The Costs of Different Vaccine Delivery Strategies to Reach Children Up to 18 Months in Rural and Urban Areas in Tanzania

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OCTOBER 2019

This study was supported by the Bill & Melinda Gates Foundation

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THINK WELL

MINISTRY OF HEALTH AND SOCIAL WELFARE
IMMUNIZATION AND VACCINE DEVELOPMENT (IVD) PROGRAM

JSI

RESEARCH TEAM

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PROGRAMMATIC OR POLICY ISSUE

- **Tanzania will enter the Gavi Preparatory Transition Phase in 2020**
  - Government of Tanzania will need to invest more in delivery costs
  - Reliable cost information is required to make a case to MoFP to mobilize resources, and inform new vaccine introduction planning
  - Planning knowledge and procedure not always understood by district-level immunization stakeholders, leading to lower prioritization of immunization
- **2016-2020 cMYP identified the need to conduct a study to estimate the cost per fully immunized child**
- **Knowledge gaps exist on the cost of different vaccine delivery strategies**
  - Use of non-facility-based delivery strategies is required as geographic distances are great – 71% of the population lives in rural and hard to reach areas

STAKEHOLDER ENGAGEMENT

- The research team **engaged with the MoHCDGEC-IVD and the Directorate of Policy and Planning** to develop and refine the research question and determine the sample
- The team **conducted stakeholder meetings** with key partners (e.g., WHO, UNICEF, CHAI) to fine tune the proposed study
- The team **engaged the Prime Minister's Office, Regional Administration and Local Government (PORALG)** to give clearance for data collection at regional and district levels
- The team **presented research progress at ICC meeting** mid-way through the research
- JSI **interviewed 20+ stakeholders** to request input on using cost information for planning and budgeting
- The team has **periodically engaged IVD staff** for updates and review of study progress and interpretation of results

RESEARCH QUESTION AND DEFINITIONS

What is the average **delivery cost** to immunize children up to 18 months in rural and urban areas – associated with current coverage levels and the current mix of delivery strategies?

Delivery strategies included:

- Fixed facility delivery (50%+ of immunization budget)
- Outreach
- Mobile clinics to reach nomadic and hard-to-reach communities

Definition of delivery costs (also referred to as operational costs):

The costs associated with delivering immunizations to target populations, exclusive of vaccine costs and injection supply costs. Delivery costs may include any or all of the following recurrent and capital cost items:

(1) Paid human resources*
(2) Volunteer human resources
(3) Per diem and travel allowances
(4) Cold chain equipment and their overheads (e.g. energy, maintenance, repairs)
(5) Vehicles, transport and fuel
(6) Program management
(7) Training and capacity building
(8) Social mobilization and advocacy
(9) Disease surveillance and activities related to adverse events following immunization (AEFI)
(10) Buildings, utilities, other overheads and shared costs
(11) Waste management
(12) Other supplies and recurrent costs
(13) Other non-vaccine costs

* Although paid human resources (salaried labor) are normally included as part of delivery costs, we have excluded them from our results as they are paid centrally, and therefore separate from delivery cost budgets.

COSTED VACCINES

Antigens	Age	Type of Fully Immunized Child (FIC)
OPV0	At birth up to 14 days	DTP3
BCG	At birth or first contact	
OPV1, DTP-HepB-Hib1, PCV 1, Rota 1	6 Weeks	
OPV2, DTP-HepB-Hib2, PCV 2, Rota 2	10 Weeks	
OPV3, DTP-HepB-Hib3, PCV 3	14 Weeks	
Measles/Rubella – 1st dose	9 Months	Measles/ Rubella 1
Measles/Rubella – 2nd dose	18 Months	Measles/ Rubella 2

METHODOLOGY

- **Perspective:** Government/provider
- **Costing methodology:** Ingredients-based, retrospective costing with time period of July 2016 – June 2017
- **Types of costs:** Economic and financial full costing (not incremental)
- **Levels included:** Facility, district, region and national
- **Cost calculation:** Average unit costs were calculated using inverse probability of sampling weights and volume-weights
- **National projection:** Calibration estimation method used to project results, using auxiliary information about national delivery volumes

Definitions

Economic costs Financial outlays plus opportunity costs of volunteer time and any donated items such as vaccines.

Financial costs Financial outlays, usually with straight-line depreciation of capital items (i.e., total cost of item / number of years it will be used, without any discounting).

SAMPLING STRATEGY

Regions	Districts	Health Facilities	Total Facilities
Random selection from the 8 zones, categorized into 4 groups based on coverage*	Random selection of 2 districts and purposive selection of 1 district**	Random selection of 4-5 health facilities per district***	
Region 1	3	5	15
Region 2	3	4	12
Region 3	3	5	15
Region 4	3	4	12
Total	**12 districts**	**54 facilities****	

* Northern zone omitted due to another ongoing study; Zanzibar excluded as it has its own IVD Program and modus operandi.
** Random selection of 1 urban district and 1 rural district which does not include nomads in the catchment population. Purposive selection of 1 rural district which includes nomads in the catchment population.
*** Five health facilities selected in rural districts with nomads.
**** Three facilities were later dropped from the sample due to data problems.

RESULTS

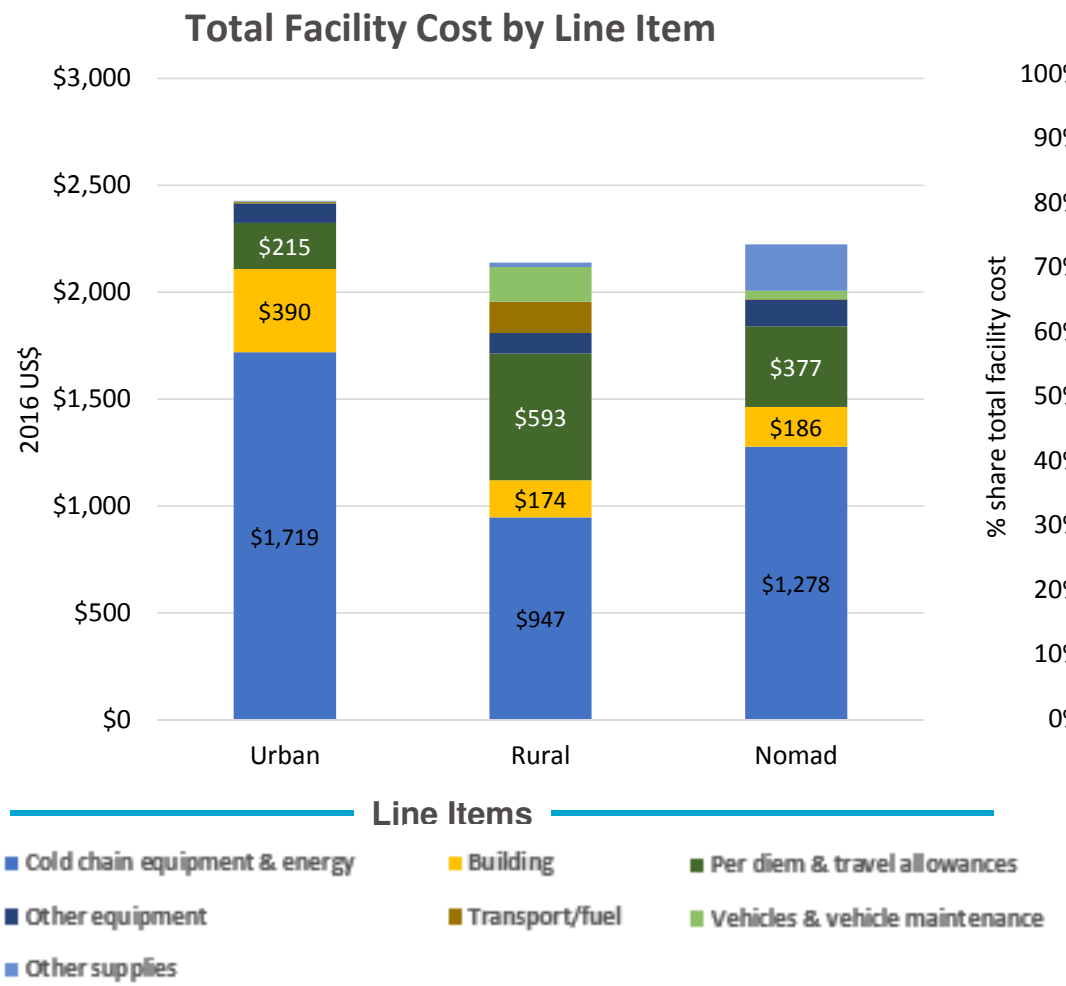
- **“Delivery costs” refers to costs exclusive of vaccines, injection supplies and paid human resources (labor) costs**

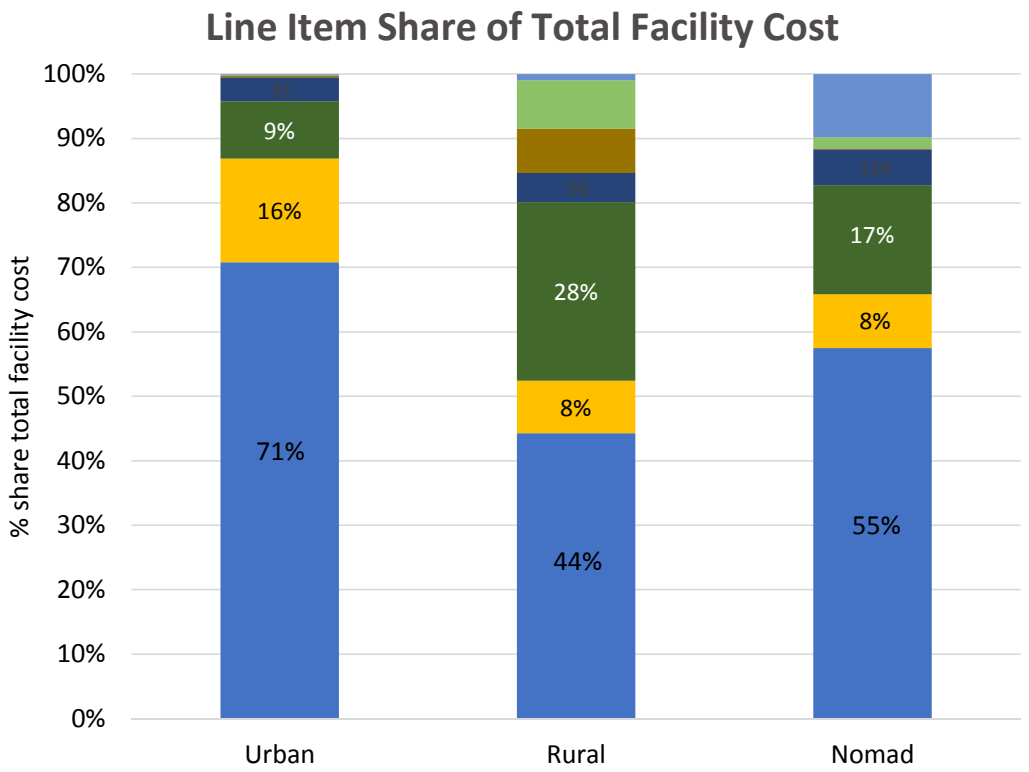
- **We present economic costs only unless otherwise noted:**
  - We found a small difference between economic and financial costs, meaning there is a financial outlay for most of the resources being used to deliver the immunization program, and limited donated items comprising the delivery costs
  - Financial costs can be found in the study report

- **Findings are presented in 2016 US$**

TOTAL DELIVERY COST FOR IMMUNIZATION PROGRAM BY LINE ITEM

(EXCLUDING VACCINES, INJECTION SUPPLIES AND LABOR COSTS) (FACILITY AVERAGE)

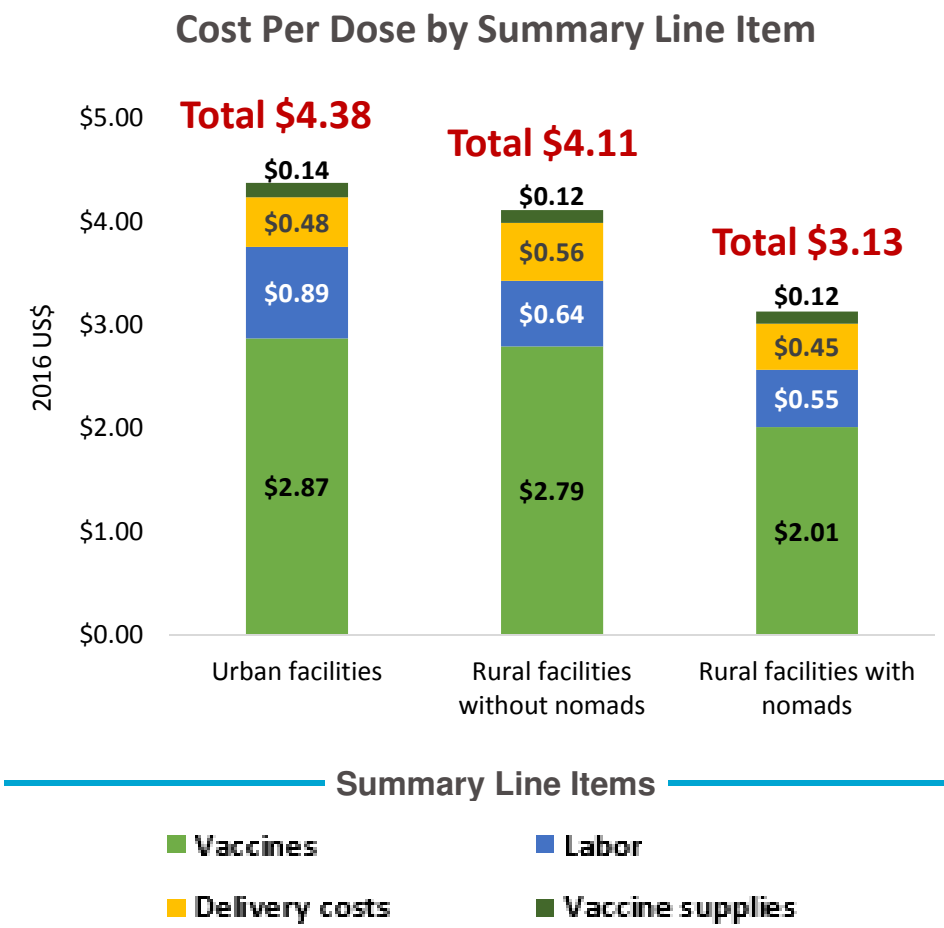


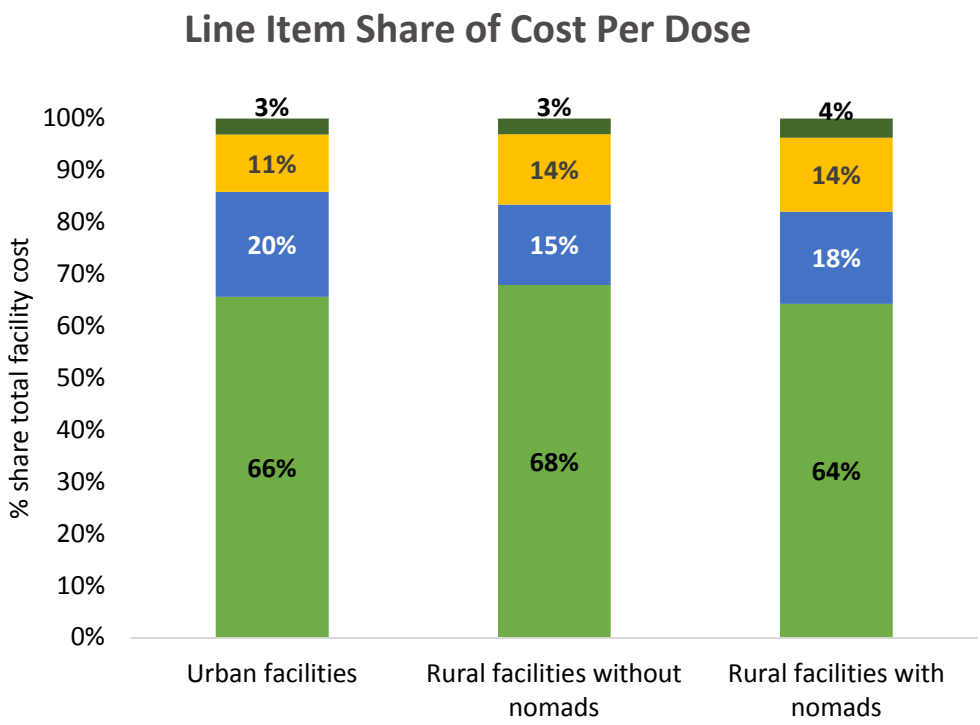


Main cost drivers:

- *Cold chain equipment & energy*
- *Per diem & travel allowances*

DELIVERY AND NON-DELIVERY COST PER DOSE BY SUMMARY LINE ITEM
(FACILITY AVERAGE)





Delivery costs (excluding labor) account for 11-14% of the cost per dose delivered; with labor, they account for 29-32% of the cost per dose delivered.

DELIVERY UNIT COSTS BY DELIVERY STRATEGY

(EXCLUDING VACCINES, INJECTION SUPPLIES AND LABOR COSTS) (FACILITY AVERAGE)

Type of cost	Unit cost per dose (2016 US$)		
	All delivery strategies	Facility-based delivery	Outreach-based delivery*
All health facilities (n=51)			
Economic costs	0.49	0.43	1.47
Financial costs	0.46	0.40	1.46
*Urban areas (n=17)**			
Economic costs	0.48	0.48	0.62
Financial costs	0.44	0.43	0.59
*Rural areas without nomads (n=20)**			
Economic costs	0.56	0.43	1.91
Financial costs	0.53	0.40	1.89
*Rural areas with nomads (n=14)**			
Economic costs	0.45	0.40	1.16
Financial costs	0.42	0.38	1.15

* Outreach-based delivery was not used in all areas. In the 17 urban areas, 6 used outreach. In the 20 rural areas without nomads, 13 used outreach. In the 14 rural areas with nomads, 8 used outreach.

The economic delivery cost per dose delivered through outreach (used both in urban areas and in rural areas with and without nomads) was over three times the cost per dose delivered at facilities (fixed site). Outreach is least expensive in urban areas, likely due to smaller distances covered.

DELIVERY UNIT COSTS

(EXCLUDING VACCINES, INJECTION SUPPLIES AND LABOR COSTS) (FACILITY AVERAGE)

Type of cost	Unit cost per FIC (2016 US$)		
	Measles/ Rubella 1st dose	Measles/ Rubella 2nd dose	DTP3
All health facilities (n=51)			
Economic costs	8.04	10.42	8.27
Financial costs	7.55	9.78	7.76
*Urban areas (n=17)**			
Economic costs	8.89	8.09	8.28
Financial costs	8.11	7.38	7.55
*Rural areas without nomads (n=20)**			
Economic costs	8.33	11.38	8.86
Financial costs	7.87	10.75	8.37
*Rural areas with nomads (n=14)**			
Economic costs	7.35	11.30	7.70
Financial costs	6.98	10.73	7.32

* Outreach-based delivery was not used in all areas. In the 17 urban areas, 6 used outreach. In the 20 rural areas without nomads, 13 used outreach. In the 14 rural areas with nomads, 8 used outreach.

The economic cost per FIC is:

- ***Measles/Rubella 1st dose (M1):*** *highest in urban areas and lowest in rural areas with nomads*
- ***Measles/Rubella 2nd dose (M2):*** *highest in rural areas without nomads and lowest in urban areas*
- ***DTP3:*** *highest in rural areas without nomads and lowest in rural areas with nomads*

These results may be unusual, because normally the cost per DTP3 FIC is lower than the cost per M1 or M2 FIC as more children reach DTP3 than M1 and M2. These results may reflect the patient mix that came to certain facilities in the sample during the study period and/or could be the result of errors in administrative and/or study data collection.

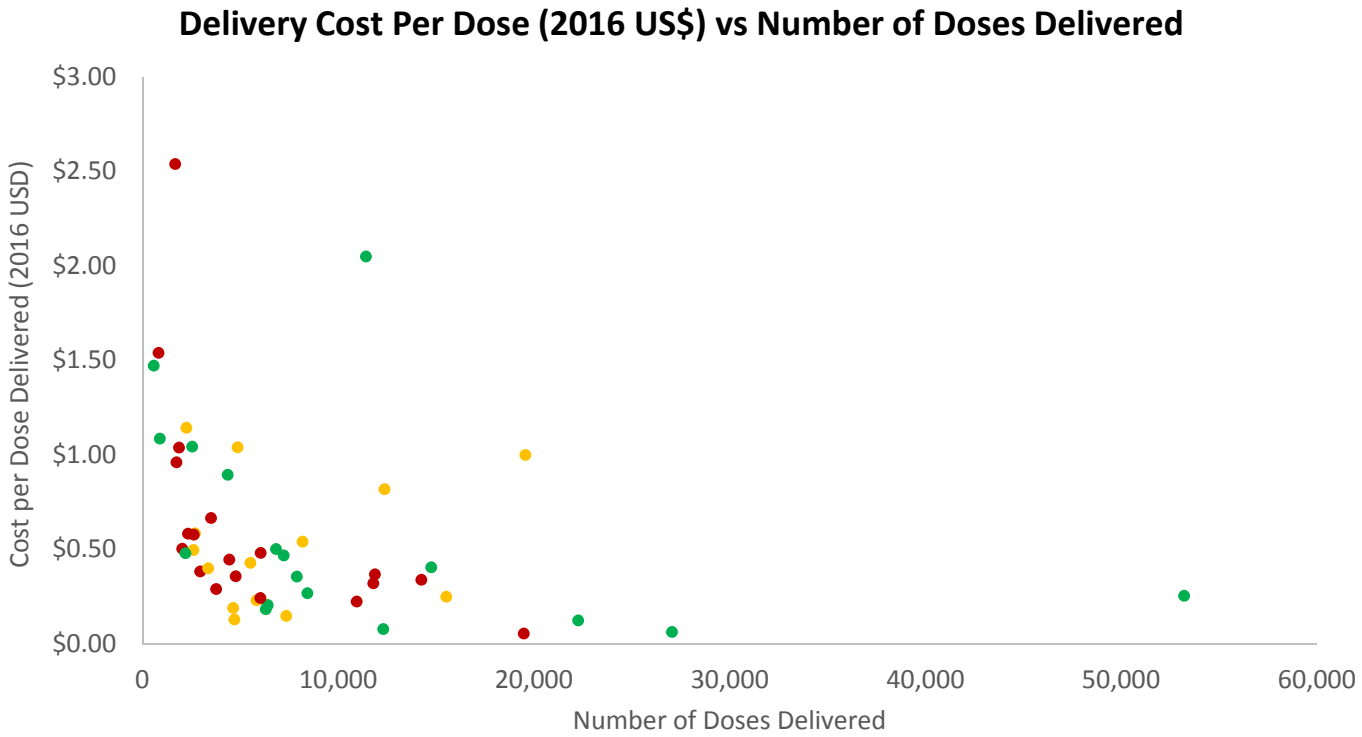
NUMBER OF DOSES DELIVERED AND FIC ACHIEVED
(FACILITY AVERAGE)

The highest volumes in terms of doses delivered and FIC achieved are seen in urban facilities, with an average volume of 25,027 doses delivered in a one-year period. Lowest volumes are in rural facilities without nomads.

Facility type	Average doses delivered per facility	Average number of FIC per facility		
		Measles/ Rubella 1st dose	Measles/ Rubella 2nd dose	DTP3
Urban facilities	25,027	1,219	1,028	1,544
Rural facilities without nomads	9,646	527	381	547
Rural facilities with nomads	10,662	637	396	576

DELIVERY VOLUME AND ECONOMIC DELIVERY COST PER DOSE

(EXCLUDING VACCINES, INJECTION SUPPLIES AND LABOR COSTS)



There is a negative association between economic cost per dose delivered and number of doses delivered – as the number of doses delivered increases, the cost per dose decreases – though there is still high variability in the cost per dose at similar delivery volumes.

- Rural facility with nomads
- Rural facility without nomads
- Urban facility

MOBILE DELIVERY: SENSITIVITY ANALYSIS FINDINGS

(INCLUDING VACCINES, INJECTION SUPPLIES AND LABOR COSTS)

- As there was no mobile delivery in any of our sampled sites during the period July 2016 -June 2017 (despite it being planned at 18/51 facilities), we used modelling to estimate what unit costs and delivery volumes would have been if this planned mobile delivery had been carried out.
- The modelled cost of mobile delivery is US$5.76 per dose*. The inclusion of mobile delivery decreases the estimated unit costs of the other delivery strategies because overhead costs are spread across more doses.

Type of cost	Existing delivery (2016 US$) (including vaccines, injection supplies and labor)			With mobile delivery (2016 US$) (including vaccines, injection supplies and labor)		
	Facility-based delivery	Outreach-based delivery	Mobile delivery**	Facility-based delivery	Outreach-based delivery	Mobile delivery**
Economic cost per dose delivered	3.62	5.88	N/A	2.92	5.15	5.76
Financial cost per dose delivered	3.57	5.85	N/A	2.90	5.15	5.76

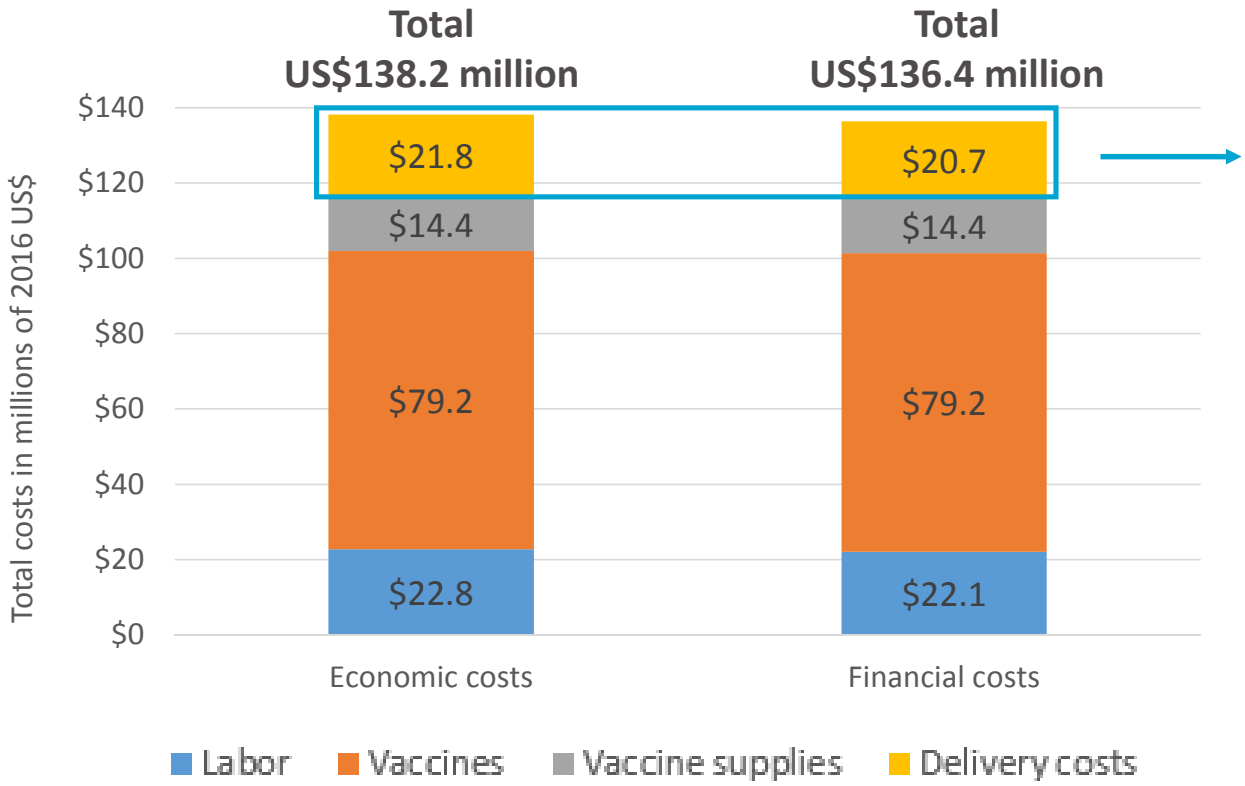
* Cost includes vaccines, injection supplies and labor costs. We could not separate out the delivery portion of the modelled mobile delivery cost due to lack of data and too much uncertainty around assumptions that would have to be made.

** n=18

DELIVERY COST SHARE OF TOTAL COST

(EXCLUDING VACCINES, INJECTION SUPPLIES AND LABOR COSTS)

Delivery costs make up 15.8% of total economic cost and 15.1% of total financial cost. By level of the health system, the delivery portion of total costs is comprised of: facility-level costs (72.4%), district-level costs (20.5%), regional costs (7.0%) and national level costs (0.5%).



Delivery cost per dose

- *Economic: US$0.67*
- *Financial: US$0.64*

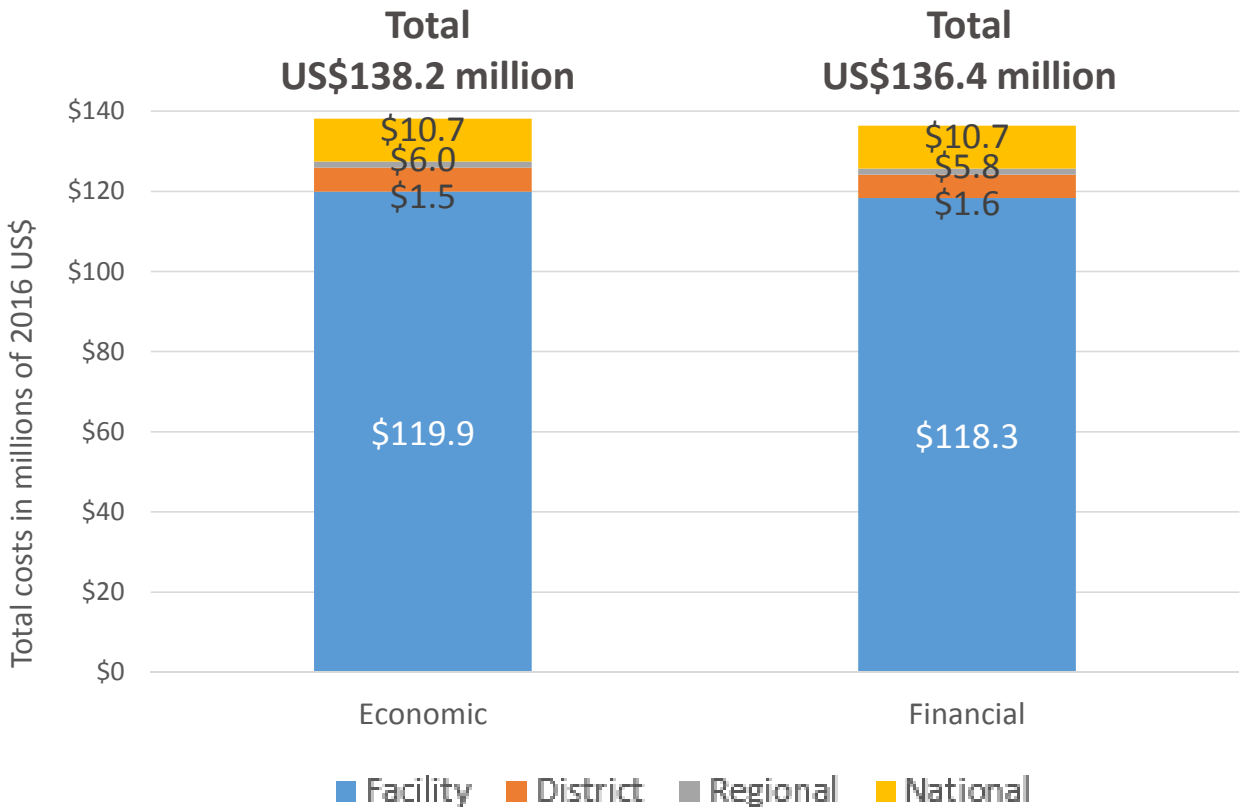
Delivery cost per capita

- *Economic: US$0.38*
- *Financial: US$0.36*

TOTAL COSTS BY LEVEL OF THE HEALTH SYSTEM

(INCLUDING VACCINES, INJECTION SUPPLIES AND LABOR COSTS)

For both economic and financial costing, facility costs comprised the greatest share of total costs at 87%, with district-level costs comprising 4%, regional costs comprising 1% and national level costs comprising 8%.



Cost per dose (all levels)

- *Economic: US$4.32*
- *Financial: US$4.27*

Cost per capita (all levels)

- *Economic: US$2.41*
- *Financial: US$2.38*

COMPARISON OF DELIVERY COST PER DOSE FINDINGS WITH OTHER SUB-SAHARAN AFRICAN COUNTRIES

We reviewed all grey and published literature from 2005-2018 from Sub-Saharan Africa reporting economic cost per dose delivered, excluding vaccine costs.

Country	Vaccines costed*	Delivery strategy	Cost per dose (2016 US$)
Benin[1]	BCG, Measles, DTP-HepB-Hib, OPV, YF	Health facility	$0.75
Tanzania	**BCG, Measles/Rubella, DTP-HepB-Hib1, OPV, PCV, Rotavirus**	**Multiple strategies****	**$1.28*****
Uganda[2]	BCG, Measles, DTP-HepB-Hib, OPV	Health facility	$1.67
Zambia[3]	BCG, Measles, DTP-HepB-Hib, OPV	Multiple strategies**	$2.11
Ghana[4]	BCG, Measles, DTP-HepB-Hib, OPV, YF	Multiple strategies**	$3.18

[1]AMP 2014. [2]Guthrie et al. 2014. [3]Schutte et al. 2015. [4]Le Gargasson et al. 2015.
BCG = Bacillus Calmette–Guérin vaccine. OPV = Oral polio vaccine. PCV = Pneumococcal vaccine. YF = Yellow fever vaccine.
* For comparator countries, vaccines costed are included on the schedule for children under the age of 1.
** This is the estimate from our current study. Multiple strategies refers to a combination of two or more delivery strategies – in this case, health facility and outreach delivery.
*** For comparability with other countries in this table, the estimate includes delivery cost, labor and injection supplies.
For a complete comparison of these unit costs, please see https://immunizationeconomics.org/ican-idcc.

SUMMARY OF DELIVERY COST RESULTS

(EXCLUDING VACCINES, INJECTION SUPPLIES AND LABOR COSTS) (FACILITY AVERAGE)

- **Total delivery costs**:
  - Across all geographies, total facility-level economic delivery costs are around US$2,200/year regardless of location.
  - By cost item: cold chain equipment & energy is the main cost-driving item at both urban and rural facilities, with and without nomads. However, cold chain costs are much lower in rural facilities without nomads, both in absolute values and as a percentage of total costs.
- **Facility-level cost per dose delivered:**
  - Across all geographies, the average economic cost per dose delivered is estimated at US$0.49.
- **Facility-level cost per FIC**:
  - Across all geographies, the cost per FIC (Measles/Rubella 1st dose) is US$8.04. The cost per dose defined as Measles/Rubella 2nd dose is US$10.42, while the cost per FIC defined as DTP3 is US$8.27.

SUMMARY OF DELIVERY COST RESULTS
(EXCLUDING VACCINES, INJECTION SUPPLIES AND LABOR COSTS)

- **By delivery strategy:**
  - Facility-based delivery cost per dose is highest in urban areas.
  - Outreach cost per dose is highest in rural areas without nomads.
  - There was no mobile delivery in any of our sampled facilities, despite it being planned. Respondents reported lack of transport as a key reason for cancelled mobile sessions.
    - Assuming higher transport-related costs than those incurred on outreach, we estimate the cost of mobile service delivery to be US$5.76 per dose (including vaccines, injection supplies and labor costs).

- **By urban/rural:**
  - Highest delivery volumes are seen in urban facilities (facility average 25,027 doses/year), then rural facilities with nomads (10,662 doses/year), then rural areas without nomads (9,646 doses/year).
  - In rural areas with nomads the cost per dose delivered is the lowest, at US$0.45, followed by urban areas (US$0.48) and rural areas without nomads (US$0.56). This difference may be due to sampling error, not by true cost differences between urban/rural areas.

SUMMARY OF TOTAL COST RESULTS

- **Total delivery cost (excluding vaccines, injection supplies and labor costs):**
  - The total economic delivery cost of the immunization program, including facility, district, regional and national level costs, is US$21.8 million or US$0.38 per capita.
  - The share of costs by level of the health system is: facility-level costs (72.4%), district-level costs (20.5%), regional costs (7.0%) and national costs (0.5%).

- **Total cost (including vaccines, injection supplies and labor costs):**
  - The total economic cost of the immunization program, including facility, district, regional and national level costs, is US$138 million or US$2.41 per capita.
  - The share by summary line item is: labor (16.5%), vaccines (57.3%), injection supplies (10.4%) and delivery costs (15.8%).
  - The share of costs by level of the health system is: facility-level costs (87%), district-level costs (4%), regional costs (1%), national costs (8%).

SUMMARY OF RESULTS

- **Some results are expected.**
  - Delivery volume per facility is highest in urban areas.
  - Delivery strategy is an important determinant of costs:
    - Overall, outreach costs more per dose than facility-based delivery.
    - Outreach is more expensive in rural than urban areas, presumably due to the greater distances covered.

- **Overall, findings are in line with delivery cost results from similar studies conducted in other Sub-Saharan African countries.**
  - Cost per dose delivered, exclusive of vaccine cost but including injection supplies and labor costs for comparability:
    - Four other countries in the region: US$0.75 - US$3.18.
    - Tanzania: US$1.28.

SUMMARY OF RESULTS

Some results are unexpected.

- There is only a small difference between facility-based delivery costs in urban and rural areas, but this may be due to sampling error, not a true difference in costs.
- There is a relationship between delivery volumes and cost per dose delivered, but it isn't as clear as we have seen in other costing studies. This may be due to high variability in the data.
- In urban areas, cost per DTP3 FIC is lower than cost per M1 FIC but higher than cost per M2 FIC. Normally you would expect cost per FIC to increase progressively from DTP3 to M1 and M2, since more children reach DTP3 than M1 and M2. These results may reflect the patient mix that came to the urban facilities in the sample during the study period, and/or might be the result of data problems in urban areas.

OPPORTUNITIES FOR USE OF RESULTS

- Joint Annual Health Sector Review
- Gavi HSS application
- cMYP (2021-26)
- Annual planning guidelines for Comprehensive Council Health Plans
- Budget advocacy

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