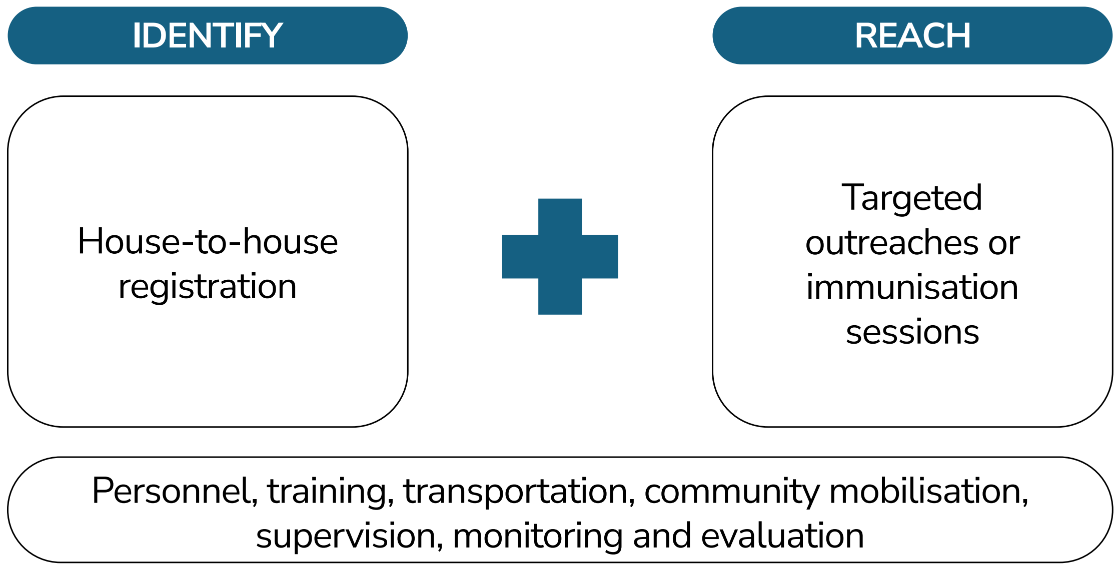
2.2 Scope

This costing study was based on the 'Big Catch-up' campaign conducted in Uganda in November 2024, which aimed to reach ZD and UI children. This costing study/exercise focused on the key interventions (Figure 1) as follows:

(i) **House-to-house registration of children.** This was conducted to identify the ZD and UI children eligible for vaccination. Under the House-to-house registration, Village Health Teams (VHTs) visited each house and registered children under five years in their respective villages. These lists were subsequently used to update the health facility micro plans and map hotspots for outreach activities.

(ii) **Targeted Outreaches/Immunisation Sessions to reach/vaccinate children:** After registration, outreach sessions were conducted in identified hotspots where ZD children were located, specifically targeting these areas to vaccinate the children.

Figure 1: Costed interventions



2.2.1 Who is a zero-dose child (ZDC)?

A zero-dose child refers to a child who has not received any routine vaccine. For operational purposes, Gavi defines a zero-dose child as one who has not received the first dose of the diphtheria-tetanus-pertussis-containing vaccine (DTP1) between 12-24 monnths.4 For the big catch-up campaign, the Ministry of Health defined a zero-dose child as any child below the age of 5 who had not received the first dose of DPT. A Zero-Dose (ZD) child identified referred to any child under the age of five (older than six weeks) who was registered during the house-to-house campaign and had not yet received the first dose of the DPT vaccine. ZD children reached were those in the same age group who received their first DPT dose during the campaign. In contrast, Under-Immunized (UI) children identified were those under five who had not received the third dose of the DPT vaccine at the time of registration. UI children reached were those who received their third DPT dose during the campaign. These two groups (ZD and UI) were defined as mutually exclusive.

Table 1: Definitions of zero dose and under immunised children

Term	Definition
Zero dose child identified	This refers to children under the age of five (older than 6 weeks) who were **registered** during the house-to-house registration of the Big Catch-Up campaign and **had not received the first dose of the DPT vaccine.**
Zero dose child reached	This refers to children under the age of five (older than 6 weeks) who were vaccinated during the big catch-up campaign with **the first dose of DPT vaccine.**
Under immunised child identified	This refers to children under the age of five who were **registered** during the house-to-house registration of the Big Catch-Up campaign **and had not received the third dose of the DPT vaccine.**
Under immunised child reached	This refers to children under the age of five who were **vaccinated** during the big catch-up campaign with **the third dose of DPT vaccine.**
By registration, we refer to the process through which Village Health Teams gathered social demographic and immunization data about children under five years old in their respective villages.	

2.3 Study sites

The costing activity was conducted in the three Learning Hub (LH) districts—Mubende, Wakiso, and Kasese. Within each district, sub-counties were purposively selected based on the availability of process evaluation data previously collected by the LH team during the Big Catch-up Campaign[1], geographical representation, underserved populations, and the presence of both urban and rural communities.

[1] The LH conducted process evaluation during the big catch-up campaign in all three districts. The primary objectives were to assess the quality and fidelity of the 'Big Catch-up' implementation and document the contextual factors influencing its execution. The data collected provided valuable context to the findings in this study.

A total of 18 health facilities were selected across the selected sub-counties for the costing exercise (Table 2). The health facilities were purposively selected based on the following criteria: (i) prior inclusion in the Learning Hub project under other sub-studies, ii) health facilities where process evaluation observations during the big catch-up had been conducted, (iii) geographic representation, and (iv) the level of facility. At the selected health facility, the data collection exercise involved eliciting inputs/resources expended in the 'big catch-up' through interviewing/interacting with health workers who were directly involved in the implementation, interviewing the VHTs involved in the house-to-house registration as well as vaccination, interviewing finance officers at the facility, and reviewing records.

Table 2: Selected sub-counties and health facilities that participated in the study

	Health facilities visited
Mubende district	
Butoloogo sub-county	Butoloogo HCIII, Kanyogoga HCII
Kiruuma sub-county	Kituule HCII
Kigando sub-county	Butawata HCIII, Suubi HCII, Mawujjo HCII
Kasese district	
Lake Katwe sub-county	Katungulu HCII, Kasenyi HCIII
Karambi sub-county	Karambi HCIII, Kisololo HCII
Isango sub-county	Kyembara HCIII, Kamukumbi HCII
Wakiso district	
Busukuma sub-county	Namulonge HCIII, Kasozi HCIII
Bweyogerere sub-county	Bweyogerere HCIII
Masulita Town council sub-county	Kanzize HCII
Namayumba sub-county	Namayumba HCII
Bussi sub-county	Bussi HCIII

2.4 Programmatic and contextual data alongside the costing study

The Learning Hub conducted a process evaluation alongside the big catch-up campaign in November 2024. The primary objective of the process evaluation was to assess the implementation of the Big Catch-up campaign in November 2024 in Wakiso, Kasese and Mubende districts. Specifically, the evaluation aimed to understand the **i) context:** ZD prevalence before and after the intervention, **ii) implementation fidelity:** how the intervention was implemented, how it compares to previous practices, whether it was implemented as planned and what worked well or what did not and iii) the **appropriateness** of the intervention. The costing exercise will leverage these findings to contextualise the costing study findings.

2.5 Costing methodology

The methodology adopted for this costing exercise was based on the research principles for studies that estimate the cost of reaching ZD children, published in August 2024 by Think Well5, Common approaches for costing and financing analyses of routine immunisation by Brenzel et al6, WHO-led consensus statement on vaccine delivery costing,7 how to cost immunisation programs by Resch et al.8 Global Health Cost Consortium (GHCC) Reporting Checklist9 and the costing guidance developed by John Snow, Inc. (JSI).10

A combination of bottom-up ingredients and activity-based approaches was used to identify, quantify, and value (in monetary terms) the activities and corresponding inputs used to implement those activities at each phase of the intervention. Both financial and economic costs were captured. Financial costs were defined as the direct monetary expenditures provided by the Ministry of Health for implementing the intervention. Economic costs, on the other hand, were defined as opportunity costs, including the value of personnel time dedicated to the intervention and in-kind contributions from partner organizations.
In summary, the costing exercise followed three key steps involved in the methodology:

i) **Identifying** all resource inputs or 'ingredients or activities that were involved in the implementation of the interventions during the period under consideration.

ii) **Quantification/measurement** of respective resource inputs or 'ingredients or activities that were identified or used in the intervention implementation for the period under consideration.

iii) **Valuation** of resource inputs, activities, or ingredients, or resource requirements, based on the appropriate monetary costs, such as through the use of purchase prices (including subsidy scenarios), market prices, and shadow pricing, particularly for volunteer resources. Donated resources were also valued based on procurement prices; where these prices did not exist, an option of equivalent shadow pricing was adopted. All inputs were valued in 2024 Uganda Shillings before being converted to US dollars using the November 2024 exchange rate.

2.6 Study population, perspective, and time horizon

The costing study utilised the target age group used during the campaign – children under five years of age. The payer/provider (Ministry of Health/UNEPI) perspective focuses on the costs of the intervention that are met or incurred by the provider of services.11 The rationale for focusing on this perspective is consistent in providing insights into the policy, programming, and resource mobilisation process to facilitate the rollout of effective interventions that address the ZDC and UI children. We included the costs incurred at the district, sub-county, health facility, and community levels. The study time horizon was 3 months, corresponding to the start and end of the 'big catch-up' intervention (campaign).

2.7 Data, data collection process, and sources

Costs and outcome data was collected through the following approaches:

a) **Key informant interviews (KIIs):** Respondents were purposively selected from the district, health facility, and community levels, provided they participated in the campaign. These included District Health Officers (DHOs), immunisation focal persons, Assistant District Health Officers (ADHOs), district biostatisticians, Chief Administrative Officers, health workers, and VHTs.

b) **Document Review:** Relevant documents were identified and reviewed, including program budgets, implementation guidelines, meeting minutes from planning sessions, training reports, process evaluation reports, and other field documents. This review aimed to understand the implementation process, identify the key activities carried out at each stage, determine the corresponding resource inputs, and assess the guidance provided on budgets and expenditures during the implementation period.

c) **Data abstraction** Involved Extracting data on vaccine stocks, related supplies used, the number of eligible children registered during house-to-house registration, and those reached with various antigens during vaccination from sources such as data registers, VHT registers, HMIS registers, EPIVAC, and DHIS2 systems. This information was utilised mainly to extract the outcomes of the implementation exercise.

d) **Time and motion:** To estimate the economic costs, interviews with individual involved in the planning and implementation phases such as district-level teams, supervisors, health workers, and VHTs incorporated questions to quantify the time spent on key activities associated with the 'big catch-up' campaigns. Since these contributions are not directly funded by the payer/provider, they were estimated and valued using shadow pricing to assess their value – that is, determining the time expended by each resource and estimating the value of that time based on salaries or equivalents for those specific cadres or estimated values of voluntary effort.

Table 3 summarises the number of interviews conducted at each level in each district. Table S1 in the annexes breaks down the number of people interviewed in each of the health facilities.

Table 3: Number of interviews conducted by level

	Mubende district	Kasese district	Wakiso district	Type of people interviewed
	Number of interviews conducted			
District Health Team	6	9	7	District Health Officer (DHO), Assistant District Health Officer (ADHO), Biostatistician, Health Educator, Accounts Office, District cold chain technician
Sub-county	3	3	3	VHT coordinators, sub-county supervisors

	Mubende district	Kasese district	Wakiso district	Type of people interviewed
	Number of interviews conducted			
Health workers	7	14	21	Health incharges, immunisation focal persons and other health workers involved in the big catch up
Village Health Teams (VHTs)	12	17	24	Village Health Team member

2.7.1 Data collection tools

A word-based questionnaire was designed and administered through face-to-face interviews to collect both costing, outcome/effectiveness, and contextual data. The tool was adapted from a generic version provided by Boonstoppel et al. 12 for immunisation campaign costing. It was utilised at the district level and modified slightly for use at health facilities to assess specific activities. The data captured was verified for accuracy and completeness before being transferred or entered into an Excel workbook. The data collection and cleaning procedures adhered to standard operating procedures (SOPs) for quality assurance (QA), which were thoroughly reviewed during the training of research assistants.

2.8 Estimating resources and costs

Table 4 summarises the quantification method and valuation approach for each expenditure and activity line item used to calculate and report costs in this study.

Table 4: Expenditure line items, resource line times and valuation methods

Expenditure line item	Quantification methods	Valuation methods
Recurrent costs		
Salaried labour	The quantification process captured the total time spent delivering the intervention. Immunization staff reported the number of hours allocated to various campaign activities throughout the implementation period. Human resource costs for administrative personnel were excluded unless respondents explicitly indicated their involvement in the campaign.	Staff time was valued using monthly remuneration figures derived from the Ministry of Health public service salary scales.
Recurrent costs		
Non-salaried labour (e.g VHTs)	Time contributions from Village Health Teams (VHTs) and non-clinical staff who directly supported the campaign were included. We quantified the number of hours they dedicated specifically to campaign activities.	We accounted for the stipends disbursed during the campaign as part of the financial cost, and estimated the economic cost based on the additional hours spent on implementation activities. We assumed a minimum monthly wage rate of USD 177.13
Per diem/Safari Day Allowance	Per diem, Safari Day Allowance, and transport reimbursements were calculated based on the number of days individuals were supported to participate in campaign-related activities, including meetings, trainings, vaccination sessions, and data processing tasks.	The intervention rates for per diems and transport allowances were retrieved from financial reports and verified through interviews.
Vaccine costs and vaccine injection supplies.	Districts and health facilities maintain records of vaccine receipts and usage. We extracted data from vaccine control books at both the health facility and district levels. Additionally, unit costs for the vaccines were verified using delivery logs from the National Medical Stores.	To value the vaccine administration, we used the unit cost of delivering DPT vaccine (UNICEF estimates)14 and multiplied this by the number of doses given during the campaign.
Fuel	This included fuel consumed by vehicles and motorcycles used during the campaign. All vehicles and motorcycles involved in the exercise were accounted for. Fuel costs were estimated based on actual fuel expenditures, including additional contributions from partners or out-of-pocket expenses.	We used the price of fuel used in the financial reports to allocate the total fuel costs.
Vehicle maintenance costs	Quantification was based on actual reported vehicle maintenance costs specifically for the big catch-up campaign.	Vehicle maintenance was valued at actual expenditure incurred or based on the maintenance costs detailed in the expenditure reports.

Expenditure line item	Quantification methods	Valuation methods
Recurrent costs		
Printing	Printing costs were based on actual expenditures reported at the district and health facility levels. Additional printing expenses covered by EPI partners or out-of-pocket contributions from health workers were also documented.	This was valued using actual expenditure reported and other costs from out of pocket expenditures from health workers.
Training costs	Training costs were calculated based on the number of training days and the number of participants. Additional expenses such as venue rental, facilitator fees, per diems, travel allowances, and training supplies were also included.	Actual expenditure incurred by EPI programme, at all levels.
Vehicles and motorcycles	Vehicles and motorcycles used in the campaign were captured. This mostly included vehicle/ motorcycle hire.	We captured the vehicle/motorcycle hire cost based on financial reports or expenditures reported by respondents.
Activities		
Activity	Expenditure items included in the activity	Allocation method
Data processing during campaign	This activity involved the time allocated by health assistants, data assistants, and biostatisticians for data collection, aggregation, and analysis.	Staff were asked to estimate the time they dedicated to data entry and analysis. This time was then monetized using their corresponding hourly wage rates.
Supervision	This included staff time for district and sub-county supervisors, as well as associated transport and fuel expenses, per diems, and travel.	Staff were asked to estimate the time they dedicated to supervision activities, which was then monetized using their hourly salary rates. Additionally, respondents were requested to report any travel-related expenses specifically incurred for supervision during the campaign.

Expenditure line item	Quantification methods	Valuation methods
Recurrent costs		
Outreaches/ vaccination	Time allocated by health workers to conduct the outreaches/ vaccination during the big catch up.	Staff were asked to estimate the time they dedicated outreaches. This time was then monetized using their corresponding hourly wage rates.
Social Mobilisation and communication	This included staff time, transport and fuel costs, per diem and travel allowances (if applicable). Village health team members (VHT) were also included in this activity.	District health educators and Village Health Teams (VHTs) were asked to estimate the time they dedicated to social mobilisation and advocacy activities. This time was then costed using their respective hourly salary rates. Respondents also reported any travel expenses specifically incurred in relation to social mobilisation efforts.
Cold chain maintenance	Cold chain maintenance includes staff time, operating costs (energy costs) and costs of any repairs.	Staff were asked to estimate the time they dedicated to this activity, which was then costed using their hourly wage rates. Reported repair expenses were included in the analysis; however, no maintenance costs were imputed if no repairs were reported.
Other	This included any expenditure items which could not easily be allocated to the other cost components.	In cases where cost allocation was unclear, the full amount was categorized under 'Other.' This was calculated by multiplying the quantity of items by their respective unit costs.
*** We did not measure and value the cold chain equipment as non was purchased for the purposes of the big catch up campaign.**		

2.9 Data analysis

2.9.1 District and Health Facility Costs

Campaign implementation costs were incurred at three key administrative levels, namely: at district level (mainly for centralized planning, publicity and social mobilization, supervision, trainings, data processing, etc); at health facility level (including for supervision, vaccination, outreaches, vaccines and associated supplies, etc) and at community level (mainly VHT house-to-house registration, community mobilization, etc). Given that the unit of analysis was the health facility, we allocated (attributed) these costs to a particular health facility using a step-wise approach as follows:

Step 1: Estimated resources spent at district level.

The key activities conducted at district-level associated with 'big catch-up' implementation were identified, quantified and costed. These mainly included meetings and trainings, advocacy and mobilisation, monitoring and supervision, data processing, and other relevant expenses. Each activity was disaggregated into financial and economic costs, and total district-level costs were estimated. In our study we defined Economic costs as opportunity costs. In this analysis, **economic costs** = In-kind contributions + Unpaid venue cost + Personnel time (spent on activities such as meetings/ trainings, advocacy and mobilisation, cold chain maintenance, monitoring and supervision, vaccination (outreaches and routine) and data processing). **Financial costs** = Supplies + Allowances (transport refund, per diems) + Meals and Refreshments + Equipment hire + Communication costs (e.g radio talk shows) + Fuel +Other costs.

Given the challenge of estimating costs attributed to activities related to either identification (registration) process, or vaccination, at the district level, we adopted a 30:70 allocation assumption, except for clear-cut activities such as cold-chain maintenance that was associated with vaccination. The allocation assumption was based on discussions and experiences with the district implementers considering the intensity and proportion of the registration or vaccination activity to the entire campaign. This allocation applied to the following activities: (i) meetings and trainings, (ii) advocacy and mobilisation, (iii) monitoring and supervision, and (iv) data processing.

Step 2: Allocating district-level resources to sub-counties.

As already noted, all sub-counties participated in district-level 'centralized' activities particularly during the preparatory stage. We applied a rule-of-thumb to allocate the district-level resources equally to all sub-counties within that district. In this case, each sub-county received a share of district-level resources (spent in joint activities) both attributable to identification (registration) and vaccination.

Step 3: Allocating sub-county level resources to health facilities.

Once district-level resources had been allocated to the sub-county, the next step was to share these resources across the health facilities within that particular sub-county. To distribute registration-related costs, we calculated an allocation formula based on the proportion of DPT 1 and DPT3 children registered per health facility over the total number registered for the same antigens in entire sub-county. The same approach was used to allocate costs related to vaccination by using number of children vaccinated for DPT1 and DPT 3 at the health facility compared to the entire sub-county.

Step 4: Estimated costs related to identification and vaccination at health facility.

Identification and vaccination costs reflect a combination of costs attributed to the facility from sub-county (following the step-wise allocation process), and costs associated with activities conducted at the health facility as well as the community or facility catchment area.

At the health facility level, the cost categories that were considered included: vehicles, transport, and fuel; vaccines; human resources, including volunteer contributions (particularly from VHTs towards registration and immunisation); training; social mobilisation and advocacy; per diem and travel allowances. For activities that were not expressly attributed to either vaccination or registration, a 30:70 allocation (registration: vaccination) was done, for example, facility level social mobilization and advocacy activities, supervision, etc.

Step 5: Incremental costs

Once all allocations and atributions of costs were done across levels up to the health facility, total costs associated with registration and costs associated with vaccination during the implementation of the campaign were estimated at health facility level. Since vaccination programming is integrated into broader healthcare service delivery, this study assumed that resources expended during the intervention were **'incremental,'** because they were incurred on activities that are beyond the 'business-as-usual' scenario. The activities undertaken to implement the interventions beyond a 'business-as-usual' scenario were then summed up to determine the overall cost for each health facility.

The estimated costs expended at the selected health facility were defined as **(Exp.HF(Internal)** for simplicity purposes. The health facility-level total incremental costs were estimated by summing the sub-county-level costs 'attributable' or 'allocated' to the health facility (Alloc.). HF(Sc) and costs incremental expenses/costs incurred at that specific health facility (Exp.HF(Internal). **Total Incremental costs at Health Facility=Alloc.HF(SC)+Exp.HF (Internal).** The total incremental costs reflect the sum of incremental costs incurred by all 18 health facilities, which are spread across 11 sub-counties and 3 districts included in this study.

Step 6: Attribution of total costs to vaccination-related costs.

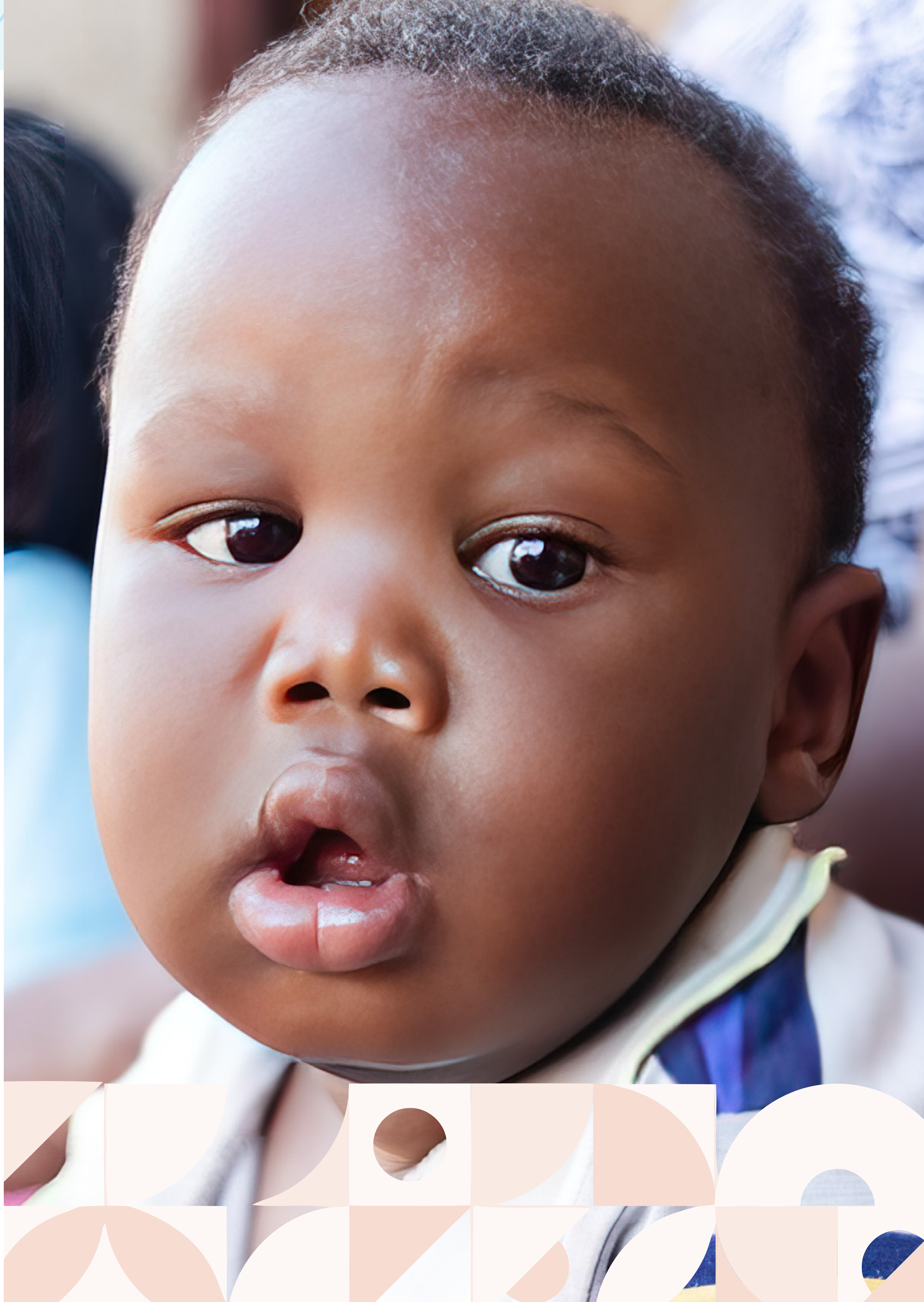
We attributed costs to each antigen delivered during the campaign by combining vaccine delivery costs with the costs of vaccines and supplies. For delivery costs, we calculated the proportion of children vaccinated with each antigen relative to the total number of children vaccinated across all antigens. For example, if DPT1 represented a certain share of total vaccinations, including DPT, MR, HPV, etc, that proportion was used to allocate the overall delivery costs to DPT1. Separately, the cost of vaccines and supplies was determined by multiplying the per-dose cost of each antigen by the number of doses administered during the campaign. The sum of these two components, delivery costs and vaccine/supply costs, constituted the total cost attributed to each antigen. This method ensured a fair allocation of resources across the multiple antigens delivered.

2.9.3 measurement of the outcome

The primary outcome of this costing study was the **cost per zero-dose child vaccinated or reached through the big catch-up campaign.** This was estimated by dividing the total costs incurred on activities related to vaccination by the number of zero-dose children reached or vaccinated. A secondary outcome considered was the **cost per zero-dose child identified/ registered during the big catch-up campaign,** which was estimated by aggregating the incremental costs associated with activities related to house-to-house registration and dividing by the number of zero-dose children identified/registered.

2.9.4 Assumptions

- Our analysis assumes that routine immunization services—'business-as-usual'—remained minimally functional during the Big Catch-Up (BCU) period. Therefore, all costs associated with implementation of the campaign were considered incremental. The actual implementation of the BCU the campaign spanned a minimum of 10 days, including 1–2 days for training, 3 days for house-to-house registration, and 6 days dedicated to outreach activities.
- We assumed that all children who received DPT1 were previously zero-dose, and that those who received other antigens—such as BCG, Measles-Rubella (MR), Human Papillomavirus (HPV), and Tetanus (Td) vaccines—were eligible for those respective vaccines.
- In our analysis, the ZD children included those who were identified as not having received the first dose of DPT1 and were subsequently vaccinated with DPT1.
- In our analysis the Under Immunised children included children who were identified as not having DPT3 and were consequently vaccinated with DPT3.
- We assumed that routine vaccination continued during the Big Catch-Up period. To adjust for this, we reviewed immunisation data from prior months and calculated the average daily number of children vaccinated by dividing the monthly total by 30 days. This daily figure was then multiplied by six to estimate the number of children likely vaccinated through routine services during the six-day campaign. That estimate was subtracted from the total number of children immunised during the Big Catch-Up to isolate the additional impact attributable to the campaign itself. (Table S6, Annexes).



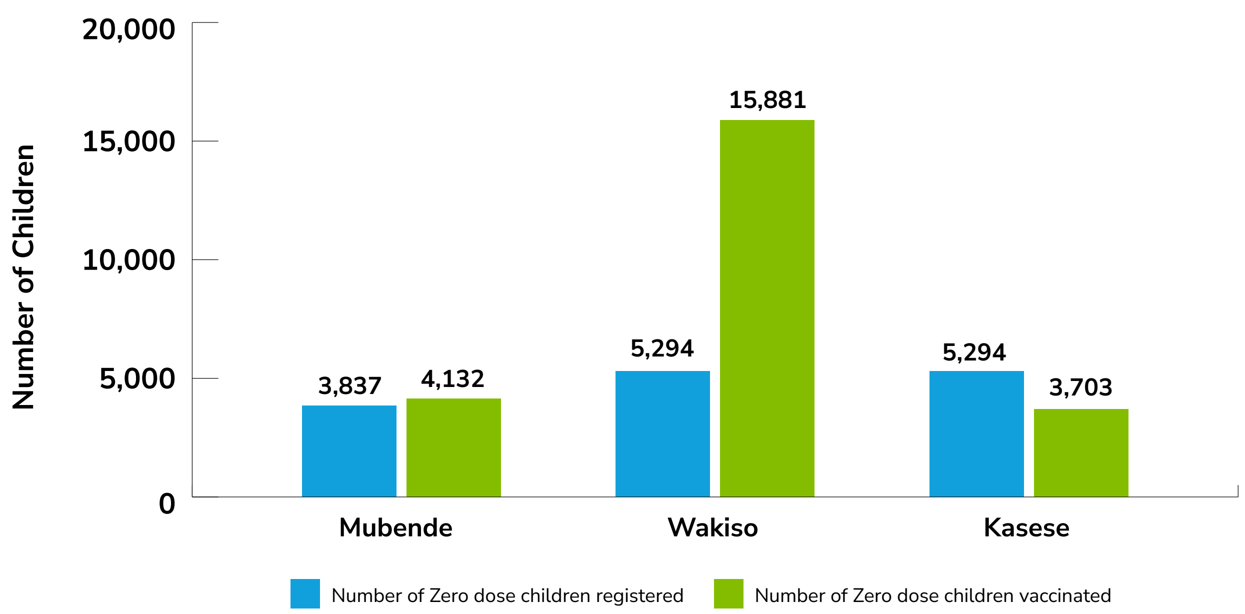
3.0 Results

3.1 Number of children identified and reached during the big catch up.

3.1.1 Zero dose children identified and reached for the study districts

Across the three study districts, a total of 119,156 children under five years were registered through house-to-house registration, with 12% (14,425) identified as zero-dose children—those who had never received the DPT1 vaccine (Figure S1, annexes). Mubende registered 26.6% (3,837) of the total zero-dose children registered, and Kasese and Wakiso districts each registered 36.7% (5,294 each). (Figure 2). During outreach activities, 23,716 children received DPT1, with Mubende accounting for 4,132 vaccinations, Wakiso 15,881, and Kasese 3,703 (Figure 2).

Figure 2: Number of zero dose children identified/registered (who had never received DPT)1 and number of children vaccinated with DPT1 in Mubende, Wakiso and Kasese districts during the big catch up campaign.



This bar graph summarises the number of children registered who had never received DPT1 during house-to-house registration (Zero-dose children) and the number of children vaccinated with DPT1 during the targeted outreaches

The number of vaccinated children exceeds the number of registered. This is attributed to the rushed implementation timeline, which required Village Health Teams (VHTs) to complete household registration within just three days. Additionally, only one VHT was assigned per village, which proved inadequate for larger areas. The total effect was that the house-to-house registration exercise was not comprehensive and exhaustive.

3.1.2 Under-immunised children identified and reached at district level

From the 119,156 children registered across the three study districts, 17.7% (21,080) were classified as under-immunised children having never received the third dose of the DPT vaccine (DPT3) (Figure S1, Annexes). Mubende district had 22.76% of its registered children as under-immunised. Similarly, Kasese and Wakiso districts had 13.7%, and 19.9% of their recorded children under immunised respectively. Focusing on only the study sites (selected health facilities within the study districts, 621 (18.6%) from selected study sites in Mubende district were under immunised (for DPT3), 663 (23.8%) from study sites in Kasese district, and 1,986 (16.9%) from study sites in Wakiso district. The number of under-immunised children vaccinated in the study sites was 1,334 for Mubende, 110 for Kasese, and 604 for Wakiso districts.

In some districts, the number of vaccinated children exceeds the number of registered. This is largely attributed to the rushed implementation timeline, which required Village Health Teams (VHTs) to complete household registration within just three days. Additionally, only one VHT was assigned per village, which proved inadequate for larger areas. The house-to-house registration exercise was not comprehensive and exhaustive. Further details on registration and vaccination by sub-county are provided in Table S2 in the annexes.

3.2 Number of children identified and registered in the sampled health facilities. (within the study districts).

Table 5 presents data from selected health facilities across the study districts. In Mubende, a total of 3,336 children were registered, of whom 587 (17.6%) were identified as zero-dose and 621 (18.6%) as under-immunised. In Kasese, 2,790 children were registered, with 312 (18.5%) being zero-dose and 394 (23.8%) under-immunised. Wakiso district recorded the highest number of registered children at 11,780, with 1,312 (11.2%) being zero-dose and 1,833 (15.7%) under-immunised. The number of zero-dose children vaccinated with DPT1 in the study sites was 939 in Mubende, 124 in Kasese, and 889 in Wakiso. For under-immunised children receiving DPT3, the numbers vaccinated were 2,029 in Mubende, 110 in Kasese, and 604 in Wakiso.

A total of 1,833 children were registered as under-immunised -had not received the third dose of DPT3. Focusing specifically on the selected study sites within each district, 621 children (18.6%) in Mubende, 663 (23.8%) in Kasese, and 1,986 (16.9%) in Wakiso were under-immunised for DPT3. Among these, 1,315 under-immunised children were vaccinated in Mubende, 181 in Kasese, and 1,606 in Wakiso. These findings highlight both the burden of under-immunisation and the progress made in reaching these children through targeted interventions at the facility level.

Table 5: Number of children registered and vaccinated by sub-county (only sampled health facilities)

				DPT1		DPT3	
District	Sub-county	Sub-county Characteristics	Health facility	Registered*	Vaccinated**	Registered	Vaccinated
Mubende	Kiruuma	Under-served (served by only one health facility)	Kituule HCII	131	121	143	169
	Butoloogo	Hard to reach and sparsely populated	Butoloogo HCIII	140	674	179	993
			Kanyogoga HCII	22	53	28	90
	Kigando	Pastoral and sparsely populated	Butawata HCIII	230	91	228	63
			Mauwjjo HCII	64	27	43	19
			Suubi HCII	**587**	**966**	**621**	**1,315**
Kasese	Isango	Mountainous and sparsely populated	Kyempara HCIII	5	31	3	22
			Kamakumbi HCII	2	3	2	10
	Karambi	Border sub-county (Congo and Uganda)	Karambi HCIII	205	29	267	14
			Kishololo HCII	44	27	58	22
	L.Katwe	Fishing community	Katungulu HCII	28	5	36	13
			Kasenyi HCII	28	29	28	29
			Total	**312**	**124**	**394**	**110**
Wakiso	Bussi	Island	Bussi HCIII	22	84	12	90
		Peri-urban	Namulonge HCIII	14	110	13	44
	Busukuma		Kasozi HCIII	19	52	32	71
	Bweyogerere	Urban slum	Bweyogerere HCIII	348	563	745	340
	Masulita	Urban-rural	Kanzize HCII	2	32	2	25
	Namayumba	Urban rural	Namayumba HCII	8	48	14	34
			Total	**413**	**889**	**818**	**604**
			Grand total	**1,312**	**1,952**	**1,833**	**2,029**

*The number of children registered as never having received the first dose of DPT (zero dose children)
**The number of zero-dose children vaccinated with the first dose of DPT

4.0 Total costs of implementation

As indicated in section 2.8.1, the costs incurred at various administrative levels within the district were attributed to a health facility as the unit of analysis using a step-wise approach. Further, the costs were categorized as either costs associated with identification/registration or costs associated with vaccination. This categorization reflected the nature of and outcome of various activities implemented. A further categorization of costs into financial costs and economic costs was done. In brief, the step-wise approach described in section 2.8.1 demonstrates centralized costs incurred at district level were shared across the sub-counties in the district, and further down to the health facilities for eventual analysis.

4.1 Attributing district-level costs to sub-counties

Firstly, we estimated the resources that were spent at the district level. Table 6 below shows the total expenditure for centralized activities at the district level during the implementation of the big catch-up. A range of activities was carried out at the district level to support the implementation across the entire district. These activities included both preparatory and operational tasks such as district planning meetings, training and capacity building, advocacy and mobilisation (e.g., radio adverts, mentions, and talk shows), monitoring and supervision, data processing, and cold chain maintenance. Trainings and planning meetings involved members of the District Health Team, key administrative officials such as the Chief Administrative Officer and District Education Officer, political leaders at both district and sub-county levels (Local council chairmen, representatives from the security arm), health facility in-charges representing all health facilities in the district, as well as sub-county supervisors.

The overall implementation cost in the three districts was $214,931. The total district-level costs for Mubende were $44,975, with each sub-county in Mubende (19 sub-counties) sharing $2,367. The total district level costs for Kasese were $95,353, and each sub-county (44 sub-counties) shared $2,167. The total district level costs for Wakiso were $74,563, and each sub-county (27 sub-counties) shared $2,762.

These elevated costs in Kasese are partly attributable to the administrative complexity in Kasese, which comprises 44 sub-counties, compared to 27 in Wakiso and 19 in Mubende. The primary cost driver in all districts was data processing (36% of the total cost), primarily conducted at the district and sub-county levels. Most of these costs were in-kind support from partners such as PATH, which provided allowances for health assistants to aggregate data throughout the campaign period. Additionally, some EPI partners provided funds to photocopy additional registration forms, which were insufficient to facilitate registration by VHTs.

Table 6: Total expenditure (in US$) at the district level during the implementation of the big catch up

	Mubende district			Kasese district			Wakiso district			
Cost Category	**Financial cost**	**Economic cost**	**Total cost**	**Financial cost**	**Economic cost**	**Total cost**	**Financial cost**	**Economic cost**	**Total cost**	**Grand total (%)**
Meetings and Trainings	6,518	6,924	13,442	10,853	11,233	22,086	10,569	11,178	21,747	57,275 (27%)
Advocacy and mobilisation	5,367	5,909	11,276	4,930	4,989	9,919	7,117	7,179	14,296	35,491 (17%)
Monitoring and supervision	2,269	398	2,667	14,964	7,306	22,270	4,696	2,015	6,710	31,647 (15%)
Data processing	6,874	8,193	15,067	17,335	19,434	36,768	8,185	18,161	26,346	78,181 (36%)
Cold chain maintenance	1,453	320	1,772	2,661	938	3,599	2,727	1,646	4,373	9744 (5%)
Other costs	375	375	750	375	375	750	477	613	1,090	2,590 (1%)
Grand total	22,857	22,119	**44,975**	51,118	44,274	**95,393**	33,771	40,792	**74,563**	**214,931**

The table shows shared costs by category across sub-counties in each district, excluding vaccine costs, outreach allowances, and time contributions of health workers and VHTs. These excluded costs are accounted for at the health facility level.

4.2 Identification and vaccination-related costs at the sub-county level

Once district-level costs had been allocated to sub-counties, these costs were subsequently allocated from sub-county to health facilities within that sub-county, including the selected health facilities, taking into consideration the identification and vaccination cost categorizations. Sub-county level costs were allocated to health facilities based on 'level of performance during the campaign' which was proxied by number of children a particular health facility vaccinated for DPT1 & DPT3 as a proportion of the entire sub-county performance on those indicators. In otherwards, the share of sub-county level costs for each health facility within a particular sub-county reflected the proportion of DPT1 and DPT3 registered and vaccinated out of the total sum of DPT1 & DPT3 for the entire sub-county). This criterion resulted into costs attributed to registration and costs attributed to vaccination for each health facility within that sub-county. In Table 7, reflects the operationalization of this criterion and indicates that the total cost for registration and identification across all sampled health facilities in each district was $4,763, with Mubende incurring the highest expense at $2,496. Vaccination-related costs were even higher, totalling $13,553 across all sampled health facilities, with Wakiso recording the highest expenditure at $5,541.

Table 7: Cost allocation of sub-county resources to each health facility sampled.

District	Sub-county	Sub-county characteristics	Health facility	Registration related costs	Vaccination related costs
Mubende	Kiruuma	Under-served (served by only one health facility)	Kituule HCII	710.13	1,656.97
	Butoloogo	Hard to reach and sparsely populated	Butoloogo HCIII	613.91	1,526.06
			Kanyogoga HCII	96.22	130.91
	Kigando	Pastoral and sparsely populated	Butawata HCIII	534.93	1,275.87
			Mauwjjo HCII & Suubi HCII	124.97	381.10
			Total cost	**2,080.16**	**4,970.92**
Kasese	Isango	Mountainous and sparsely populated	Kyempara HCIII	433.60	1,218.69
			Kamakumbi HCII	216.80	298.92
	Karambi	Border sub-county (Congo and Uganda)	Karambi HCIII	390.08	372.90
			Kisholollo HCII	84.30	424.93
	L.Katwe	Fishing community	Katungulu HCII	109.83	171.81
			Kasenyi HCII	96.10	553.60
			Total cost	**1,330.72**	**3,040.85**
Wakiso	Bussi	Island	Bussi HCIII	41.73	1,656.96
	Busukuma	Peri-urban	Namulonge HCIII	51.42	589.50
			Kasozi HCIII	97.13	470.84
	Bweyogerere	Urban slum	Bweyogerere HCIII	683.93	1,100.63
	Masulita	Urban-rural	Kanzize HCII	15.49	1,101.88
	Namayumba	Urban rural	Namayumba HCII	46.62	621.63
			Total cost	**936.32**	**5,541.43**
		Overall total cost		**4,763**	**13,553**

4.3 Costs related to the identification and registration of children at the health facility level

We then calculated the costs related to the identification and registration of children at the health facility level, based on information gathered through interviews conducted at these facilities. Table 8 presents a summary of the financial and economic costs incurred across sampled health facilities in the districts of Mubende, Kasese, and Wakiso. A total of $41,545 was spent across these facilities, with Kasese district recording the highest expenditure at $15,132, followed by Wakiso with $14,578 and Mubende with $10,466. The primary cost driver across all districts was house-to-house mobilisation and registration, accounting for 64% of the total expenditure.

Personnel-related expenses were the primary cost driver for the house-to-house registration, comprising 77% of the total expenditure. Of this, 62% represented economic costs, while 15% were financial costs. Allowances made up the remaining 23% of the total costs. Personnel time encompassed activities such as attending meetings, participating in training sessions, and conducting the actual registration. Although Village Health Teams (VHTs) are not formally employed, they received allowances during the campaign period to support their efforts in mobilizing and registering children at the household level.

Table 8: Registration/Identification related costs of children at the sampled health facilities during the implementation of the big catch-up campaign.

	Mubende district			Kasese district			Wakiso district			Grand total
Cost Category	Financial cost	Economic cost	Total cost	Financial cost	Economic cost	Total cost	Financial cost	Economic cost	Total cost	
Meetings and Trainings	892	962	1,854	730	571	1,301	757	708	1,465	4,620 (11%)
House to House Registration**	1,587	5,127	6,714	948	1,110	2,058	933	6,843	7,835	16,607 (40%)
Monitoring and supervision	142	737	879	54	607	661	210	475	685	2,225 (5%)
Data processing***	61	958	1,019	10,117	996	11,113	291	2,397	2,687	14,819 (36%)
Other costs	-	-	-	-	-	-	1,156	2,118	3,274	3,274 (8%)
Grand total	**1,160**	**7,784**	**10,466**	**11,848**	**3,284**	**15,132**	**2,038**	**12,541**	**14,578**	**41,545**

**The cost of house-to-house registration includes personnel time and allowances paid to VHTs.
*** These data processing activities, entirely part of the Big Catch-Up campaign and not research-related, involved aggregating data from outreach and routine services at facility and sub-county levels for monitoring, analysis, and reporting. After registration, data from paper-based tools were compiled into line lists and child health registers at the health facility level, then entered into the EPIVAC system by data focal persons. Data from immunisation outreaches and routine services were entered into DHIS2

4.4 Total costs spent on vaccine-related activities at the health facility level. (Vaccine and vaccine delivery costs)

We also calculated the costs associated with vaccinating children at the health facility level, based on information gathered through interviews conducted at these facilities. Table 9 presents a summary of the financial and economic costs of vaccination across the sampled health facilities in each district, with a total expenditure of $164,538. Kasese district recorded the highest combined costs of $63,509, followed by Wakiso and Mubende with total costs $56,709 and $44,325, respectively. The main cost driver across all districts was vaccination conducted through outreaches. The primary cost drivers for these outreach activities were personnel-related expenses, particularly the time invested by health workers and VHTs in training and conducting the outreach sessions, which accounted for 85% of the costs. To compensate for their time and effort, both groups received allowances. Vaccine-related costs accounted for 5% of the total expenditure, largely influenced by the number of children vaccinated with DPT1. As such, any increase in the number of children receiving DPT1 would significantly raise costs in this category.

Table 9: Total Costs (US$) related to vaccination at the selected/visited health facilities during the big catch-up campaign.

	Mubende district			Kasese district			Wakiso district			
Cost Category	Financial cost	Economic cost	Total cost	Financial cost	Economic cost	Total cost	Financial cost	Economic cost	Total cost	Grand total (%)
Meetings and Trainings	2,081	2,246	4,327	1,702	1,331	3,033	1,767	1,652	3,419	10,779 (7%)
Social mobilisation during vaccination	1,099	6,047	7,147	552	3,589	4,141	497	4282	4,779	16,066 (10%)
Vaccination at the Health facility**	835	1,481	2,316	877	1,407	2,285	877	1,328	2,206	6,805 (4%)
Vaccination during outreaches **	7,635	14,448	22,083	10,316	11,063	21,379	10,675	16,485	27,160	70,622 (43%)
Monitoring and supervision	332	1,720	2,051	125	1,417	1,542	489	1,109	1,598	5,192 (3%)
Vaccines*	3,951	-	3,591	605	-	605	3,573	-	3,573	8,129 (5%)
Data processing***	142	2,236	2,378	23,607	2,323	25,930	679	5592	6,271	32,579 (21%)
Other costs	49	22	71	4,408	185	4,594	2,746	4956	7,702	12,366 (8%)
Total	**16,125**	**28,200**	**44,325**	**42,194**	**21,316**	**63,509**	**21,303**	**35,406**	**56,709**	**164,538**

*Costs related to vaccines were calculated based on the number of zero dose children vaccinated. (children vaccinated with DPT1).
**The cost of vaccination includes personnel time and allowances paid to health workers and VHTs.
*** These data processing activities, entirely part of the Big Catch-Up campaign and not research-related, involved aggregating data from outreach and routine services at facility and sub-county levels for monitoring, analysis, and reporting. After registration, data from paper-based tools were compiled into line lists and child health registers at the health facility level, then entered into the EPIVAC system by data focal persons. Data from immunisation outreaches and routine services were entered into DHIS2.

The total costs spent on vaccination-related activities at the health facility, were then classified into:

(a) **Vaccine delivery costs** reflecting the spectrum of activities that facilitate the vaccination program until the child receives the vaccine. The vaccine delivery costs reflect the combined costs for delivering all antigens delivered during the big catch-up campaigns. However, we estimated costs attributable to each antigen based on the proportion of children vaccinated for that antigen out of the total children vaccinated through the campaign. The total facility level vaccine delivery costs were $ 40,374 (with $12,174 as financial and $28,200 as economic costs) for all study facilities in Mubende district; $62,905 (with $41,589 as financial and $21,316 as economic costs) for Kasese, and $53,136 (with $17,730 as financial and $35,406 as economic costs) for Wakiso district. The total vaccine delivery costs attributed to DPT1 were $3,634 (9%) for study health facilities in Mubende District, $7,549 (12%) for study health facilities in Kasese District, and $4,251 (8%) for study health facilities in Wakiso District (Table 10).

(b) Costs of vaccines and supplies (vaccine costs) reflecting the cost per dose of a vaccine or antigen multiplied by the doses utilized (number of children vaccinated) of a particular antigen. The costs of vaccines and supplies for DPT1 were $3,591 (966 children vaccinated for DPT1) for the study health facilities in Mubende district; $605 (124 children vaccinated for DPT1) for study health facilities in Kasese District, and $3,573 (889 children vaccinated for DPT1) for study health facilities in Wakiso district (Table 10).

(c) The total costs on vaccination-related activities (costs attributed to DPT1) combined the vaccine delivery costs and the costs of vaccines and supplies. In this case, the total vaccination-related costs were $7,225 for Mubende District, $8,154 for Kasese District, and $7,824 for Wakiso District. (Table 10). In this case, the total vaccination-related costs were $7,225 for Mubende district, $8,154 for Kasese district, and $7,824 for Wakiso district. (Table 10).

Table 10: Vaccination-related costs at the at the health facility (excluding sub- county costs)

	Mubende district			Kasese district			Wakiso district		
Cost Category	Financial	Economic	Total cost	Financial	Economic	Total cost	Financial	Economic	Total cost
Vaccine delivery costs	12,174	28,200	40,374	41,589	21,316	62,905	17,730	35,406	53,136
Proportion of Vaccine delivery costs attributed to DPT1			9%			12%			8%
Vaccine Delivery costs attributed to DPT1*	1,096	2,538	3,634	4,990	2,557	7,547	1,418	2,832	4,251
Vaccine costs	3,951	-	3,951	605	-	605	3,573	-	3,573
Total costs attributed to DPT1 vaccination**	5,047	2,538	7,585	5,595	2,557	8,152	4,991	2,832	7,824

* The vaccine delivery costs attributed to DPT1 were calculated based on the proportion of children vaccinated for DPT1 out of the total children vaccinated through the campaign.
**The total costs attributed to DPT1 vaccination = vaccine delivery costs + vaccine costs

Table 11 presents the total costs (Financial and Economic) associated with DPT1 registration and vaccine delivery across the three districts. Based on the proportion of costs attributable to DPT1—18% in Mubende and Kasese, and 9% in Wakiso—the registration costs were estimated at $2,258 for Mubende, $2,963 for Kasese, and $1,396 for Wakiso. Similarly, using the DPT1 vaccination cost shares of 9% (Mubende), 12% (Kasese), and 8% (Wakiso), the vaccine delivery costs amounted to $4,090, $7,913, and $4,694, respectively. These figures are then used to calculate the cost per child identified and later vaccinated.

Table 11: Registration and vaccine-related costs in each of the sampled districts (including sub-county allocation)

	Mubende	Kasese	Wakiso
Registration costs (DPT1)			
Facility costs shared from sub-county	$2,080	$1,330.72	$936.32
Facility-specific costs (incurred at facility)	$10,467	$15,131	$14,578
Total registration related costs	$12,547	$16,462	$15,514
Percentage attributable to DPT1	18%	18%	9%
Total costs attributable to DPT1 registration	**$2,258**	**$2,963**	**$1,396**
Vaccine related costs (DPT1)			
Facility costs shared from sub-county	$4,970	$3,040	$5,541
Facility-specific costs (incurred at facility)	$40,374	$62,905	$53,136
Total vaccine-related costs	$45,344	$65,945	$58,677
Percentage attributable to DPT1	(9%)	(12%)	(8%)
Total vaccine delivery costs (Attributable to DPT1)	$4,080	$7,913	$4,694
Vaccine costs	$3,951	$605	$3,573
Total costs (vaccine delivery costs + vaccine costs)	**8,031**	**8,518**	**8,267**

4.6 Cost per zero-dose child identified

The cost per zero-dose child identified was calculated by dividing the total incremental identification costs by the number of zero-dose children reached during the campaign. The number of zero dose children identified were as follows: 587 in Mubende, 515 in Kasese, and 1,053 in Wakiso (Table 11). Corresponding unit costs were $3.85 for Mubende, $5.75 for Kasese, and $1.33 for Wakiso. The overall average cost across the three districts was $3.07. Notably, the number of children identified had a significant influence on the unit cost in each district.

Table 12: Cost per zero-dose child identified

	Mubende	Kasese	Wakiso
Total costs attributable to DPT1 registration	$2,258	$2,963	$1,396
Children registered who had never received DPT1	587	515	1053
Costs per child identified (Zero Dose Child)	$3.85	$5.75	$1.33
Overall average	Total Children (2,155)	Total costs (6,618)	**$3.07**

4.7 Cost per zero-dose child vaccinated

The cost per zero-dose child vaccinated or reached was calculated by dividing the total incremental vaccination costs by the number of zero-dose children vaccinated during the campaign. The number of children vaccinated was 894 in Mubende, 100 in Kasese, and 818 in Wakiso (Table 13). Corresponding unit costs were $8.98 for Mubende, $85.18 for Kasese, and $10.1 for Wakiso. The overall average cost across the three districts was $14. A key factor influencing the unit cost was the number of children vaccinated. For instance, Kasese incurred the highest total costs but vaccinated the fewest children, resulting in the highest cost per child among the districts.

Table 13: Cost per zero-dose child vaccinated

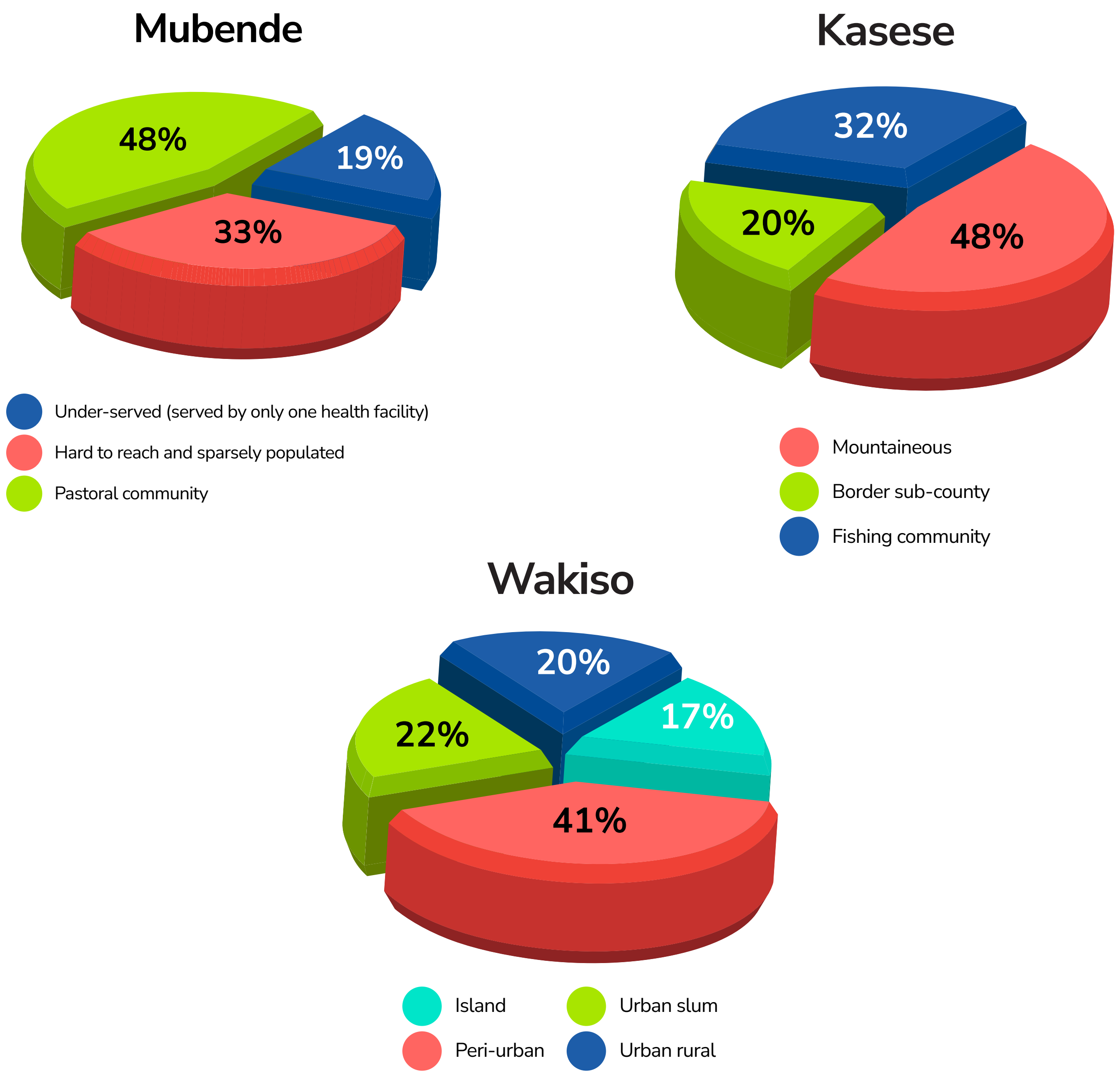
	Mubende	Kasese	Wakiso
Total costs (vaccine delivery costs + vaccine costs)	$8,031	$8,518	$8,267
Revised number of children vaccinated for DPT1*	894	100	818
Costs per child vaccinated for DPT1 (Zero Dose Child)	$8.98	$85.18	$10.1
Overall average	Total Children (1,812)	Total costs (24,816)	**$13.695**

*We subtracted the number of children who would have been reached through routine.

4.8 Did the implementation costs vary by high-risk community?

Table S5 and Figure 3 below presents data from different high-risk communities. In Mubende District, pastoral communities bore the highest share of the total costs, accounting for 48% (approximately $29,757) among the sub-counties visited. This was followed by hard-to-reach and sparsely populated communities, contributing 33% ($20,111) of the total expenditure. In Kasese District, mountainous communities accounted for 48% ($34,586) of the total cost, while fishing communities accounted for 32% ($22,835). Meanwhile, in Wakiso District, peri-urban communities represented the largest portion of the expenditure, accounting for 41% (32,431) of the total cost.

Figure 3: Pie charts showing the proportion of total costs across various high risk communities



5.0 Number of children vaccinated with other vaccines during the big catch up

The Big Catch-Up campaign not only vaccinated ZD children but also administered other essential antigens such as BCG, MR, and HPV vaccines. Table 15 presents the number of children who received these additional vaccines during the campaign. In total, 957 children were vaccinated with BCG, 3,883 received the first dose of the MR vaccine, 6,229 received the second dose of MR, and 8,276 girls were vaccinated against HPV across all three study districts.

Table 15: Number of children vaccinated with BCG, MR and HPV vaccines during the big catch up

			BCG	MR1	MR2	HPV
District	Sub-county	Health facility	Vaccinated	Vaccinated	Vaccinated	Vaccinated
Mubende	Kiruuma	Kituule HCII	11	313	885	359
	Butoloogo	Butoloogo HCIII	255	832	867	2226
		Kanyogoga HCII	54	86	119	1440
	Kigando	Butawata HCIII	113	119	433	331
		Total	**443**	**1,350**	**2,304**	**4,356**
Kasese	Isango	Kyempara HCIII	4	34	0	161
		Kamakumbi HCII	1	24	0	67
	Karambi	Karambi HCIII	40	17	0	0
		Kisholo HCII	0	28	23	94
	L.Katwe	Katungulu HCII	3	25	69	124
		Kasenyi HCII	11	43	32	25
		Total	**56**	**171**	**124**	**471**
Wakiso	Bussi	Bussi HCIII	42	417	198	309
	Busukuma	Namulonge HCIII	111	35	3	0
		Kasozi HCIII	115	409	2350	1477
	Bweyogerere	Bweyogerere HCIII	163	1405	1239	1277
	Masulita	Kanzize HCII	0	58	0	220
	Namayumba	Namayumba HCII	37	38	11	166
		Total	**468**	**2362**	**3801**	**3449**
		Grand total	**957**	**3883**	**6229**	**8,276**

5.1 Cost per child vaccinated with other antigens

Table 16 provides a summary of vaccine-related costs and the cost per child vaccinated for BCG, MR, and HPV across all districts. For BCG, a total of 780 children (excluding those vaccinated during routine) children were vaccinated at a total cost of $8,616, resulting in a cost per child vaccinated of $11.04. In the case of MR, which includes both doses of the vaccine, 13,535 children were vaccinated with a total expenditure of $78,732, bringing the cost per child vaccinated to $5.82. For HPV, 8,120 children were vaccinated across all districts, with a total cost of $107,446, resulting in a cost per child vaccinated of $13.23.

Table 16: Cost per child vaccinated with other antigens

	BCG			MR			HPV		
	Mubende	Kasese	Wakiso	Mubende	Kasese	Wakiso	Mubende	Kasese	Wakiso
Total vaccine delivery costs	$1814	$3957	$2347	$15,417	$18,465	$31099	$18,591	$29,016	$17,603
Vaccine costs	$225	$29	$243	$4,969	$401	$8,382	$22,401	$2,383	$17,452
Total costs	$2,039	$3,986	$2,591	$20,386	$18,866	$39,481	$40,992	$31,399	$35,055
Number of children vaccinated	349	29	402	4,890	395	8,250	4284	453	3383
Cost per child vaccinated	$5.8	$132	$6.4	$4.2	$47.8	$4.78	$9.56	$69.3	$10.36
Cost per child vaccinated			**$11.04**			**$5.73**			**$12.98**

6.0 Discussion

This study leveraged Uganda's nationwide "Big Catch-Up" campaign to estimate the incremental costs of identifying and vaccinating ZDC in three selected districts. Zero-dose children were defined as those who had not received the first dose of the DPT (Diphtheria, Pertussis, and Tetanus) vaccine. The findings revealed that the cost per ZD child identified was $3.07 [range:$1.33 to $5.75] while the cost per ZD vaccinated was $14 (range: $8.98 and $85.18). Extrapolating these figures to the national level, and based on an estimated 188,349 ZDC in Uganda in 2024, the total cost to vaccinate all identified ZDC would exceed $2,448,537. It is important to note that this estimate only includes surviving children in their first year of life and does not account for all children under five years of age, suggesting that the actual cost of reaching all ZDC is likely to be substantially higher. These findings are particularly significant in the context of Uganda's health financing landscape, where the total health budget constitutes only 6.1% of the national budget, approximately $1.56 billion. The results underscore the considerable financial investment required to identify and immunise zero-dose children and highlight the need for sustained and targeted support to close immunisation gaps.

The cost estimates observed across the study districts and health facilities were significantly influenced by the variations in coverages (number of children reached during BCU) and the unique district characteristics such as number of administrative units (sub-counties). Districts such as Kasese and Wakiso consistently reported higher costs, largely due to the extensive number of sub-counties they serve—44 in Kasese and 27 in Wakiso. This administrative spread translates into a larger number of villages, parishes, and communities, thereby increasing the logistical and operational demands of implementation. Geographical and infrastructural challenges further compounded these costs. Kasese, characterized by mountainous terrain, and both Kasese and Mubende, with numerous hard-to-reach areas, presented significant barriers to identifying and reaching ZDCs. The process of locating and engaging families in these remote areas was inherently resource-intensive, requiring substantial time and effort, especially under tight timelines and limited budgets.

Human resource constraints also played a critical role. In underserved sub-counties, the shortage of health personnel hindered both the identification of ZDCs and the delivery of routine sation services. For instance, in Kiruuma subcounty, a single health facility—Kituule Health Centre II—is responsible for serving five parishes despite being originally designed to serve just one. This mismatch between service capacity and population coverage underscores the need for strategic resource allocation and system strengthening.

The high-cost estimates observed across study districts and health facilities were strongly influenced by the number of ZD children identified and vaccinated. Facilities that reached a larger number of ZD children generally reported lower average costs per child, benefiting from economies of scale. In contrast, where few ZD children were found, the cost per child was significantly higher due to fixed operational costs being spread across fewer beneficiaries.

This pattern also held true in sub-analyses of the cost per child vaccinated with other antigens. For instance, in districts like Mubende and Wakiso, where large numbers of children were vaccinated, particularly with HPV, the cost per child was notably lower. These findings highlight that average costs are dynamic and responsive to changes in the number of children reached. As immunisation coverage improves and the pool of ZD or under-immunised children shrinks, the cost of reaching each additional child is expected to rise. This shift from economies of scale to diseconomies of scale reflects the increasing effort and resources required to locate and vaccinate the remaining unvaccinated children. While campaigns and supplementary immunisation activities can generate economies of scale—such as lower per-child costs when large populations are reached—these efficiencies tend to diminish as coverage increases. The marginal cost often rises due to the need for more targeted, resource-intensive approaches. Thus, although scaling up may enhance overall efficiency, it also demands disproportionate investments to ensure that all ZD children are reached.

Integrating additional antigens into campaign-based outreach can offer significant cost-saving opportunities. By targeting the same child for multiple vaccines during a single outreach effort, health workers can maximise the impact of each visit. Moreover, the time and resources invested in reaching remote or underserved communities can benefit a broader group of children, thereby increasing overall coverage and improving cost-efficiency. Evidence supports the effectiveness of campaign-based delivery in boosting vaccine uptake, particularly among zero-dose children who are often missed by routine facility-based services. 15 These children are more likely to be identified through community-based efforts, underscoring the value of integrating zero-dose identification and vaccination into broader immunisation campaigns. Such integration enhances coverage and optimizes resource use, making it a strategic approach for sustaining progress in reaching the most vulnerable populations.

As demonstrated in this study, the cost of reaching and vaccinating ZD children is notably high and varies significantly depending on the type of high-risk community targeted. Our findings indicate that the highest costs are incurred in pastoral, mountainous, hard-to-reach, and peri-urban communities. While each of these settings presents unique challenges, the primary cost driver across all is personnel time. In mountainous areas, for example, households are sparsely distributed, requiring VHTs and health workers to spend several hours/days locating ZD children. Similarly, pastoralist communities often live in mobile household clusters, making tracking and following up with families difficult. In hard-to-reach areas, the physical effort and time required to access households further increase operational costs. Because ZD children are often dispersed within broader communities, identifying them frequently necessitates extensive outreach, sometimes involving visits to nearly every household in a village to locate just one or two children. This highlights the potential value of establishing a robust tracking system and leveraging innovative technologies, such as GPS, to locate and target specific households accurately, provided relevant data is available. Ensuring universal birth registration could also significantly enhance the efficiency of immunisation programs by enabling targeted outreach, thereby reducing the need for resource-intensive community-wide campaigns.

The implementation challenges during the house-to-house registration can also explain the high identification costs. The high identification costs were mainly driven by the low numbers of ZD children registered. Despite registration efforts, there was no clear link between the registration process, which mapped out the number of zero-dose children, and the vaccination efforts. The house-to-house registration was conducted over just three days, often by a single VHT per village. In larger villages, this limited manpower and time frame meant many households were not reached. Consequently, the data collected during registration were not effectively used to guide outreach planning or target zero-dose children. The disconnect between registration and vaccination efforts likely contributed to the high average costs observed. A more thorough and better-resourced registration process could have improved targeting and potentially reduced overall costs. In areas with unique challenges—such as mountainous or hard-to-reach regions—house-to-house registration plays a crucial role in helping health workers identify hotspots. This localised data can significantly enhance outreach efforts by enabling more targeted, data-driven decision-making. However, prior to making the registration efforts routine, UNEPI needs to evaluate its effectiveness and cost-effectiveness.

How do these findings compare with other studies?

Although studies estimating the cost of increasing immunisation coverage do not specifically estimate the cost of reaching ZD children, they can still be used for comparison, as there is limited evidence on the costs of reaching these children. A recent scoping review found that the median intervention cost per dose for increasing immunisation coverage through immunisation camps, similar to the campaign, was about US$39. 16 These findings are not directly comparable due to differing objectives, but also the provision of other health services beyond immunisation during these campaigns. Another study by Deelder et al. in India, which investigated the cost-effectiveness of periodic intensification of routine immunisation, showed that the incremental cost per zero-dose child was about US$83, with district-level estimates ranging from US$22 to US$193.17 Our estimates fall within the range of these estimates making them somewhat comparable. However, the cost per zero dose child vaccinated in our study was slightly lower. Furthermore, a cost-effectiveness modelling study conducted in Zambia, comparing delivery strategies, found that the most efficient strategy to reach measles zero-dose children was targeted supplementary immunisation activities (SIAs), estimated at US$8 per zero-dose child reached.18 These estimates are significantly lower than ours, partly because the study did not focus on reaching zero dose children and these SIAS were not conducted nationwide, which reduces the overall implementation cost. In contrast, Uganda's "Big Catch-Up" campaign was nationwide, contributing to higher costs. The wide variation in these studies' objectives, as they are not zero-dose (DPT1) specific, makes direct comparison challenging.

Catalytic/displacement effects

We must be cognizant that the intervention had catalytic or displacement effects. The Big Catch-Up Campaign had both positive and negative effects. On the positive side, it increased awareness of the zero-dose concept, helping communities understand what it means and why it matters. This heightened recognition of immunisation gaps prompted some caregivers to proactively seek vaccination for their zero-dose or under-immunized children at nearby health facilities and outreach sites. Additionally, the campaign strengthened the health system by enhancing collaboration at district and community levels, improving coordination among healthcare providers and key local stakeholders—including VHTs, political leaders, and opinion leaders.

However, the initiative also presented challenges. One major concern was the increased workload for VHTs, who have no structured incentives or rewards, affecting their motivation and overall effectiveness. Many VHTs voiced frustration over the insufficient facilitation provided, as they were required to leave their jobs and prioritise campaign activities, often resulting in productivity losses at their workplaces or disruptions to their economic activities. Additionally, immunisation services were disrupted, as many health workers, including those from private health facilities, were reassigned to conduct vaccinations at outreach sites, reducing routine immunisation capacity. This underscores broader staffing shortages, which impact outreach efforts and routine service delivery. These operational challenges should be carefully considered when planning future large-scale immunisation campaigns to ensure sustainability and minimise disruptions.

Enablers and barriers to implementation

Although the registration exercise was intended as a precursor to identify and target zero-dose and under-immunized children, it was never used for that purpose. Instead, registration and vaccination were carried out as separate activities, foregoing the expected synergies and cost savings from their integration.

Several barriers hindered the implementation. Firstly, the planning and budgeting processes lacked flexibility to address district-specific challenges, such as long distances and geographical barriers. For instance, transport refunds for training were capped at 20,000 UGX (US$ 5), yet some VHTs and health workers incurred expenses exceeding 60,000 UGX (US$17) without reimbursement. Districts were unable to adjust budget allocations without Ministry of Health approval, and tight timelines discouraged attempts to do so. Additionally, processing e-financial payments was tedious and cumbersome, requiring manual verification of implementers' names based on submitted phone numbers.

Secondly, the house-to-house registration was not fully implemented, and not all eligible children were registered due to short timelines and insufficient training of health workers and VHTs. This led to confusion about their tasks and a rushed implementation. Furthermore, there were inadequate logistics, such as registration forms, vaccines, and vaccine supplies. Vaccine shortages, particularly for HPV, Yellow Fever, Rotavirus, and DPT, along with inadequate logistical support (e.g., vaccine carriers), hindered vaccination efforts. Some teams had to delay activities until vaccine carriers were available, limiting the intervention's reach.

VHTs faced resistance from households uncertain about the registration process and the reason for administering multiple injections to children. This resistance was largely due to inadequate mobilisation efforts, especially in remote and hard-to-reach villages. Additionally, the Ministry of Health did not plan for data processing, including data aggregation, analysis, and reporting. PATH-Uganda stepped in to support data clerks at the parish level in aggregating registration data daily, which was then submitted to the national level. These challenges underscore the need for more adaptable planning and budgeting processes, as well as streamlined payment verification systems to ensure timely and fair compensation. They also highlight areas for improvement in future campaigns to ensure more effective implementation and better outcomes.

Despite these challenges, implementation was facilitated by strong political will, with leaders at various levels—district, sub-county, local, and religious—providing support and buy-in, significantly aiding mobilisation efforts, especially at the community level. This was also facilitated by the strong coordination at district level through daily district meetings, which helped streamline implementation and guided monitoring and supervision. The involvement of community members, including peer mothers and VHTs who are trusted within their communities, was crucial to the campaign's success. Primary Health Care (PHC) funds in some districts supplemented the insufficient budget for essential items like photocopying and vaccine transportation. At the national and district levels, financial support from implementation partners such as CDC/AFENET, PATH, IDI, and UNICEF further supplemented the budget. This support enabled the facilitation of data entrants, photocopying additional registration forms, and engaging more VHTs to enhance house-to-house registration. Additionally, in some districts, the use of human resources from private health facilities contributed to the success of the outreaches, addressing the issue of inadequate staffing at many health facilities.

Strengths and limitations

This study provides valuable insights into the cost of reaching zero-dose (ZD) children. Conducted across three geographically diverse districts, it captures a broad range of high-risk communities, including underserved urban and rural populations. The use of process evaluation data collected during implementation adds important context, helping to interpret the cost findings and strengthen the overall analysis.

However, the results of this analysis must be interpreted and understood in context; it only on the incremental costs incurred during the Big Catch-Up (BCU) campaign and does not include routine immunization costs. This assumes that routine services were minimally active during the campaign period, and that BCU activities such as vaccine delivery, registration, and intensive social mobilization were additional to standard operations. For example, while Ministry of Health guidelines require one outreach per facility per month, these are typically limited in scope and visibility compared to BCU efforts.

We, however, estimated the number of children that would have been vaccinated under routine vaccination in a typical six days. We could not disaggregate possible costs that could have been incurred during routine immunization for the six days because we assumed those costs were minimal based on the low level of activity. We believe this omission would not have significantly altered the results.

Disaggregating costs by specific activities (e.g., registration, data processing, outreach) was challenging due to shared expenditures. National-level costs such as planning, training, and supervision were excluded, limiting the findings to sub-national levels. However, partner contributions at the district level were captured. Cost data were collected from multiple levels (district, sub-county, facility, and community), with triangulation and validation enhancing accuracy. Lastly, data collection occurred four months post-implementation, introducing potential recall bias, though efforts were made to mitigate this by encouraging respondents to reference documentation.

7.0 Conclusion

Our findings indicate that the average cost to identify a zero-dose (ZD) child—defined as a child who has not received the first dose of DPT (DPT1)—was $3.07 across all three districts, while the cost to vaccinate a ZD child with DPT1 was $12.3 (range: $8.3 and $68.7) and varied with the district, with Kasese district posting the highest unit cost ($68.7) and Mubende district with the lowest ($8.3).

These figures highlight the considerable financial investment required to locate and immunise ZD children, with even higher costs associated with completing the full immunisation schedule. However, when large numbers of children are reached, significant cost savings can be achieved through economies of scale. While targeted outreach campaigns have proven effective in reaching ZD children, their long-term sustainability remains uncertain. To improve efficiency and reduce implementation costs in future campaigns, it is essential to leverage localized data and triangulate multiple sources—such as DHIS2, house-to-house registration data, census estimates, and IHME projections—to better identify areas with high concentrations of ZD or under-immunized children. The Big Catch-Up campaign demonstrated the value of broad outreach and provides a strong foundation for future efforts. However, strategic spacing and data-driven targeting will be critical to ensure cost-effectiveness and maximize impact. Budgeting should be adaptive, with more resources allocated to low-coverage areas. These insights are particularly relevant for immunization programs in low- and middle-income countries, where optimizing resources is crucial. Before launching future campaigns, UNEPI should also evaluate the effectiveness, cost-efficiency, and sustainability of house-to-house registration activities to inform planning and ensure no child is left behind.

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These figures highlight the considerable financial investment required to locate and immunise ZD children, with even higher costs associated with completing the full immunisation schedule.

8.0 Recommendations

Short term

1. **Immunisation programs, including UNEPI, should ensure efficient, adequate, and context-sensitive allocation of resources.** Budgeting should consider district-specific challenges—such as geographic barriers and high travel costs—rather than applying uniform rates that may not reflect actual needs. Hard-to-reach areas, including islands, mountainous regions, and underserved communities, often require additional financial and human resources to ensure timely and effective implementation. Furthermore, planning and budgeting processes should actively involve lower-level stakeholders and remain flexible to adapt to the local context.

However, before institutionalising house-to-house registration as a routine strategy, UNEPI/MoH should conduct a comprehensive evaluation of its effectiveness and cost-effectiveness to ensure optimal resource allocation and impact.

Medium term

2. **To sustain the identification of zero-dose children, Immunisation programs including UNEPI should strengthen community-based registration by improving planning, training, and resource allocation.** This effort can be further enhanced by engaging trusted community actors, such as Village Health Teams, local leaders, religious figures, and peer mothers, who can significantly improve data accuracy and broaden the reach of registration efforts. These combined strategies will not only enhance the identification and targeting of ZD children but may also contribute to reducing overall program costs by minimising inefficiencies and missed cases. Updating immunisation registers at least quarterly will enable more targeted and efficient outreach efforts, ultimately improving coverage and reducing missed vaccination opportunities.

3. **Immunisation programs including UNEPI should consider using digital platforms to capture immunisation and registration data at both community and health facility levels.** This transition has the potential to significantly reduce data processing costs and improve data quality and timeliness. The electronic Community Health Information System (eCHIS), currently being piloted in selected districts, presents a promising solution for digitising house-to-house registration. However, national rollout will require upfront investment in digital infrastructure, including mobile devices and training for frontline health workers.

Long term

4. **Integration:** To maximise impact and efficiency, immunisation programmes, including UNEPI, should strategically leverage and, where feasible, integrate Zero-Dose (ZD) efforts into existing and planned health interventions. This includes platforms such as Integrated Child Health Days, routine immunisation outreach, and immunisation campaigns, as well as broader health initiatives targeting malaria, HIV, TB, nutrition and others. At the heart of these efforts is a single caregiver—often a mother—interacting with the health system. By aligning ZD identification and outreach with services she already accesses, we not

only improve coverage but also reduce the marginal cost of reaching zero-dose children. Integration ensures that ZD efforts are not siloed but embedded within the broader health system, enhancing sustainability, efficiency, and equity.

Other considerations

5. **Sustainability** must be a central criterion in the selection and implementation of Zero-Dose (ZD) interventions. As donor funding becomes increasingly constrained—evident in recent funding reductions—countries must prioritise approaches that can be maintained and scaled through domestic resources and systems.

   ZD strategies should be designed with long-term viability in mind, integrating into existing health infrastructure, leveraging community ownership, and aligning with national health priorities. This ensures that progress made in reaching zero-dose children is not only impactful in the short term but also resilient and enduring beyond the lifecycle of external funding.

6. **Capturing the Patient Perspective.** To design equitable and responsive immunisation strategies, future studies must incorporate the patient perspective, particularly the direct and indirect costs faced by caregivers. These include transportation expenses, time away from work, and income loss, which can vary significantly across different geographic and socio-economic settings. Special attention should be given to underserved and high-risk populations such as pastoralist communities, refugees, border populations, and mining communities. Understanding these barriers is essential to tailoring interventions that are both accessible and equitable.

7. **Evaluating the Cost-Effectiveness of Identification and Reach Strategies.** Further research is also necessary to assess the cost-effectiveness of registration systems and targeted outreach strategies aimed at identifying and reaching zero-dose children. Evidence from such studies will be crucial for informing budgeting decisions and guiding efficient resource allocation, ensuring that investments produce maximum impact in reducing immunisation inequities.

> “Further research or analysis is necessary to evaluate the cost-effectiveness of targeted strategies aimed at identifying and reaching zero dose and under-immunised children

9.0 References

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10.0 Annexes

10.1 Number of interviews conducted in the selected sub-counties and health facilities

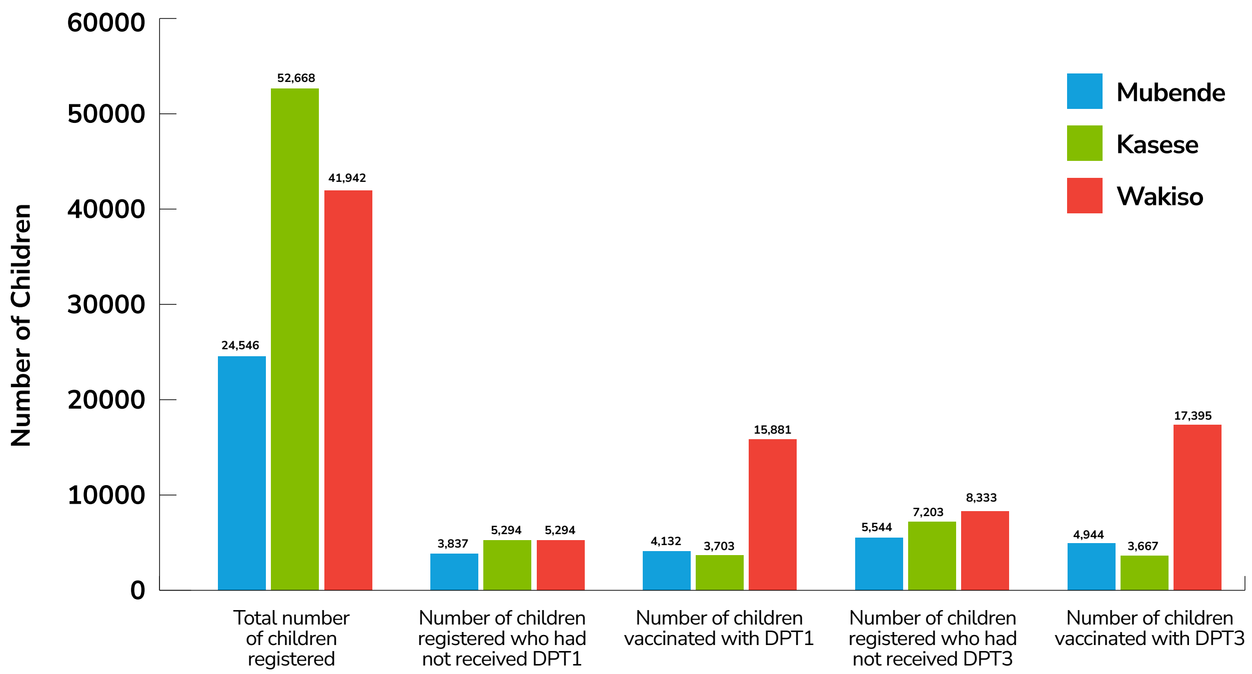
Table S1: Selected sub-counties and health facilities that participated in the study

	Health facilities visited	Number of interviews conducted
Mubende district		
	District Health Team	6
Butoloogo sub-county	Butoloogo HCIII	6
	Kanyogoga HCII	3
Kiruuma sub-county	Kituule HCII	4
Kigando sub-county	Butawata HCIII	4
	Suubi HCII	3
	Mawujjo HCII	3
Kasese district		29
	District Health Team	9
Lake Katwe sub-county	Katungulu HCII	7
	Kasenyi HCIII	2
Karambi sub-county	Karambi HCIII	2
	Kisololo HCII	4
Isango sub-county	Kyembara HCIII	5
	Kamukumbi HCII	6

	Health facilities visited	Number of interviews conducted
Wakiso district		35
	District Health Team	7
Busukuma sub-county	Namulonge HCIII	6
	Kasozi HCIII	12
Bweyogerere sub-county	Bweyogerere HCIII	9
Masulita Town council sub-county	Kanzize HCII	3
Namayumba sub-county	Namayumba HCII	4
Bussi sub-county	Bussi HCIII	4
		45

10.2 Number of children registered and vaccinated during the big catch up in Mubende, Kasese and Wakiso districts.

Figure S1: Number of children registered and vaccinated during the big catch up campaign in Mubende, Kasese and Wakiso districts



The bar graph summarises the total number of children registered during the big catch-up campaign (this includes all other antigens) in the selected districts. It then presents the number of children registered through house-to-house registration by VHTs who had never received DPT1 (zero dose) and DPT3 (under-immunised). It also shows the number of children who were then vaccinated with DPT1 and DPT3 during the targeted outreaches.

10.3 Number of children registered and vaccinated disaggregated by sub-county

Table S2: Number of children registered and vaccinated by sub-county (only sampled sub-counties)

			DPT1		DPT3	
District	Sub-county	Total number registered	Registered*	Vaccinated**	Registered*	Vaccinated**
Mubende	Kigando	1,332	294	91	314	63
	Butoloogo	1,204	162	727	207	1,083
	Kiruuma	800	131	121	143	169
		3,336	**587**	**939**	**664**	**1,315**
Kasese	Isango	280	7	34	5	32
	Karambi	1,734	342	102	445	73
	L.Katwe	776	166	83	213	76
		2,790	**515**	**219**	**663**	**181**
Wakiso	Bussi	1,037	247	101	428	102
	Busukuma	2,247	171	188	264	317
	Bweyogerere	6,503	440	552	884	1,034
	Masulita	489	80	55	134	45
	Namayumba	1,504	115	147	276	108
		11,780	**1,053**	**1,043**	**1,986**	**1,606**

*The number of children registered as never having received DPT1 – zero dose children.
**The number of zero-dose children vaccinated with DPT1

TableS3: Number of children vaccinated with other antigens during the big catch up campaign

District	Sub-county	Total number registered	BCG		MR1		MR2		HPV
			Registered	Vaccinated	Registered	Vaccinated	Registered	Vaccinated	Vaccinated
Mubende	Kigando	1,332	371	113	285	119	258	433	331
	Butoloogo	1,204	125	309	248	918	549	986	2366
	Kiruuma	800	258	11	194	313	387	885	359
		3,336	**754**	**433**	**727**	**1350**	**1194**	**2304**	**3056**
Kasese	Isango	280	1	5	19	58	144	0	
	Karambi	1,734	265	61	596	99	1508	96	
	L.Katwe	776	137	30	306	81	536	322	
		2,790	**403**	**96**	**921**	**238**	**2188**	**418**	
Wakiso	Bussi	1,037	135	53	745	910	906	2235	315
	Busukuma	2,247	85	41	396	1654	873	4870	2354
	Bweyogerere	6,503	73	173	529	1594	1352	3478	898
	Masulita	578	27	36	241	149	426	1195	295
	Namayumba	1,504	8	124	529	137	980	90	103
		11,780	**193**	**427**	**1695**	**4500**	**4537**	**11868**	**3965**

Table S4: Table showing the total costs of vaccination at each selected health facility

District	Sub-county	Health facility	Total cost of vaccination (sub-county)	Total cost vaccination (health facility)	Total vaccine cost of BCGa	Total vaccine cost of MRa	Total vaccine cost of HPVa	Total cost BCG	Total cost MR	Total cost HPV
Mubende	Kiruuma	Kituule HCII	1,656.97	6,400	6	1,629	1,817	8,063	9,686	9,874
	Butoloogo	Butoloogo HCIII	1,526.06	7,921	133	2,311	11,264	9,580	11,758	20,711
		Kanyogoga HCII	130.91	4,644	28	279	7,286	4,803	5,054	12,061
	Kigando	Butawata HCIII	1,275.87	17,120	59	751	1,675	18,455	19,147	20,071
		Total cost	**4,590**	**36,085**	225	4,969	22,041	40,900	45,644	62,716
Kasese	Isango	Kyempara HCIII	1,218.69	17,137	2	46	815	18,358	18,402	19,170
		Kamakumbi HCII	298.92	9,018	1	33	339	9,317	9,350	9,656
	Karambi	Karambi HCIII	372.9	10,952	21	23	-	11,346	11,348	11,325
		Kisholoo HCII	424.93	7,641	-	69	476	8,066	8,135	8,542
	L.Katwe	Katungulu HCII	171.81	10,240	2	128	627	10,413	10,540	11,039
		Kasenyi HCII	553.6	7,915	6	102	127	8,474	8,571	8,595
		Total cost	**3,040.85**	**62,903**	29	401	2,383	65,973	66,345	68,327
Wakiso	Bussi	Bussi HCIII	1,656.96	7,867	22	836	1,564	9,546	10,360	11,088
	Busukuma	Namulonge HCIII	589.5	7,175	58	52	-	7,822	7,816	7,765
		Kasozi HCIII	470.84	16,652	60	3,752	7,474	17,183	20,875	24,596
	Bweyogerere	Bweyogerere HCIII	1,100.63	10,374	85	3,596	6,462	11,559	15,070	17,936
	Masulita	Kanzize HCII	1,101.88	3,953	-	79	1,113	5,055	5,134	6,168
	Namayumba	Namayumba HCII	621.63	6,574	19	67	840	7,215	7,262	8,036
		Total cost	**5,541.44**	**52,595**	243	8,382	17,452	58,380	66,518	75,588

aCost of vaccines = Cost of delivering vaccine (UNICEF estimates) *number of doses administered during the campaign.

Table S5: Costs disaggregated by high risk communities

District	Sub-county	Sub-county characteristics	Health facility	Total costa of identification	Total costa of vaccination**	Grand total	% of total cost
Mubende	Kiruuma	Under-served (served by only one health facility)	Kituule HCII	3,093	8,505	11,598	19%
	Butoloogo	Hard to reach and sparsely populated	Butoloogo HCIII	2,242	11,941	14,183	33%
			Kanyogoga HCII	957	4,971	5,928	
	Kigando	Pastoral and sparsely populated	Butawata HCIII	4,742	18,733	23,475	48%
			Mauwjjo HCII & Suubi HCII	1,513	4,769	6,282	
Kasese	Isango	Mountainous and sparsely populated	Kyempara HCIII	4,024	18,356	22,379	48%
			Kamakumbi HCII	2,890	9,317	12,207	
	Karambi	Border sub-county (Congo and Uganda)	Karambi HCIII	3,143	373	3,516	20%
			Kisholoo HCII	2,451	8,066	10,517	
	L.Katwe	Fishing community	Katungulu HCII	2,859	10,412	13,271	32%
			Kasenyi HCII	1,095	8,469	9,564	
Wakiso	Bussi	Island	Bussi HCIII	3,642	9,834	13,476	17%
	Busukuma	Peri-urban	Namulonge HCIII	1,505	8,712	10,217	41%
			Kasozi HCIII	4,898	17,316	22,214	
	Bweyogerere	Urban slum	Bweyogerere HCIII	3,519	13,559	17,078	22%
	Masulita	Urban-rural	Kanzize HCII	871	5,173	6,044	8%
	Namayumba	Urban rural	Namayumba HCII	2,447	7,374	9,820	12%

***Cost of vaccination includes the cost of vaccines and vaccine delivery costs

Table S6: Number of children vaccinated during routine immunisation in the selected health facilities.

	Number vaccinated during October 2024	Number vaccinated during October 2024 /30 days	Number of children vaccinated per day * 6 days of BCU
DPT1	Mubende 361 Kasese 118 Wakiso 353	Mubende 12 Kasese 4 Wakiso 12	Mubende 72 Kasese 24 Wakiso 71
DPT3	Mubende 359 Kasese 106 Wakiso 300	Mubende 12 Kasese 4 Wakiso 10	Mubende 72 Kasese 24 Wakiso 60
BCG	Mubende 418 Kasese 136 Wakiso 338	Mubende 14 Kasese 5 Wakiso 11	Mubende 84 Kasese 30 Wakiso 66
HPV	Mubende 367 Kasese 93 Wakiso 330	Mubende 12 Kasese 3 Wakiso 11	Mubende 72 Kasese 18 Wakiso 66
MR	Mubende 393 Kasese 8 Wakiso 654	Mubende 13 Kasese 0.3>>1 Wakiso 22	Mubende 79 Kasese 6 Wakiso 132

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