**Estimating the costs of the vaccine supply chain and service delivery for selected districts in
Kenya and Tanzania**

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20 **Abstract**

21 Having data on the costs of the immunization system can provide decision-makers with
22 information to benchmark the costs when evaluating the impact of new technologies or
23 programmatic innovations. This paper estimated the supply chain and immunization service
24 delivery costs and cost per dose in selected districts in Kenya and Tanzania. We also present
25 operational data describing the supply chain and service delivery points (SDPs).

26 To estimate the supply chain costs, we collected resource-use data for the cold chain, distribution
27 system, and health worker time and per diems paid. We also estimated the service delivery costs,
28 which included the time cost of health workers to provide immunization services, and per diems
29 and transport costs for outreach sessions. Data on the annual quantities of vaccines distributed to
30 each facility, and the occurrence and duration of stockouts were collected from stock ledgers.
31 These data were collected from the national store, 2 regional and 4 district stores, and 12 SDPs in
32 each country for 2012. Cost per dose for the supply chain and immunization service delivery
33 were estimated.

34 The average annual costs per dose at the SDPs were \$0.34 (standard deviation (s.d.) \$0.18) for
35 Kenya when including only the vaccine supply chain costs, and \$1.33 (s.d. \$0.82) when
36 including immunization service delivery costs. In Tanzania, these costs were \$0.67 (s.d. \$0.35)
37 and \$2.82 (s.d. \$1.64), respectively. Both countries experienced vaccine stockouts in 2012,
38 Bacillus Calmette-Guérin vaccine being more likely to be stocked out in Kenya, and oral
39 poliovirus vaccine in Tanzania. When stockouts happened, they usually lasted for at least one
40 month.

41 Tanzania made investments in 2011 in preparation for planned vaccine introductions, and their
42 supply chain cost per dose is expected to decline with the new vaccine introductions.

43 Immunization service delivery costs are a significant portion of the total costs at the SDPs.

44

45 *Keywords: cost per dose; vaccine supply chain cost; Expanded Program on Immunization;*

46 *micro-costing; Kenya; Tanzania.*

47

48 **1. Introduction**

49 There is a growing focus on the importance of vaccine supply chains and the imperative for
50 increased investments to improve these supply chains.[1,2] When new investment decisions need
51 to be made regarding an existing health system, it is critical to assess the total costs and savings
52 associated with the proposed investments. Doing so requires a baseline understanding of the
53 economic costs of the current system. For health commodities, the total system costs that need to
54 be evaluated include the costs of operating the product supply chain and the costs of service
55 delivery. Unfortunately, only a few countries have collected system costs for their vaccine
56 supply chains,[3–8] yet having these data would empower governments to make well-informed
57 investment decisions.

58

59 The purpose of this study was to expand the breadth of data on the costs of supply chains and
60 service delivery to inform local as well as global stakeholders. The objective was to estimate the
61 supply chain and immunization service delivery costs and cost per dose of vaccine delivered or
62 used in 2012 in selected districts in Kenya and Tanzania. We also sought to characterize the
63 immunization systems by collecting complementary service metric data and information
64 regarding immunization practices from each of the SDPs (health centers, health posts, and
65 dispensaries) in our sample.

66

67 In 2012, Tanzania's Expanded Programme on Immunization schedule included the Bacillus
68 Calmette-Guérin (BCG), oral polio, diphtheria tetanus pertussis - hepatitis B - *Haemophilus*
69 *influenzae* type B (pentavalent), measles, and tetanus toxoid vaccines. In addition to these

vaccines, Kenya administers yellow fever vaccine to children in select districts and introduced the pneumococcal conjugate vaccine into routine immunization in 2011. In both countries, vaccines pass through three storage locations (national, regional, and district) before arriving at the service delivery levels.

2. Materials and Methods

2.1. Study design

We used an ingredients-based costing method [9] to estimate the resources used for the supply chain and service delivery in 2012. We modified costing questionnaires from previous supply chain assessments.[4,10] The questionnaires were field tested in each country and further customized as needed. Health workers at each facility were interviewed using these questionnaires and they provided information on the resources used for the vaccine supply chain and service delivery.

The study was conducted in the Central and Coast regions in Kenya, and the Morogoro and Tanga regions in Tanzania. In each country, we included one region with high immunization coverage rates and one with low coverage rates. We used a convenience sampling approach to select the districts and SDPs in each of the target regions, but we made a purposive effort to include districts and SDPs with high rates of immunization coverage and others with low coverage. The two regions in the Kenya sample had 8 and 4 districts, respectively, and the districts in our sample had between 6 and 54 public SDPs. The two regions in the Tanzania sample had 7 and 8 districts, respectively, and the districts in the sample had between 28 and 45 public SDPs. In addition to collecting data from the 2 regions in each country, we also collected

data from the national store, 4 districts, and 12 SDPs in each country. Field visits for data collection were conducted between June and August of 2013.

2.2. Cost categories

We collected resource-use data to enable the estimation of the transportation and the storage costs of the supply chain. For the transportation costs, we collected information on the mode of transport used for vaccines, number of trips, and vehicle repair and maintenance costs. We also collected information on the costs of public transport or hired vehicles, if used. In Tanzania, immunization supplies (syringes and safety boxes) were transported on the same trips as vaccines. However, in Kenya their distribution system was separate from the vaccine supply chain and we did not collect the distribution costs for that separate supply chain.

To estimate the storage costs, we gathered information on the type of cold chain equipment available at each level, as well as the energy, maintenance, and repair costs for each piece of equipment. We obtained information on the types and quantities of cold boxes and vaccine carriers at each facility. Health workers and support staff were asked to provide their job titles and grades, as well as the percentage of time spent on vaccine supply chain activities, surveillance, supervision, and on non-immunization activities. In addition, we collected information on the number of workers traveling for each trip and per diems paid for trips to collect or deliver vaccines.

To estimate the costs of immunization service delivery, we asked staff at the SDPs to estimate the percentage of their time spent on providing immunization services, the number of outreach

sessions per month, number of locations where outreach was held, distance from the health center, mode of transport, the number of staff going for each outreach session, and per diems, if paid.

2.3. Annual throughput

We reviewed vaccine stock registers and recorded the quantities in stock delivered, distributed, or used during 2012 at each facility. The quantities of vaccines distributed or used were then used as the annual throughput and served as the denominators in our cost estimates. Stock ledgers were also reviewed to document whether the facility had experienced any vaccine stockout, including the type of vaccine and duration of the stockout.

2.4. Unit prices

We collected country-specific resources prices and prices from secondary sources, as shown in Appendix Table A.

2.5. Data analysis

Data analysis was done in Microsoft Excel (Redmond, WA, USA). All costs were estimated for one year and presented in 2012 US dollars (US\$). An exchange rate of 83 Kenyan shillings and 1,562 Tanzanian shilling per US\$ was used.[11] Below we provide details on how the costs were estimated.

2.5.1. Vaccine storage costs

Appendix Table A also shows the prices of selected cold chain equipment which were obtained from the Cold Chain Equipment Manager (CCEM) tool.[12] We assumed that cold and freezer

rooms had an economic life of 15 years; and refrigerators, freezers, cold boxes and vaccine carriers had a life of 10 years. Annual cold chain capital costs were calculated by dividing the current replacement price for equipment by its annualized economic life, assuming a 3% discount rate (annualization factor for 10 year at 3% is 8.53). The annualized costs per equipment item were then aggregated to estimate the costs for the facility.

Energy costs for the cold chain were calculated by multiplying the kilowatt hours (kWh) used per 24 hours by the unit price of electricity and then by 365. The data on the kWh/24 hours was also obtained from the CCEM tool.[12] We used an electricity price of \$0.24 per kWh in Kenya and \$0.13 in Tanzania (Appendix Table A). For cold chain equipment using kerosene or gas, the reported monthly expenditure for kerosene or gas was converted to US\$ and multiplied by 12 to get the annual cost for energy.

2.5.2. Transport costs

None of the vehicles, other than the refrigerated trucks in Tanzania, were solely for use for vaccine logistics. Therefore, for vehicles not solely used for vaccine logistics, we allocated the reported expenditure on fuel and vehicle maintenance to vaccine supply chain costs based on the number of days the vehicle was reported as used for vaccine supply chain activities. We also used this percentage of time to allocate vehicle depreciation to vaccine supply chain costs. To calculate annual vehicle depreciation costs, we assumed each vehicle had a 10 year economic life and divided the replacement price by the annualized economic life. Selected vehicle prices are shown in Appendix Table A.

If public transport or third-party vehicles were contracted for use in the supply chain, the actual amount paid per trip was converted to US\$ and included in the costs. Transport costs were allocated to the facility responsible for the collection or distribution.

2.5.3. Salaries and per diems

Annual salary costs for vaccine supply chain or immunization service delivery activities were estimated by multiplying each of the staff's monthly salary by the reported percentage of time spent on these activities, and then by 12 to convert to annual costs. These costs were then aggregated for all staff at the facility to estimate facility-level salary costs. Selected salaries and reported average and range of time spent on the activities are shown in Appendix Table A.

The annual per diems costs for vaccine distribution were calculated as the product of the number of trips made per year, the per diems paid per trip (Appendix Table A), and the number of workers traveling per trip. Similar calculations were made to estimate the per diem costs for outreach sessions: these were the product of the per diem paid per person per outreach session, the number of outreach sessions held per month, and the number of staff paid. This cost was then multiplied by 12 to get the annual amount spent on per diems for outreach sessions.

2.5.4. Value of vaccines

The price per dose of each vaccine was obtained from the World Health Organization (WHO) Stock Management Tool [13] and this price per dose was multiplied by the quantities of vaccines distributed to or used at each facility to estimate the value of vaccines for the facility.

2.5.5. *Total costs and cost per dose*

Total supply chain costs were estimated by aggregating the cold chain, transport, and salaries and per diem costs at each facility, but excluding the value of the vaccines. The SDPs' total costs were also estimated by adding the supply chain and immunization service delivery costs.

Our primary evaluation metric was the cost per dose of vaccine delivered or used at each facility. The cost per dose was calculated by dividing the estimated annual vaccine supply chain costs (excluding or including immunization service delivery costs) by the annual number of doses of vaccines distributed to or used at the facility. An average cost per dose was calculated by supply chain level and added across all levels to obtain the cost per dose for the entire supply chain, using the estimates in our sample.

Other metrics calculated at each facility included total supply chain costs as a percentage of the value of vaccines and total supply chain and immunization service delivery costs as a percentage of vaccine value.

2.6. *Operational data*

We collected operational data for the service delivery levels including the target population, use of outreach sessions, and methods used for disposing immunization waste. We also asked the health workers to assess whether they thought their facilities experienced missed immunization opportunities and the causes of these missed opportunities.

3. Results

3.1. Vaccine supply chain and costs

3.1.2. National stores

In 2012, there were approximately 1.34 million children under one year of age in Kenya.

Vaccines at the national cold store were stored in four cold rooms and one freezer room. They distributed approximately 30 million doses of vaccine to the regions, and these vaccines were valued at approximately \$27 million. The vaccines were transported in the polystyrene boxes used in international shipments. Quarterly vaccine deliveries using non-refrigerated trucks were made to each of the eight regions, using separate trips to each region.

Similarly, the Tanzania national store served approximately 1.7 million children aged under one year. Eight new cold rooms were constructed in 2011 at the national vaccine store, and these were added to the three cold rooms and two freezers that had been in use for approximately 20 years, providing a significant enhancement in storage capacity in preparation for the introduction of rotavirus and pneumococcal conjugate vaccines, which were introduced in 2013. The national store also purchased two new refrigerated trucks for vaccine distribution in 2011. Approximately 19 million doses of vaccines with a value of about \$16 million were stored at the national vaccine store and distributed to the regions through eight zonal stores. Monthly vaccine deliveries were made to the 24 regional vaccine stores using ten routes.

We estimated that annual supply chain costs were approximately \$89,000 for the Kenya national store and \$262,000 for Tanzania, as shown in Table 1. Vaccine storage and transport costs were

higher for Tanzania because of the expansion of the cold rooms and purchase of two refrigerated vehicles in preparation for new vaccine introduction.

3.1.2. Regions

The Central Province in Kenya distributed about 2 million doses of vaccines and the Coastal Province distributed approximately 4 million doses, valued at approximately \$1.5 million and \$3.5 million, respectively. Some of the vaccines for the Coastal Province may include campaign vaccines. The regions received vaccines from the national store, and districts collected vaccines from the regions; thus, regions did not incur any costs related to vaccine transport. The average economic costs for vaccine storage and personnel for the regions were estimated at approximately \$25,000 per year (Table 1). The Central Province had higher costs because it had more staff working on vaccine supply chain logistics and also more cold chain equipment.

Each of the two regions in our sample for Tanzania (Morogoro and Tanga) distributed approximately one million doses of vaccines valued at approximately \$500,000. Both regions made monthly deliveries to the districts using non-refrigerated vehicles. Each of the regional vaccine stores reported having a cold room. The average economic costs at the regional stores were estimated at approximately \$34,000 (Table 1). The main reason for the difference in costs was because of transport costs and per diems. Tanga region has more districts and longer distances for vaccine distribution, hence more distribution trips were made than in the Morogoro region.

The staff at the regions in Kenya reported spending 50–70% of their time on vaccine supply chain duties. In Tanzania, they reported spending 10–60% of the time (Table A).

3.1.3. Districts

The four districts in our Kenya sample distributed an average of 283,000 doses of vaccines, valued at an average of approximately \$263,000 per district. The annual average economic costs per district were approximately \$20,000 with a standard deviation (s.d.) of \$5,777 (Table 2).

Two districts collected vaccines from the regions every other month, and two districts collected vaccines monthly, which was the main reason for variability in the transport costs across the districts. The number of staff at each district ranged from 2 to 4, and differences in pay grades and reported time spent on vaccine supply chain activities led to variability in salary costs.

For Tanzania, the four districts distributed an average of 145,000 doses valued at an average of approximately \$67,000 annually. Three of the districts in our sample had vaccines delivered by the regional vaccine stores, and only one reported collecting vaccines from the regional level, which explained some of the variability in transport costs. All the districts delivered vaccines monthly to the SDPs. Table 2 shows that the average economic costs were \$23,880 (s.d. \$5,567) per district. Salaries were the largest share of costs and also had large variations. The reasons for the variations were because of the number of staff (3 of the 4 districts had 2 staff while one district had 5 staff), the amount of time spent on supply chain duties (range 20–80%), and the pay grades of the staff.

3.1.4. Service delivery points

In 2012, the target number of infants served at each SDP in our Kenya sample ranged from 76 to 1,492. Routine immunization was provided daily at all facilities, and 5 of the 12 SDPs reported conducting outreach monthly at multiple locations for each SDP. Incineration was the most common method of disposing of immunization waste at the health facility, with seven facilities reporting using this method. Four facilities reported that they sent immunization waste to the district or region for disposal, and only one reported burning and burying the waste.

In Tanzania, the smallest target population served by a health center in our sample was 175 children while the largest was 1,160. Eleven health facilities reported conducting immunization sessions at least five days a week, and one reported that the sessions are conducted twice weekly. All of the SDPs conducted monthly outreach sessions to multiple locations. Eight of the SDPs reported using the burn and bury method for disposing immunization waste, and the other four reported using incineration.

As shown in Table 3, average supply chain costs per SDPs in Kenya were \$2,199 (s.d. \$968), and when including the costs of providing immunization services, the cost per facility averaged \$8,628 (s.d. \$5,141). The estimates for Tanzania were \$4,334 (s.d. \$2,434) and \$16,799 (s.d. \$7,796), respectively. Salaries and per diems were the largest share of costs at the SDPs. The SDPs in the Kenya sample had 2 to 3 staff, while in Tanzania there were 3 to 4 staff. In both countries SDP staff reported spending about 70% of their time on vaccine supply chain and immunization service delivery. Differences in salary costs were also explained by differences in the pay grades of the staff.

3.2. *Supply chain metrics by tier*

The costs per dose increased as we moved down the supply chain (Table 4). In Kenya, the cost per dose distributed ranged from \$0.003 at the national level to \$0.34 (s.d. \$0.18) at the SDPs. The supply chain costs at the SDP were 38% (s.d. 24%) of the value of vaccines held at this level. The aggregated supply chain cost per dose from the national level to the SDP was \$0.43 per dose. When we add the costs of providing immunization services, the estimated total cost per dose was \$1.42.

For Tanzania, the supply chain cost per dose ranged from \$0.01 at the national level to \$0.67 (s.d. \$0.35) at the SDP. The supply chain costs at the SDP were 101% (s.d. 64%) of the value of the vaccines held at the SDPs. The aggregated cost per dose from the national level to the SDPs was \$0.88 when including only supply chain costs, and \$3.03 when including both supply chain and immunization service delivery costs.

3.3. *Stockouts*

Figures 1a and 1b show that in 2012, stockouts were more prevalent in Kenya than Tanzania. The vaccines most affected by stockouts were BCG in Kenya and oral polio in Tanzania. Stockouts at the national level were caused by delays with ordering vaccines or delay of shipments. Eleven of the twelve SDPs in the Kenya sample reported experiencing at least one stockout. The most common reason given were low stock or stockouts at the higher level facilities. When stockouts happened, they usually lasted for at least one month.

3.4. Reasons for missed vaccination opportunities

In Kenya, when SDP staff were asked if they thought they had problems with missed vaccinations at their facility, staff at one SDP responded that the practice of only opening BCG and measles vaccines twice a week (even though other vaccines were offered daily) could result in missed opportunities for these vaccines. Staff at one facility reported that the BCG stockout led to missed opportunities, while staff at another facility cited a strike by nurses as a possible cause. None of the staff at the Tanzania facilities reported missed vaccination opportunities or causes.

4. Discussion

Our study estimated that vaccine supply chain costs were \$0.43 per dose for Kenya and \$0.88 for Tanzania, and \$1.42 and \$3.02 per dose when including immunization service delivery for Kenya and Tanzania, respectively. We found that the cost per dose of providing immunization services is higher than the supply chain costs. Staff salaries are the main portion of the service delivery costs. For the supply chain costs, total costs per facility decreased as we moved down the supply chain, but the cost per dose delivered increased because of the fixed costs. The finding that the supply chain cost per dose goes up as you move down the supply chain is mainly driven by the human resource costs at the lower levels of the supply chain..

Previous studies that have estimated vaccine supply chain costs reported total supply chain cost per dose of US\$0.24 in Vietnam,[4] \$1.06 and \$1.21 for two provinces in Mozambique,[7] and \$0.23 in Benin.[14] Other studies which assessed cost of immunization services focused on the

incremental costs associated with adding a new vaccine and are, therefore, not directly comparable to the results presented in this study.[6,8]

This analysis was not intended to compare costs in Kenya and Tanzania. However, we can highlight one main reason for the differences between the two country results. The supply chain costs for Tanzania were much higher than those for Kenya because of Tanzania's investments made in preparation for new vaccine introductions. As a result of these recent purchases prior to the assessment year, the national store had excess capacity for vaccine storage because the new vaccines had not yet been introduced. The cost per dose is expected to decline as the new vaccines are introduced and the available capacity is used more efficiently. This highlights the need to understand the country context when supply chain assessments are undertaken and to caution against performing cross-country comparisons without an understanding of the environment and context of the study. Differences in salaries and number of staff and time spent on vaccine supply chain and immunization services may also explain some of the differences in costs.

Supply chain metrics such as the cost per dose and supply chain costs as a percentage of the value of vaccines should not be used to benchmark the performance of the supply chain without ensuring that the assessments are comparing the same throughput. The introduction of a new expensive vaccine or a change in the presentation of a vaccine used (for example, the change from a 10-dose to a 2-dose per vial presentation where the latter has a lower wastage rate and hence results in a decrease in the number of doses ordered), can increase or decrease the

estimated supply chain metrics, and yet there is no real change in the total supply chain costs or the efficiency of the supply chain.

Cost estimates in this study and future studies of similar design can be leveraged as inputs for cost-effectiveness studies and also can be used as a baseline assessment when evaluating the impact of potential investments in new technologies or programmatic innovations. In addition, operational data could be used by policymakers to identify areas where improvements in the supply chain may add value to service delivery. For example, we found that stockouts were a problem in both countries. Our study also found that health workers did not seem to associate stockouts with missed vaccination opportunities. It is possible that the health workers were confident that caregivers would return to the facility when the vaccine was restocked. However, we did not inquire about the measures taken by the health workers to ensure that children returned for vaccination when the vaccine was restocked.

Our analysis has several limitations. First, the number of facilities included in the analysis is small and, therefore the variances of the cost estimates are large and also, the results may not be generalizable for the entire country or even for the regions included in our sample. However, we undertook this assessment and analysis to provide some indication of the costs associated with the supply chain and immunization service delivery in selected districts. Future studies can improve on the estimates by increasing the sample size which can permit sub-group analyses to reduce the variance of the estimates. These sub-group analyses can enable the estimation of costs separately for urban and rural facilities, and by the size of the target population served, as these are possible sources of cost variability. Second, we did not collect supply chain costs associated with immunization supplies in Kenya because these were distributed using a different supply

chain than vaccines. Thus, we have underestimated the costs of the Kenya vaccine supply chain. In Tanzania, both vaccines and immunization supplies were bundled in the distribution and hence both costs are captured. Third, distance and accessibility were not a factor used in selecting the purposive sample, and yet these factors can have a large effect on costs. These factors could also explain the variability in our estimates, and we suggest that future analyses explore the impact of these factors on costs. Fourth, the stock data collected at some facilities may include vaccines intended for campaigns—we asked the respondents to provide stock data specifically on routine immunizations only, but there is a possibility of errors in reporting leading to campaign vaccines being included. Most of the facilities did not include the information on the drivers and the portion of time they spent on vaccine logistics, with the exception of their per diem costs; thus, a portion of the labor costs of the drivers that should be allocated to vaccine supply chain are not included.

In conclusion, our study increases the body of evidence on vaccine supply chain and immunization service delivery costs. It highlights the importance of including both supply chain and immunization service provision costs, as the cost of service provision are significant, accounting for almost 75% of the costs at the SDPs. For all the districts and SDPs in our sample, human resource costs accounted for the largest share of the supply chain and service delivery costs, showing the importance of human resource investments in immunization systems.

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Table 1. Annual vaccine supply chain costs for the national and regional vaccine stores in Kenya and Tanzania in 2012 (US\$).

	Kenya			Tanzania		
	National store	Central region	Coast region	National store	Morogoro region	Tanga region
Vaccine storage	\$33,360	\$17,527	\$13,601	\$83,173	\$6,670	\$6,366
Transportation	\$25,112	0 ^a	0 ^a	\$140,695	\$1,924	\$4,622
Salaries and per diems	\$22,337	\$11,669	\$7,452	\$38,293	\$21,180	\$26,451
Forwarding / clearing agent	\$7,933	NA	NA	0 ^b	NA	NA
Total vaccine supply chain costs	\$88,743	\$29,196	\$21,053	\$262,161	\$29,773	\$37,439

^a National store distributed vaccines to the regions and the districts collected vaccines from the region and so the region did not incur any vaccine transport costs.

^b Tanzania did not use a clearing agent to clear the vaccines when they arrived at the airport, but used their own staff. These costs are included in the human resource costs reported.

Abbreviations: NA, Not Applicable.

Table 2. Annual average and standard deviations of the vaccine supply chain costs for the districts in Kenya and Tanzania in 2012 (US\$).

	Kenya (n=4 districts)		Tanzania (n=4 districts)	
	Mean	Standard deviation	Mean	Standard deviation
Vaccine storage	\$2,916	\$229	\$1,889	\$1,603
Transportation	\$3,374	\$2,221	\$8,417	\$3,629
Salaries and per diems	\$13,855	\$5,573	\$13,573	\$8,178
Total vaccine supply chain costs	\$20,145	\$5,777	\$23,880	\$5,569

Table 3. Annual averages and standard deviations of the vaccine supply chain and immunization service delivery costs for the service delivery points (SDPs) in Kenya and Tanzania in 2012 (US\$).

	Kenya		Tanzania	
	SDPs (n = 12)	Standard deviation	SDPs (n = 12)	Standard deviation
<i>Vaccine supply chain costs</i>				
Vaccine storage	\$528	\$202	\$496	\$173
Transportation	\$64	\$74	\$71	\$199
Salaries and per diems	\$1,606	\$1,082	\$3,767	\$2,526
Total vaccine supply chain costs	\$2,199	\$968	\$4,334	\$2,434
<i>Immunization service delivery costs</i>				
Transportation for outreach activities	\$89	\$161	\$848	\$1,199
Salaries and per diems	\$6,341	\$4,725	\$11,617	\$6,942
Total costs (vaccine supply chain and immunization service delivery)	\$8,628	\$5,141	\$16,799	\$7,796

Table 4. Cost per dose in 2012 US\$ and costs as a percentage of the value of vaccines for Kenya and Tanzania.

	Kenya				Tanzania			
	National store ^a	Regional stores ^b	Districts ^c	SDPs ^c	National store ^a	Regional stores ^b	Districts ^c	SDPs ^c
Vaccine supply chain cost per dose	\$0.003	\$0.015; \$0.005	\$0.08 (\$0.04)	\$0.34 (\$0.18)	\$0.014	\$0.03; \$0.04	\$0.16 (\$0.01)	\$0.67 (\$0.35)
Vaccine supply chain costs as a percentage of the value of vaccines	0.3%	2%; 0.6%	8.7% (5%)	38.4% (24%)	1%	4%; 5%	36% (5%)	101% (64%)
Vaccine supply chain and immunization service delivery cost per dose	NA ^d	NA	NA	\$1.33 (\$0.82)	NA	NA	NA	\$2.82 (\$1.64)

^a Kenya national store distributed 29,520,000 doses while the Tanzania national store distributed 19,287,000 doses in 2012.

^b The values reported correspond to the estimates for each of the two regions in the sample, where the respective estimates for each region are separated by the semi colon.

^c These are the averages costs and percentages for the districts and service delivery points (SDPs) in our sample. Standard deviations shown in parenthesis.

^d This is not applicable because immunization service delivery costs are only incurred at the SDPs.

Abbreviations: NA, Not Applicable.

Fig. 1a. Duration of stockouts by vaccine type and location in Kenya.

Abbreviations: BCG, Bacillus Calmette-Guérin; PCV-10, pneumococcal conjugate vaccine; Penta, diphtheria tetanus pertussis-hepatitis B-*Haemophilus influenzae* type b; Polio, oral polio vaccine; SDP, service delivery point.

Fig. 1b. Duration of stockouts by vaccine type and location in Tanzania.

Abbreviations: BCG, bacillus Calmette-Guérin; Penta, diphtheria tetanus pertussis-hepatitis B-*Haemophilus influenzae* type b; Polio, oral polio vaccine; SDP, service delivery point.