THINK WELL

THE COST OF DELIVERING COVID-19 VACCINES IN CÔTE D'IVOIRE

STUDY REPORT | JULY 2023

G:ENESIS
25 YEARS OF UNLOCKING VALUE

ACKNOWLEDGMENTS

This study was conducted by a team from Genesis Analytics (Carl Schütte, Elise Smith, and Kelsey Vaughan), under the guidance of ThinkWell (Laura Boonstoppel and Flavia Moi). Gaicha Saddy from the Genesis Analytics Abidjan office provided support on the ground. Data collection was led by Prof. Alfred Douba and Dr. Christian Akani from Université Felix Houphouet Boigny, Abidjan, with support from Kevin Dayoro (co-investigator) and Prosper Toowlys Gnakouri, Natacha Konan Quevin, Atta Kouassi Brou, Mireille Kouame Ble, Francis Coffi, Michel Zirigouri Gnapka (enumerators), and Jean Pierre Kouame (data manager). A Ministry of Health-appointed focal person, Mr. Alexandre Guebo, Technical Advisor for Health Financing and Resource Mobilization, provided guidance and oversight to the study.

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TABLE OF CONTENTS

ABBREVIATIONS

AEFI	Adverse event following immunization
C19	COVID-19
C19VFM	COVID-19 Vaccine Financial Monitoring
CFA	West African CFA franc
COVAX	COVID-19 Vaccine Global Access
CoVDP	COVID-19 Vaccine Delivery Partnership
DCPEV	Direction de Coordination du Programme Élargi de Vaccination (Expanded Program on Immunization)
EPI	Expanded Program on Immunization
FTE	Full-time equivalent
HMIS	Health management information system
HRH	Human resources for health
IEC	Information, education, and communication
INHP	Institut National d'Hygiène Publique (National Public Hygiene Institute)
LMIC	Low- and middle-income countries
MOH	Ministère de la Santé, de l´Hygiène Publique et de la Couverture Maladie Universelle (Ministry of Health, Public Hygiene and Universal Health Coverage
NDVP	National Deployment and Vaccination Plan
NPSP	Nouvelle Pharmacie de la Santé Publique Côte d'Ivoire (New Public Health Pharmacy of Côte d'Ivoire)
PSP-CI	Public Health Pharmacy of Côte d'Ivoire
SOGETCI	Société Générale des Technologies de Côte d'Ivoire
UCC	Ultra-cold chain
UNICEF	United Nations Children's Fund
USD	United States dollar (also $)
WHO	World Health Organization

EXECUTIVE SUMMARY

RATIONALE

The delivery of COVID-19 (C19) vaccines posed unprecedented challenges in terms of delivery volume and reaching new target populations. Meanwhile, what it costs to deliver these vaccines remains highly uncertain. To support the government in planning and budgeting for the C19 vaccination program, Genesis Analytics and ThinkWell conducted a study to estimate the cost of delivering C19 vaccines in Côte d'Ivoire.

METHODOLOGY

This was a retrospective, bottom-up costing study that estimated the financial and economic costs incurred by Côte d'Ivoire's public health system to deliver C19 vaccines in 2022. Costs were estimated from a payer perspective, including the Ministry of Health, Public Hygiene and Universal Health Coverage (MOH) and development partners. The study covers the delivery period from March to May 2022, and a start-up period of approximately one month prior to the start of vaccination. Data was collected retrospectively in June 2022 by a team from the Université Felix Houphouet Boigny from a purposively selected sample of 30 health facilities within six districts and three regions (Abidjan 1, Abidjan 2, and Gbêkê), as well as from the national-level MOH and partners. The sample included high- and low-volume sites, and facilities that used different delivery strategies (facility-based, outreach, and mobile units). Costs were disaggregated across program activities and resource types to analyze cost drivers. Volume-weighted average unit costs were calculated for each level of the health system and aggregated. Cost findings are presented in 2022 United States dollars (USD or $). A small-scale qualitative assessment was also conducted to better understand the financial and non-financial support provided by partners and donors and help contextualize cost findings.

Estimating the cost of delivering COVID-19 vaccines in low- and middle-income countries

This study is part of a multi-country project that utilizes standardized methods to generate cost evidence on the delivery of C19 vaccines in low- and middle-income countries. The project is led by ThinkWell, and supported by the Bill & Melinda Gates Foundation, and covers studies in Côte d'Ivoire, the Democratic Republic of Congo, Mozambique, Uganda, Vietnam, Bangladesh, and the Philippines.

For more information, please see **https://immunizationeconomics.org/covid19-vaccine-delivery-costing**

IMPLEMENTATION OF THE C19 VACCINATION PROGRAM IN CÔTE D'IVOIRE

Côte d'Ivoire started C19 vaccinations in March 2021, under the management of the Direction de Coordination Programme Élargi de Vaccination (DCPEV). By the end of 2021, only around 7% of the total population had been vaccinated, after which Côte d'Ivoire became a priority country for the C19 Vaccine Delivery Partnership (CoVDP) and received targeted support to increase coverage levels. By March 2022, the target was expanded to the entire population over the age of 12, and booster doses

became available in April 2022. At the time of data collection for this study, around 30% of the population had received at least one dose of a C19 vaccine. As of February 2023, more than 25 million doses had been delivered, and around 72% of the country's eligible population was partially or fully vaccinated against C19.

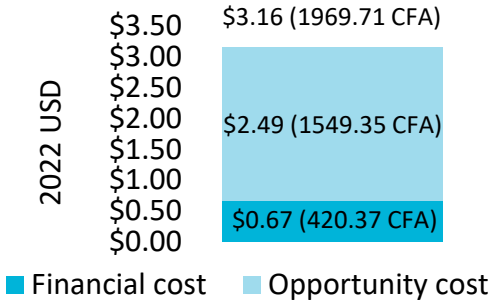
Côte d'Ivoire's C19 vaccine program primarily utilizes facility-based delivery. In addition, outreach and mobile strategies are implemented during monthly intensification periods of 10-15 days. The country also had two mass vaccination sites in Abidjan. The program largely relied on its existing capacity and health workforce, and additional hiring was very limited. Additional volunteers were mobilized to support with social mobilization, client registration, and crowd management.

Several challenges in implementing the C19 vaccination program were identified during the qualitative interviews:

- Allowances that were earmarked for the implementation of the C19 vaccination program were insufficient and often not paid for several months, severely disrupting activities.
- Although some gaps were filled by volunteers, staff shortages were flagged as a key issue.
- Limited travel and transport-related funding challenged outreach activities, resulting in staff paying for fuel themselves without reimbursement.
- Problems related to the management of C19 vaccination-related waste occurred at all levels, with incinerators being out of order for long periods of time, and delays in waste pick-up by higher administrative levels.
- Some respondents at the facility-level reported technical issues related to limited network for the use of QR codes for registration and generation of vaccine certificates.

COST OF DELIVERING C19 VACCINES

The financial cost of delivering C19 vaccines in Côte d'Ivoire during March-May 2022 was relatively low at $0.67 (420.37 CFA) per dose; vaccine injection and safety supplies represented the largest cost driver (55%), followed by volunteer allowances. The economic delivery costs were much higher ($3.16 or 1969.71 CFA per dose), due to the significant opportunity cost of labor, which made up almost 80% of the total cost per dose. Other significant opportunity costs included the value of volunteer allowances that were promised but not paid out (9%). Capital costs, such as those for cold chain equipment and vehicles, were very small.



While the financial cost per dose is much lower than what COVAX expected (between $0.96 and $2.53 or 598.81 CFA and 1578.11 CFA, respectively), the economic cost per dose found in this study is high compared with what is generally assumed to be the delivery cost of routine childhood vaccines (between $0.65 and $4.07 or 405.44 CFA and 2538.70 CFA, respectively). The low financial cost reflects the limited additional hiring of paid health workers, limited investments in additional cold chain equipment that was available to the program, and limited funding available for common cost drivers such as allowances and transport, while the high opportunity cost reflects the important role that the existing health workforce played in delivering the C19 vaccination program.

There appeared to be a weak negative association between the economic cost per dose delivered and the number of doses delivered. Any economies of scale observed in the data are likely the result of efficiencies in the cost of labor, which is the main delivery cost driver.

KEY TAKEAWAYS

- The low financial cost per dose found in this study is likely a reflection of a lack of funding, as opposed to low financial requirements to support vaccination.
- The much higher economic cost per dose highlights the important role of both existing paid staff as well as volunteers. However, the economic cost per dose is still a reflection of a program that made do with the resources that were available. The additional burden on a health workforce that already suffered critical shortages pre-pandemic would not be sustainable in the long run.
- The unit cost of delivery was higher at low-volume sites. This is an important finding to consider when planning for the next phase of Côte d'Ivoire's C19 vaccination program; this is likely to involve reduced delivery volume, given that it has already reached relatively high coverage levels. To reduce the burden on health workers and achieve cost efficiencies, Côte d'Ivoire must explore integration options.
- The program relied heavily on volunteers, and Côte d'Ivoire must think critically about their role in the next phase of its C19 vaccination program. In the short term, volunteers should be regularly compensated to ensure the continuity of services. If in the longer term this support needs to be provided by regular staff, there would be significant cost implications. Our estimations showed that offering these roles a regular, low-grade salary could increase costs by 15%.

I. INTRODUCTION

To support the government in planning and budgeting for the COVID-19 vaccination program, Genesis Analytics and ThinkWell conducted a study to estimate the cost of delivering COVID-19 vaccines in Côte d'Ivoire. The delivery of COVID-19 (C19) vaccines posed unprecedented challenges in terms of delivery volume and reaching new target populations. Meanwhile, what it costs to deliver these vaccines remains highly uncertain. To address this knowledge gap and support Côte d'Ivoire's planning and budgeting for the future of its C19 vaccination program, Genesis Analytics and ThinkWell conducted a study to estimate the cost of delivering C19 vaccines in Côte d'Ivoire from March to May of 2022. This study estimates the cost of delivering C19 vaccines at different types of sites (low- and high-volume) that used different delivery strategies (facility-based, outreach, and mobile units) and different levels of the health system (national, regional, district, sub-district), and analyzes the main cost drivers. The costing study was accompanied by a small-scale qualitative assessment to better understand financial and non-financial support provided by partners and donors and help contextualize cost findings.

Estimating the cost of delivering COVID-19 vaccines in low- and middle-income countries
This study is part of a multi-country project that uses standardized methods to generate cost evidence on the delivery of C19 vaccines in low- and middle-income countries. The project is led by ThinkWell, is supported by the Bill & Melinda Gates Foundation, and covers studies in Côte d'Ivoire, the Democratic Republic of Congo, Mozambique, Uganda, Vietnam, Bangladesh, and the Philippines.

For more information, please visit **https://immunizationeconomics.org/covid19-vaccine-delivery-costing**

II. STUDY OBJECTIVES & METHODOLOGY

RATIONALE & OBJECTIVES

The primary objective of this study is to estimate the cost of delivering C19 vaccines in Côte d'Ivoire. The aim of this study was to urgently support the Ministry of Health, as well as ministries of health in other low- and middle-income countries (LMICs), to make data-informed choices when planning and budgeting for a mix of delivery strategies and delivery sites to facilitate equitable delivery of C19 vaccines.

The specific objectives of the study are as follows:

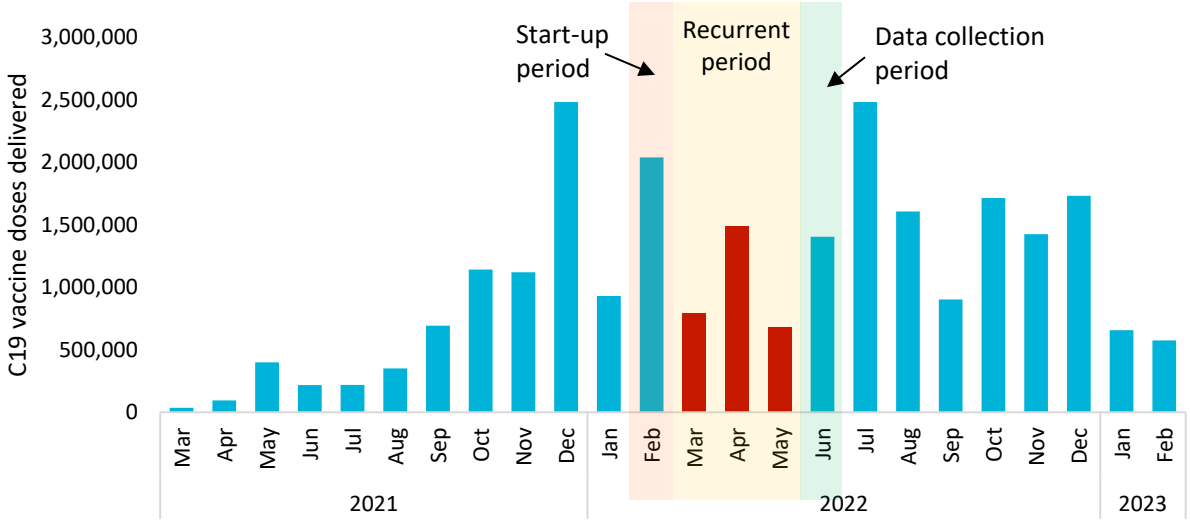
- Estimate the resource requirements and value of inputs used to deliver C19 vaccines through different delivery strategies at different levels of the health system in Côte d'Ivoire.
- Understand the main cost drivers of C19 vaccine delivery costs, including how they vary by delivery strategy, such as human resources, cold chain equipment, per diems, and transport, as well as the costs of social mobilization, which may be high given vaccine hesitancy.
- Compare the unit costs of C19 vaccination found in Côte d'Ivoire to the cost of delivery in other countries.

STUDY DESIGN

This was a retrospective, bottom-up costing study that estimated the costs of delivering C19 vaccines through Côte d'Ivoire's health system. The study estimates the cost from a payer perspective, defined in this context as the costs of delivering vaccines by the Ministry of Health, Public Hygiene and Universal Health Coverage (Ministère de la Santé, de l´Hygiène Publique et de la Couverture Maladie Universelle, MOH), regardless of whether activities are funded by the government or external partners. Potential costs incurred by other ministries were excluded as during initial consultations with the MOH, these were estimated to be very small. Costs from all levels of the health system (facility, district, regional, and national level) are included. We primarily used retrospective, bottom-up or ingredients-based costing. Program-related activities at each administrative level were costed by measuring the quantity of the inputs (see **Annex 1** for definitions) used to implement these activities, which were then multiplied by the price for each of these inputs. At the national level only, we also used top-down methods to obtain the total value of the cold chain maintenance contract and a full list of all newly purchased cold chain equipment.

We estimated costs incurred during two time periods: a start-up period and a recurrent time period from March to May 2022. The recurrent time period of March 1 to May 31, 2022, was chosen to minimize recall bias, since data collection started in June 2022, and because facilities only started systematically reporting data on the number of doses delivered per day as of March 2022. The start-up period is defined as the approximately one-month period prior to the start of vaccination. Additional start-up costs that may have been incurred after vaccination had begun, particularly related to the expansion of the program when vaccination was opened up to the entire population, are also included. Figure 1 visualizes total delivery volume during the study period, within the context of how the program has evolved over time. It shows that although delivery volume was greater before and after the study period, the study period does seem more representative of recent months of the program in late 2022 and early 2023.

Figure 1: Monthly breakdown of C19 doses delivered (March 2021–February 2023)[1]



The costing study estimated both the financial and economic cost of delivering C19 vaccines in Côte d'Ivoire, while a few cost components were excluded. Financial costs include all financial outlays, including volunteer and staff allowances, that were paid for participation in intensification periods and human resource costs of any staff newly employed specifically for the C19 program. Economic costs include all financial outlays as described above, plus opportunity costs of volunteer time and salary costs of staff that were employed prior to the C19 vaccination program. Other economic costs, such as the value of existing buildings, cold chain equipment, and other capital costs, are excluded, as well as utility costs at all levels (apart from cold chain energy costs). For waste management, staff time spent on waste management is included but the value of the service contract to a third-party supplier is excluded as it was unavailable to the study team. Although the focus of the research was on delivery costs, we also collected information on all vaccines acquired, to provide a comprehensive overview of immunization program costs.

The costing study was complemented by a small-scale qualitative assessment aimed at better understanding financial and non-financial support provided by partners and donors, and to help contextualize cost findings. The qualitative interviews explored how existing health system resources were utilized for C19 vaccination, how additional staffing needs for the C19 vaccine rollout were met, and any operational and funding challenges and successes related to the C19 vaccine rollout. It also looked at the different sources of funding and in-kind support for C19 vaccination to-date and what activities they were supporting. The interviews were also used to further explore how different activities were implemented. In total, 16 qualitative interviews were conducted at district, regional, national, and partner levels. In addition, qualitative interview questions were also included in the quantitative questionnaires at the facility level.

The study protocol was approved by the National Ethics Committee for Life Sciences and Health in June 2022. The objectives were developed following early, informal discussions with several key government stakeholders and a desk document review of the country's C19 vaccination strategy, budget, and other relevant documentation. The study's concept note was formally approved by the MOH in March 2022, and the full study protocol was presented and validated by the study team at a kick-off meeting organized by the MOH for key stakeholders in May 2022. The kick-off meeting was attended by over a dozen representatives from the MOH as well as representatives from UNICEF, the World Health Organization (WHO), and the World Bank. After addressing feedback on the protocol, it was submitted for ethical approval, which was obtained in June 2022.

SAMPLING

At the national level, we included the Directorate of Coordination of the Expanded Immunization Program (Direction de Coordination du Program Élargi de Vaccination, DCPEV), the National Public Hygiene Institute (Institut National d'Hygiène Publique, INHP), the Public Health Pharmacy of Côte d'Ivoire (Pharmacie de la Santé Publique Côte d'Ivoire, PSP-CI), as well as key donors and partners. We asked the MOH to identify the relevant stakeholders to interview, including government entities who had been or were significantly

involved in the management or implementation of C19 vaccination, as well as donors and partners that had contributed financial or in-kind donations to C19 vaccination planning, introduction, and delivery. Based on government inputs and UNICEF's C19 Vaccine Financial Monitoring (C19VFM) database, we identified Gavi, the Vaccine Alliance; UNICEF; USAID; the World Bank; and WHO as key donors and partners from whom to collect data.[2]

Our sample includes six high-coverage districts in Abidjan 1, Abidjan 2, and Gbêkê, which were purposively selected in close consultation with the DCPEV and MOH. The sampling strategy aimed to include three of the country's 33 regions, covering different geographic areas (urban and rural), the main delivery strategies employed during the period up to March 2022, and a range of delivery volumes (low- and high-volume sites). Abidjan 1 and Abidjan 2 were chosen given that nearly a quarter (23.1%) of the doses delivered as of May 3, 2022, in the country were delivered in these two Abidjan regions, with other regions representing much smaller shares of total doses delivered (<1% to 6% each). We chose a third region, Gbêkê, given that 5% of doses delivered nationally were delivered here, it exhibits more rural characteristics as compared to Abidjan, and it is geographically accessible from the capital. Within each region, we purposively selected two districts with relatively high coverage.

Within each district, five easily accessible facilities were selected in both urban and rural settings, representing a range of delivery volumes, for a total of 30 immunization sites. We consulted with the district C19 vaccination focal point to select facilities with various levels of delivery volume during the study period (March-May 2022): low (less than 500 doses), medium (500-4,000 doses), and high volume (4,000 doses). The rural/urban classification was self-reported by facility managers due to a lack of national classification data. Sites that were not active for at least six months between March 2021 and April 2022 were excluded. The final sample is shown in Table 1. Our sample of 30 facilities delivered 3% of the total doses delivered in the country during the study period March-May 2022.

The sample does not include mass vaccination sites. The sample initially included the mass vaccination site in Treichville, but staff absences at the site prevented our team from collecting data there. It was replaced with a high-volume site in the same district, though this was a 'regular,' pre-existing site with very different characteristics. The Treichville mass vaccination site was set up, equipped, and staffed specifically for C19 vaccination, and staffed with a mix of district and INHP staff. The replacement site was staffed by district-level staff only. The only other mass vaccination site in the country is the vaccinodrome at Yopougon, though as this is managed and costed by VillageReach, we did not include it in our sample.

Table 1: Final sample, coverage data, and doses delivered provided by DCPEV

National	Sampled regions	Sampled districts and coverage levels (% of the target population (>12 years old) reached by May 3, 2022, date of sample selection)	Sampled health facilities
Total:	**3 regions**	**6 districts**	**30 facilities**
3 national level institutions (DCPEV, INHP, PSP-CI) 5 key donors and partners	Abidjan 1 (high-volume, predominantly urban region)	Abobo Ouest (62%)	5 facilities – all urban – 2 medium, 3 high volume
		Anyama (48%)	5 facilities – all urban – 3 low, 2 medium volume
	Abidjan 2 (high-volume, predominantly urban region)	Cocody-Bingerville (77%)	5 facilities – all urban – 2 low, 3 medium volume
		Treichville-Marcory (72%)	5 facilities – 4 urban, 1 rural – 1 low, 3 medium, 1 high volume
	Gbêkê (low-volume, predominantly rural region)	Bouake Nord-Ouest (51%)	5 facilities – all urban – 1 medium, 4 high volume
		Bouake Sud (48%)	5 facilities – 3 urban, 2 rural – 1 low, 2 medium, 2 high volume
Total delivery volume during the study period from March-May 2022			
4,347,327	796,322	291,727	129,864

DATA COLLECTION

Data was collected using standardized questionnaires through in-person interviews at all sites, which were conducted in June 2022. Excel-based questionnaires and data analysis tools developed for use across the ThinkWell-led C19 vaccination costing study countries were tailored to the country context and to reflect the delivery strategies in use in Côte d'Ivoire. A separate questionnaire was used for each level (facility, district, regional, and national levels). Following initial adjustments and translation into French, the tools were pretested over a two-day period at two health facilities and one district in the Abidjan area. After additional modifications, the questionnaires were tested once again, after which no further changes were required. Data collection was conducted by a team from the Université Felix Houphouet Boigny.

In addition to the interviews with health staff, data were collected from records at various levels. Delivery volumes were available in Excel- or paper-based registers at the district level. DCPEV also provided data on total doses

delivered nationally on vaccine prices and on MOH salary scales, as well as a list of all newly purchased cold chain equipment. Cold chain equipment prices were taken from UNICEF's Supply Catalogue.[3] If a respondent reported that an expected cost was not incurred at their level, such as fuel or per diems, we triangulated these responses with responses at higher levels, in case these costs had been incurred there. Where no expenditure could be found at any level, we assumed that the data reported to us were correct and that these costs had not been incurred.

Information about partner and donor support for C19 vaccination was obtained through interviews or email, complemented by data from the global level to fill in gaps. Gavi and the World Bank provided data directly, but several partners did not respond to repeated requests for interviews or information (UNICEF, USAID, and WHO). We used UNICEF's C19VFM database to fill the data gaps and still include contributions from these partners. Useful life data for capital items was taken from an immunization campaign costing guide.[4]

Data collection was followed by a thorough data validation and cleaning process. Some enumerators collected data using Microsoft Word versions of the data collection tool and then transferred their answers to the Microsoft Excel-based tool. Others entered data directly into the Excel-based version. The Excel-based version had built-in validation features to improve data quality. We performed additional manual validation checks while data collection was ongoing to ensure data were entered properly and flag missing information or poor-quality data. The team sent questions of clarification back to the data collectors who provided responses, following up with respondents directly as needed. Where data could not be obtained after checking with enumerators, we imputed missing values based on data from similar sites. In other cases where data were missing at all sites, a number of assumptions were made. See **Annex 2** for more detail.

DATA ANALYSIS

For each site, costs were estimated and allocated to each resource type, program activity, type of cost (financial or opportunity cost), and between start-up and recurrent costs. The costs of shared resources were allocated to C19 vaccination and specific immunization activities based on responses from staff on time spent or usage or the proportional share of C19 to EPI doses. Cold chain maintenance costs for C19 vaccination were estimated as the difference between the 2021 (pre-C19) and the 2022 contract value. Data on staff cadre and seniority level collected from the sites were matched with the MOH salary scale to estimate monthly and annual salaries. Unlike other study countries, where the value of volunteer labor is estimated based on the local minimum wage, this study included it as the value of volunteer allowances that were supposed to have been received as per policy but were not paid out. All newly acquired capital items purchased specifically to support C19 vaccination, such as vehicles and cold chain equipment, are included in full in the startup cost, as well as apportioned to our three-month study period using straight-line depreciation based on the useful life of the item. For the economic cost, a 3% discount rate was applied.

We used Microsoft Excel to calculate total costs for the three-month study period (March 1 to May 31, 2022) and unit costs (cost per dose

delivered). We used Microsoft Excel to check the data for outliers using analytic techniques, such as summary pivot tables and graphs with trendlines. We investigated any findings that appeared on visual inspection to be problematic to identify possible data entry errors. We calculated average unit costs by dividing the sum of the total costs from all sites (weighted by volume) by the sum of the delivery volume across all sites (weighted by volume), as shown in the formula below. Because the data collected at the national level represents the enumeration of the population at that level (rather than a sample), we calculated a simple average across the total number of doses delivered during the study period. To obtain a total unit cost per dose, we aggregated the volume-weighted average unit costs at the facility, district, regional, and national levels.

$$unit\ cost_{site/dist/reg} = \frac{\sum_{i=1}^{n} C_i * w_i}{\sum_{i=1}^{n} Q_i * w_i}$$

Where n is the number of facilities/districts/regions in the sample, C_i represents the total service delivery cost at immunization site/district/region *i*, Qi represents the total service delivery volume at facility/district/region *i*, and w_i is the volume weight for the facility/district/region *i*.

All costs are presented in 2022 USD. Costs incurred in 2021 were first inflated to the 2022 West African franc (CFA) using the World Bank official inflation rate.[5] 2022 CFA was then converted to 2022 US dollars (USD, $) using a conversion rate of 1 USD = 613.61 CFA, which represents the average exchange rate for the period March 1 to May 31, 2022.[6] Where cost estimates are compared to other studies, estimates were first converted to CFA in the year for which the study reports results, then inflated to 2022 CFA, and converted to 2022 USD using the World Bank's exchange rate for 2022.

We conducted two sensitivity analyses on inputs around which we foresee uncertainty. We explored the impact of changes in volunteer remuneration on cost, assuming volunteers were paid the lowest wage on the MOH's salary scale in addition to the allowance they are currently entitled to. In addition, we tested the impact of syringe wastage on the cost of delivery, given that our cost analysis includes syringes based on estimates with 0% wastage.

LIMITATIONS

As staff were particularly busy during the period of data collection, they were sometimes unavailable to respond to our questions. A number of non-C19 vaccination campaigns were ongoing during our data collection period which impacted the ability of staff to participate in our study. Particularly at the national and regional levels, we had limited responses from respondents. The technical advisors supporting the study at the MOH were also extremely busy and could only offer limited support to the study. Though from what we know from the global evidence about the cost of routine immunization, costs at these levels are normally a small percentage compared to facility- and district-level costs, and we were able to address some missing information through imputation and assumptions.

The data collection team encountered poor record keeping at many facilities, which may have resulted in errors in study data collected. Notably, data related to the number of doses delivered presented some inconsistencies, which the team was unable to clarify due to how records are kept. These records also did not separate doses delivered between fixed-site strategies and outreach, and staff were unable to accurately

estimate the percentage of doses delivered through each delivery strategy. Some expenditures may be missing from our analysis because the data was not available or was not reported to us, such as the cost of tablets and tents, of which the use was reported in some facilities, but no records of expenditure were provided. However, these costs may have been paid for separately by partners or donors. There is also a risk of some recall bias with regards to the preparation phase, particularly about how staff spent their time, since the preparation phase took place in early 2021, more than a year before our data collection period.

There was a large amount of missing data on supplies used for C19 vaccinations, but we tested assumptions used to fill those data gaps through a sensitivity analysis (see Annex 4). Facilities did not separately track supplies used for both C19 vaccination and other vaccination or non-vaccination activities, such as gloves, and as such, we estimated the cost of this based on assumptions. To explore the potential impact of this limitation, we tested the sensitivity of our findings to changes in assumptions about syringe wastage, given that syringes represent a third of the cost of supplies. However, we found that changes in the economic cost per dose when assuming increased syringe wastage rates were not significant, as the unit cost increased by only 1%.

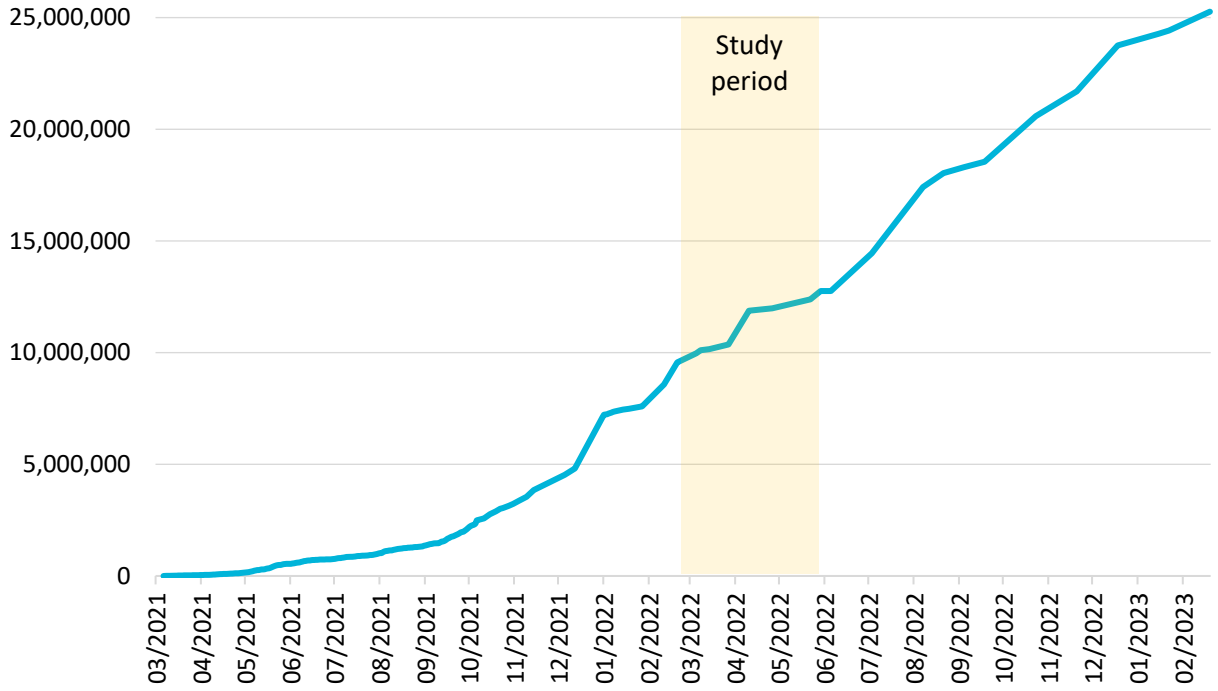
We had limited participation from some donors and partners, namely UNICEF, USAID and one of their implementing partners, and WHO, though this is unlikely to have affected the key findings of the study. Despite the fact that these donors and partners participated in the study kick-off meeting and received formal invitations from the MOH to be interviewed by the data collection team, they did not provide data for this costing study. We made multiple attempts over several months to contact them, without success. Although we were able to obtain total funding provided by UNICEF, USAID, and WHO through UNICEF's C19VFM database, being able to engage with these entities directly would have likely enriched our understanding of their contributions. Missing contributions are unlikely to change conclusions in this study, such as those regarding what activities and resource types were the key cost drivers.

III. THE C19 VACCINATION PROGRAM IN CÔTE D'IVOIRE

OVERVIEW OF THE C19 VACCINE ROLLOUT

Côte d'Ivoire started C19 vaccinations in March 2021, and after just six weeks of a targeted approach, it extended eligibility to the entire population over the age of 18, followed by an expansion to 12- to 17-year-olds in March 2022. Côte d'Ivoire recorded its first case of C19 on March 11, 2020, and registered 32,791 cases and 193 deaths by March 1, 2022, increasing to over 87,000 cases and 827 deaths by the end of October 2022. The MOH rolled out C19 vaccination on March 1, 2021, nearly a year after the first case was reported. Guided by the National Deployment and Vaccination Plan (NDVP), C19 vaccination was originally organized around three sequential phases of prioritized targeted populations.[7] However, only six weeks after the vaccination launch, the phases were abandoned, and vaccine delivery was extended to the whole population aged 18 and above. The original goal was to vaccinate 52% of the population by mid-2022.[8] In March 2022, vaccination was expanded to include 12- to 17-year-olds.[9] Booster doses became available in April 2022.[10] The revised NDVP draft published in April 2022 set a target of vaccinating approximately 69% of the total population, representing 19.8 million persons aged 12 and above.[11]

Figure 2: Cumulative number of C19 doses delivered (March 2021–October 2022)



Source: Our World in Data (2023)
Note: The yellow shaded area indicates our study time period of March-May 2022. The phased approach to vaccination was dropped in April 2021, and vaccination expanded to the population aged 18 and above.

At the time of data collection for this study, about 30% of the population in Côte d'Ivoire had received at least one dose of a C19 vaccine.[9] In 2021, 7.2 million vaccines were administered, with approximately 2.1 million persons having received two doses (7% of the total population).[12] Due to the low coverage levels, in January 2022, Côte d'Ivoire was included on the C19 Vaccine Delivery Partnership's (CoVDP) list of priority countries.[13] This meant that they have received targeted support to address vaccination bottlenecks and increase vaccination coverage levels.[14] By the end of May 2022, the C19 vaccination program in Côte d'Ivoire had delivered a total of 12.7 million doses. As of February 2023, more than 25 million doses had been delivered, meaning that about 72% of the country's eligible population had been partially or fully vaccinated against C19.[15] At the time of data collection, the majority of the doses in Côte d'Ivoire had come through COVAX (62%), followed by the African Vaccine Acquisition Trust (27%), and the remainder through other bilateral and multilateral agreements. The mix of vaccines used up until that time consisted of Pfizer (33%), Sinopharm (27%), Johnson & Johnson (23%), and AstraZeneca (17%).

MANAGEMENT OF THE C19 VACCINATION PROGRAM

Côte d'Ivoire's C19 vaccination program was managed by the DCPEV. They were responsible for the overall planning of the vaccination program, including supervision of its implementation, as well as monitoring and data management. DCPEV was also responsible for the procurement of vaccines and syringes, with support from the New Public Health Pharmacy of Côte d'Ivoire (NPSP). L'Institut National d'Hygiène Publique (INHP) was in charge of the technical coordination of the C19 vaccination program, and it collaborated with the DCPEV, the MOH, and other actors to develop the C19 response plan, coordinate the vaccination program, and train vaccinators. Regional directors and managers oversaw local planning processes for the C19 vaccination program, while district directors and managers were responsible for implementing it. During the implementation of the vaccination program, MOH representatives met virtually with all district directors daily for coordination of the program and to ensure monthly and annual objectives were on track to be met. District directors met with health facility management to ensure information was shared with staff and volunteers. Several partners and donors provided technical and financial support to the C19 vaccination program, including Gavi, UNICEF, USAID, the World Bank, WHO, Red Cross, SOGETCI, and Toyota.

C19 VACCINE STORAGE AND DISTRIBUTION

Once the vaccines arrived in the country, the NPSP ensured that that the vaccines and supplies were delivered to DCPEV, from which they were collected by districts. When vaccines arrived in the country, they were collected from the airport by the NPSP using refrigerated trucks and delivered either directly to the DCPEV or stored in the cold rooms of the NPSP before being delivered to the DCPEV. Districts in our sample collected vaccines and vaccination supplies directly from DCPEV after which they were collected by health facilities from the district depots. For facilities that do not have powered cold chain, vaccines were stored at the district

level or at another nearby facility. The allocation of vaccines to health facilities was based on the target population in the jurisdiction of each health facility. Waste management was contracted out to a third-party service provider, although some districts reported that they incinerated waste locally.

IMPLEMENTATION OF THE C19 VACCINATION PROGRAM

Côte d'Ivoire's C19 vaccine program primarily utilized facility-based delivery, complemented by outreach and mobile units, as well as two mass vaccination sites. Originally the government planned to use campaigns to deliver vaccines; however, this strategy was revised given the limited global availability of vaccines and the resulting unpredictable vaccine supply at the country level. The new strategy primarily used fixed sites, defined as both health facilities and two large high-volume or mass vaccination sites (Treichville Sports Palace and Sports Complex Yopougon), as well as outreach and mobile units. Outreach involved delivering vaccines at temporary outpost sites, which are containers or tents placed in high-traffic areas such as markets and bus stations. The mobile strategy used medical mobile units, which are large trucks outfitted as mini clinics, which travel to various locations and provide a range of services directly from the truck. The medical mobile units provided other services in addition to C19 vaccination, such as screening for certain pathologies (diabetes, high blood pressure, malaria, etc.). Tablets were used at most facilities to register vaccinations and generate QR codes for vaccine certificates. Daily facility-level reports on the number of doses delivered and vials used were sent via SMS to higher administrative levels, and original records were not kept at the facility level.

In addition to systematic facility-based delivery, monthly intensification periods of 10-15 days were organized, during which outreach and mobile strategies were implemented. The delivery strategies were designed to be linked to two vaccination periods: a monthly intensification period and a systematic period. Intensification was carried out at all health facilities in all 113 health districts, and outreach and mobile strategies were also used. The monthly intensification periods were planned to last 10 to 15 days, though recent intensification periods have lasted only 10 days. Between two intensification periods, the systematic periods were intended to offer targeted vaccination at two to four health facilities per district in areas with high traffic and/or a high number of C19 cases; we found evidence of health facilities delivering vaccines at fixed sites during both the intensification and systematic periods, as well as of the use of outreach during both periods. The mass vaccination sites in Abidjan run continuously. See Table 2 for a summary of the periods and strategies employed.

The C19 vaccination program in Côte d'Ivoire largely relied on its existing capacity, and the mobilization of additional volunteers. At the national level it was reported that no additional health care workers were recruited for the C19 vaccination program, but some reassignments were made to certain sites as required. Only volunteers were recruited specifically for the C19 program but these cadre will not be retained in the health system once the C19 vaccination program is over. Volunteers consisted of medical students, community members, and community health workers. The role of volunteers included mainly mobilization, client registration, and crowd management at vaccination sites.

Trainings were predominantly held in-person at facilities or at the district level. Training of vaccinators and supervisors at the facility level covered administration of vaccines, as well as management of adverse events, waste management, and inventory management. Training at the facility level also covered training of data collectors on the use of tablets for capturing patient vaccination data. Training of facility staff on vaccine delivery occurred as a one-off, but where facilities delivered different C19 vaccine types, separate training sessions were often organized as a new vaccine type became available at the site. Some facilities also reported to have had further, separate training sessions on administering vaccines to children 12 years and older. At the district level, district management teams—including district directors, hospital directors, district department heads, and program coordinators—also underwent C19-related training. Facilities and districts reported that no per diems were paid to staff when attending C19 vaccine-related trainings.

Table 2: Summary of vaccination strategies employed in the C19 vaccination program, as of June 2022

Vaccination period	Timing and duration	Delivery strategies	Location
Intensification period	Monthly, for 10-15 days	Fixed site: health facilities	All facilities in all 113 health districts
		Outreach: temporary outpost sites	All 113 health districts
		Mobile strategy: medical caravans (integrated with other health services)	All 113 health districts
Systematic period	Monthly, between intensification periods	Fixed site: health facilities	At least 2-4 facilities per district in all 113 health districts
		Outreach: temporary outpost sites	Occasionally in all 113 health districts
Continuous	Ongoing	Fixed site: mass vaccination/high-volume sites (2 currently operational)	Only Abidjan

Source: NDVP[10] and research findings

Various social mobilization strategies were implemented at all levels of the health system. At the national level, vaccination-related messages were broadcast on national television and radio channels, both private and public, at the expense of the MOH. At the district level, information letters were sent to town halls, community centers and religious institutions in order to equip and encourage community leaders and public figures to promote vaccination uptake in their communities. Districts also ran radio broadcasts, and in one district it was reported that radio slots were provided free of charge. Social mobilization activities were also implemented by facility staff.

FINANCING & IN-KIND DONATIONS FOR THE C19 VACCINATION PROGRAM

Partners contributed over $91 million to support C19 vaccination in Côte d'Ivoire from the start of vaccination through May 31, 2022. Table 3 shows which activities were supported and the magnitude of that support from the start of vaccination through May 31, 2022. In some cases, some of the funding recorded may have also been used to support other activities not related to C19 vaccination (e.g., C19 treatment). Some of the support from the Société Générale des Technologies de Côte d'Ivoire (SOGETCI) may have been captured through the list of newly purchased cold chain equipment that we obtained from the DCPEV. Support mainly went towards service delivery and social mobilization. In addition to what is listed below, VillageReach supported intensification periods, mainly through their own high-volume site, and the German Federal Foreign Office (AA) provided approximately $3.9 million in June 2022, outside of our study period. We did not find any record of donor support for training, cold chain maintenance, waste management, or supervision.

Table 3: Donor and partner support for C19 vaccination activities up until the end of May 2022

Donor/ partner	World Bank	USAID	UNICEF	Gavi	SOGETCI	WHO	Red Cross	Toyota	Global Affairs Canada
Amount of support (2022 USD)	At least $72.5 million	$11 million	Approx. $5 million	Approx. $2.9 million	Unknown	At least $479,728	Unknown	$97,782	$61,774
Service delivery – all strategies	✓		✓	+++		✓	✓		
Vaccine collection, distribution, and storage	✓			++	✓				
Social mobilization and advocacy	✓	✓							
Program management						✓			
Recording keeping, HMIS, M&E				+		✓			
AEFI management				++					
Other activities/unknown								✓ (donated vehicles but unclear what they were for)	✓
Vaccines and supplies	✓			✓					

Source: Interviews with donors and partners, subnational-level questionnaires, UNICEF C19VFM

+ = < $100,000
++ = $100,000-<$1,000,000
+++ = $1,000,000-<$10,000,000
++++>$10,000,000
✓ = support provided but amount unknown

KEY CHALLENGES IDENTIFIED

Insufficient and unpaid allowances that were earmarked for the implementation of the C19 vaccination program severely disrupted activities. According to the NDVP, daily allowances should be paid to volunteers, social mobilizers, vaccinators, and supervisors during the 10-15-day intensification phase each month. According to facility-level interviews, these allowances were provided by Gavi and UNICEF directly to vaccination team members, mostly using mobile money. However, at the facility level it was reported on numerous accounts that these allowances have not been paid for several months. District-level staff also mentioned a lack of transport and allowances, while regional-level staff indicated that they had not received the allowances that were earmarked in the micro-plans for supervisory activities during the intensification phases. Some sites also noted they delivered vaccines through mobile clinics in the past but had stopped due to lack of funding. One facility reported that their mobile van had not been active for the past six months prior to data collection due to per diems and travel allowances for the driver not being paid.

Staff shortages were flagged as a key issue during the implementation of the C19 vaccination program. Due to a shortage of funding to hire additional health workers to implement the C19 vaccination program, many volunteers were mobilized instead. One district noted that there were insufficient resources to continue routine activities and carry out the C19 vaccination program, and therefore additional human resources were employed for the C19 vaccination program in the form of volunteers. However, it was also noted that at one point, due to unpaid allowances to volunteers, there was a staff shortage and even the security guards had to assist with tasks such as queue management.

Limited travel and transport-related costs were reported at all levels. This included limited use of government vehicles, particularly at the facility level. Respondents indicated that government-owned motorcycles were often used although staff were not necessarily reimbursed for fuel costs. It was often reported that staff either walked, used public transport, or used personal vehicles for transport to meetings, social mobilization events, collection of vaccines and supplies from the district, and even to conduct outreach, always without reimbursement of personal expenses. In one case it was noted that the health facility received a fuel allocation but that when this was exhausted, staff had to pay for fuel and transport costs themselves.

Additional programmatic challenges that were raised included issues around waste management, and some technical issues related to registration and vaccine certificates. Respondents reported problems related to the management of C19 vaccination-related waste at all administrative levels. Some indicated that incinerators were out of order for long periods of time, which resulted in waste not being disposed of in a timely manner. Other districts reported delays in waste being collected by higher administrative levels, causing waste to remain in safety boxes at the district level for a long period of time before being removed for destruction. Some respondents at the facility level reported technical issues related to limited network for the use of QR codes for registration and generation of vaccination certificates, and one facility reported not having been able to use QR codes at all.

IIV. THE COST OF DELIVERING C19 VACCINES

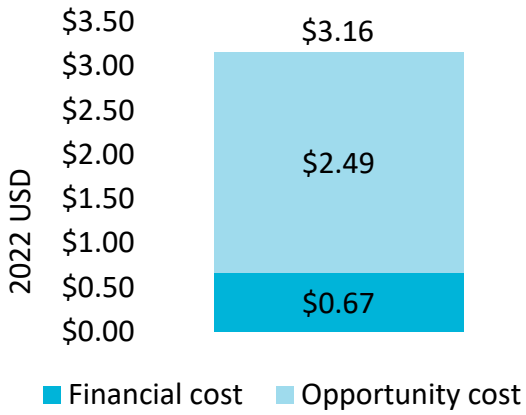
FINANCIAL DELIVERY COSTS

The financial cost of delivering one dose of a C19 vaccine in Côte d'Ivoire is $0.67, below what COVAX estimated ($0.96-2.53)

This study finds that the financial cost of delivering C19 vaccines in Côte d'Ivoire is relatively low at $0.67 per dose (Figure 3), with vaccine injection and safety supplies representing the largest cost driver (55%). The second largest cost driver, volunteer allowances, made up a much smaller share (9%). Other financial costs included the purchase of additional cold chain equipment (8%) and vehicles (7%), transport and fuel (7%), and per diem and travel allowances (6%). The financial cost also includes additional staff that were recruited for the purpose of C19 vaccination, which was limited (3%).

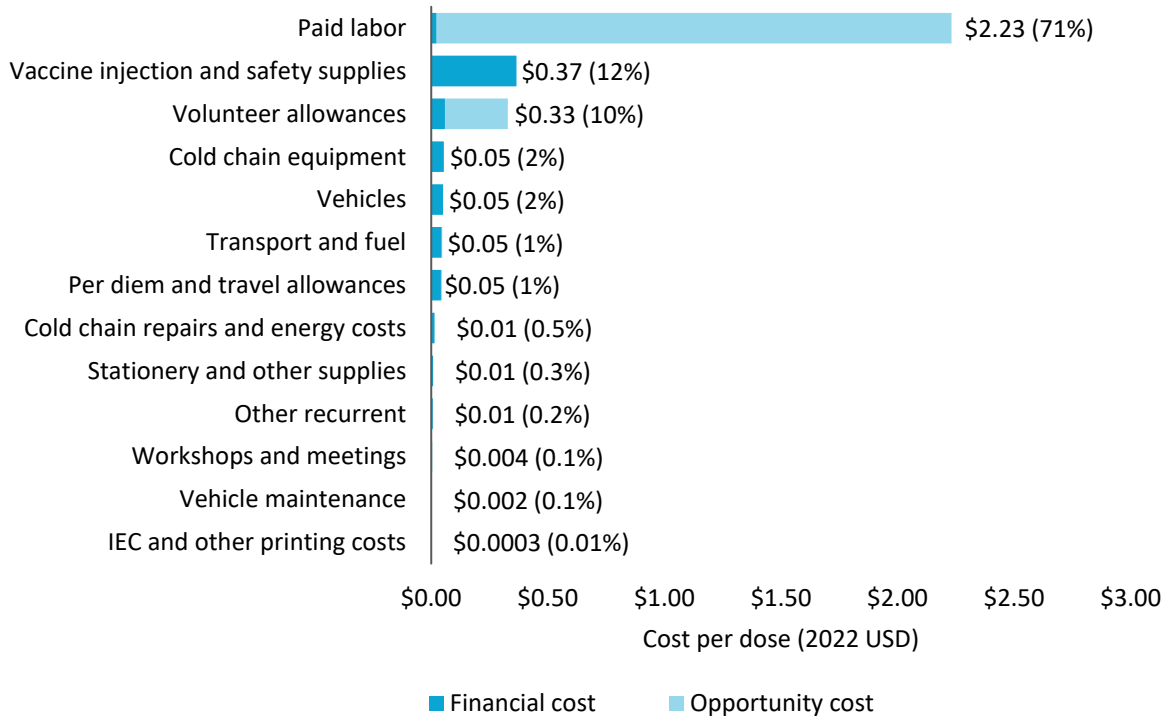
The financial cost per dose is relatively low compared with the estimate modeled by the COVAX Readiness and Delivery Working Group on Delivery Costing.[16] The group estimated the financial delivery cost in Côte d'Ivoire to range between $0.96 and $2.53, depending on the share of doses delivered through (costlier) outreach modalities and the additional number of health workers that would be recruited to meet the additional needs of the C19 vaccine delivery program. The lowest estimate assumed that up to 10% of the existing workforce could be leveraged for C19 vaccine delivery and that all additional needs would be covered through additional hiring.

Figure 3: Financial and economic delivery cost per dose



Although Côte d'Ivoire did mobilize a substantial number of volunteers to support the C19 vaccination program, additional hiring of paid health workers was very limited. In addition, this scenario assumed only 15% of the doses would be delivered through outreach and the remainder delivered through fixed sites. Unfortunately, it is unclear what proportion of doses is delivered through outreach in Côte d'Ivoire, but one important difference is that the model assumed outreach to involve significant per diems and transport costs. In reality, outreach was often conducted on foot in Côte d'Ivoire due to a lack of funding, and per diems and allowances were limited and oftentimes not paid out. Nevertheless, the delivery costs found in our study were still higher than estimated for a yellow fever campaign conducted in 2001 ($0.41 converted to USD 2022).[17]

Figure 4: Economic cost per dose for all levels, broken down by type of cost and resource type



ECONOMIC DELIVERY COSTS

Due to the significant cost of labor, the economic delivery costs are much higher ($3.16 per dose)

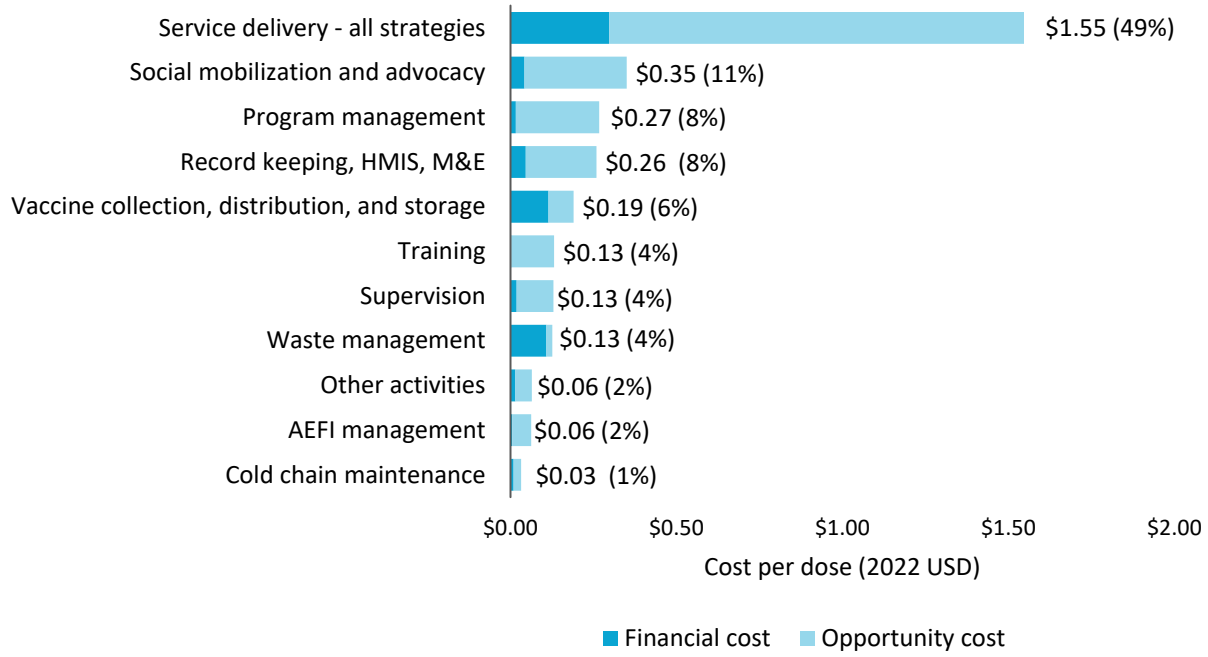
The opportunity cost per dose makes up almost 80% of the delivery cost, primarily due to the value of existing human resources. Figure 4 shows the financial cost per dose and opportunity cost of labor per dose by resource type. Paid labor constitutes the highest portion of the total economic unit cost of delivery (71%). This is a reflection of the importance that the existing health workforce played in delivering the C19 vaccination program. Therefore, service delivery is by far the biggest cost driver in both financial and economic terms, while labor costs also considerably drive social mobilization, program management, and record keeping costs (Figure 5). Other significant opportunity costs included the value of volunteer allowances that were promised but not paid out ($0.27 per dose, 9% of the total). Capital costs, such as those for cold chain equipment and vehicles, were very small.

The economic cost per dose found in this study is relatively high, despite the large delivery volumes, and more in line with the cost of lower-volume routine childhood vaccine delivery. The economic cost of delivering C19 vaccines is estimated at $3.16 per dose, while modeled estimates of the cost of delivering routine childhood vaccines estimate the economic delivery cost per dose in Côte d'Ivoire to be between $0.63 and $3.93, or $1.73 on average, converted to 2022 USD.[18] There is limited

evidence on the cost of delivering vaccines in Côte d'Ivoire. A previous costing study of EPI vaccines did not report delivery costs separate from the cost of vaccines and therefore cannot be compared with our results.[19]

Costs did not differ significantly by region, and due to data limitations, we could not analyze differences between rural and urban areas, delivery strategies, nor between the systematic and intensification phases. When comparing the average cost per dose delivered in each of the three regions, no significant differences or patterns emerge. Unit cost levels in all regions showed a large range, and averages were mainly driven by outliers. The sample aimed to include a mix of facilities located in both urban and rural areas, but because the data gathered on this characteristic were of weak quality, we could not compare unit costs. Unfortunately, because we could not obtain such granular data, we could not analyze the cost of delivery through each individual strategy, nor differences between the systematic and intensification phases.

Figure 5: Economic cost per dose for all levels, broken down by type of cost and program activity



START-UP VS. OPERATING COSTS

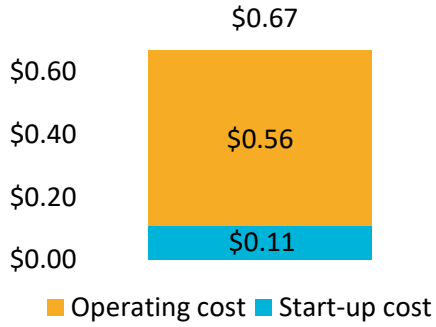
Start-up investments consist mainly of cold chain equipment and vehicle purchases and represent a small portion of the cost per dose

The biggest start-up cost was a $7.5 million investment in additional cold chain equipment, procured at the national level specifically for the C19 vaccination rollout. Previous studies suggest that new vaccine introduction often triggers mass cold chain procurement, as countries use the opportunity to replace existing equipment.[20] After C19 vaccination ends, this cold chain equipment is likely to be repurposed to support the routine vaccination program. In addition, a number of

vehicles were purchased which made up for most of the remainder. However, on a per-dose basis, these costs were relatively small, about 16% of the financial delivery cost per dose (Figure 6).

A detailed list of cold chain equipment purchases is available in Annex 9, and a breakdown of start-up costs by resource type is provided in Annex 6. We did not find evidence that the ultra-cold chain was also expanded, suggesting that existing ultra-cold storage from the Ebola-era was utilized for C19 vaccinations as well.

Figure 6: Financial start-up vs. operating cost per dose



COST BY HEALTH SYSTEM LEVEL

Most of the financial and economic costs were incurred at facility level (78-81%)

Facility-level financial costs are mainly driven by vaccine injection and safety supplies, while the economic costs were mainly driven by the value of paid and unpaid labor. Overall, facility-level costs make up 81% of the total economic cost per dose, particularly due to the staff and volunteers involved in service delivery activities (Figure 5), and 78% of the financial cost per dose. Table 4 below also shows the total financial and economic costs incurred during our study period of March to May 2022. High financial costs at the national level are driven by cold chain equipment purchases. Annex 6 contains detailed analyses of costs at all administrative levels.

Table 4: Total delivery cost and volume by health system level from March–May 2022

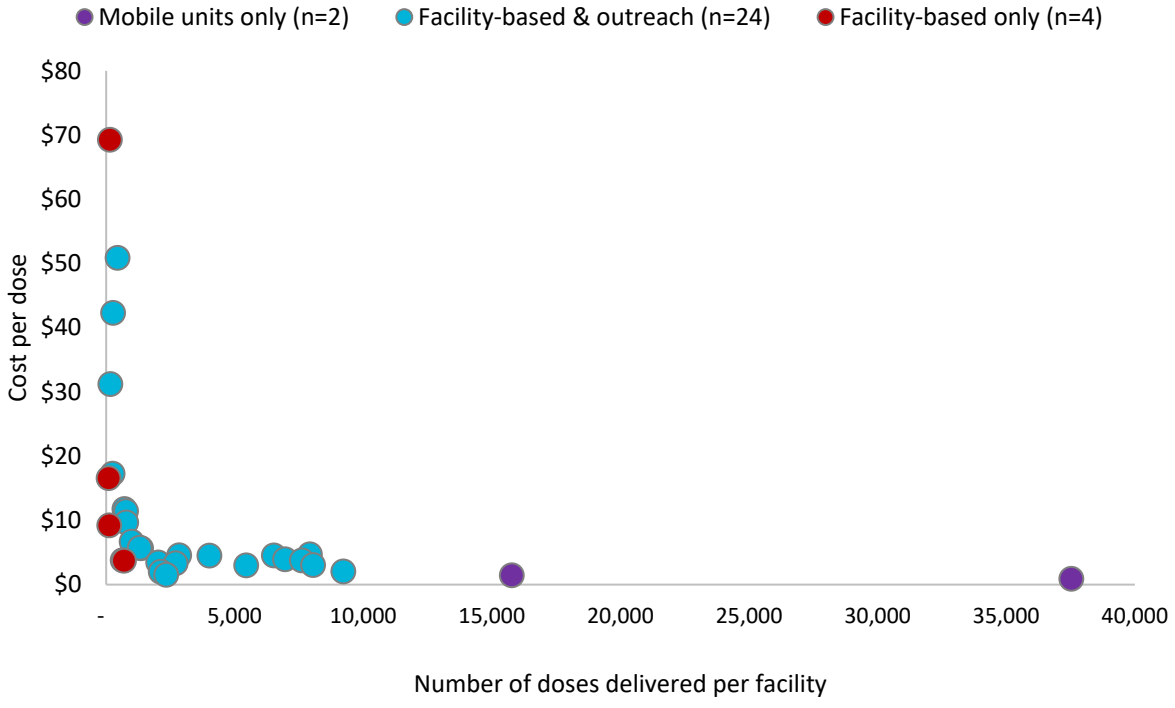
Health system level	Sample (n)	Total financial cost	Total economic cost	Delivery volume	Financial cost per dose	Economic cost per dose
National	-	$455,582	$543,982	4,347,327	$0.10	$0.13
Regional	3	$6,212	$49,050	796,322	$0.01	$0.06
District	6	$12,673	$122,013	291,727	$0.04	$0.42
Facility	30	$67,254	$331,521	129,864	$0.52	$2.55

RELATIONSHIP BETWEEN COST AND DELIVERY VOLUME

Cost per dose seems to drop with increasing delivery volume, driven by efficiencies in the labor cost per dose

There appears to be a weak negative association between the economic cost per dose delivered and the number of doses delivered (Figure 7). This relationship is commonly observed in immunization costing studies, though harder to analyze in the context of a C19 vaccination program. There were various changes in delivery volumes and modalities over time, while our data reflect an average over the study period. We noted that three of the four sites that only used facility-based delivery had relatively high delivery costs and low delivery volumes, but among the remainder of the sample that used both outreach and facility-based delivery, high variability in the cost per dose is observed at similar delivery volumes. The volume delivered through either facility-based delivery or outreach will likely have played a role in this variation, but due to lack of granularity in the data, this cannot be confirmed. The two mobile units had low delivery costs, most likely due to the exceptionally high delivery volume. Any economies of scale observed in the data are likely the result of efficiencies in the cost of labor, which is the main delivery cost driver. We also noted that some facilities were able to deliver more doses with fewer full-time equivalent (FTE) workers (see **Annex 7**). Our data, however, do not contain enough detail on how their delivery strategies, target populations, or operational challenges differed to explain why that might have been the case.

Figure 7: Economic unit cost-volume relationship, 2022 USD

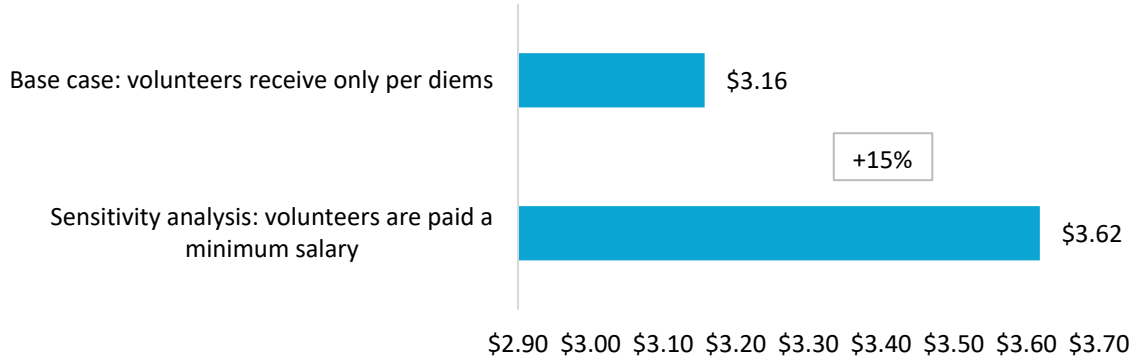


SENSITIVITY ANALYSIS

If volunteers were to be paid as low-grade staff, costs could be 15% higher

Volunteers do not receive a regular salary, and our sensitivity analysis assessed the cost of paying them at the salary level of an auxiliary nurse (C1 grade). Volunteers played a key role in the C19 vaccine rollout in Côte d'Ivoire and in many other countries. Nevertheless, they did not receive regular remuneration, and the per diems that had been committed were not always paid out. We analyzed the impact on the cost if volunteers were to be paid a regular salary. We used the salary of a low-grade auxiliary nurse (aide soignant(e), C1) which was about $244 per month during the study period, to estimate the additional cost requirements. Figure 8 shows that if volunteers were to receive a regular salary, in addition to per diems, the economic cost per dose of delivering C19 vaccines could be 15% higher. We also assessed the impact of 3% wastage of syringes, which would increase the economic cost by 1% (see Annex 4).

Figure 8: One-way sensitivity analyses on economic cost per dose (all levels)



V. KEY TAKEAWAYS

Findings from this study can provide valuable evidence for policymakers in Côte d'Ivoire and globally. This study has estimated the cost per dose of delivering C19 vaccines in Côte d'Ivoire, filling an important evidence gap both for national-level planning and budgeting to meet country and global vaccination targets. These findings can also be used at the global level, where donors and partners continue to raise funds to support C19 vaccination, particularly in priority countries. Our results can help inform planning and budgeting for the future of the C19 vaccination program in Côte d'Ivoire, as well as in countries for which there is no domestic data. Given the limited literature on immunization delivery costs in Côte d'Ivoire, these findings could also inform resource allocation decisions for other vaccination programs.

The low financial cost per dose found in this study is likely a reflection of a lack of funding, as opposed to low financial requirements to support vaccination

This study found lower than expected financial costs, but these findings should be interpreted with caution. Our study found evidence of unpaid volunteer allowances, and minimal expenses related to meetings and trainings. Donors and partners contributed over $91 million to support C19 vaccination in Côte d'Ivoire from the start of vaccination through May 2022, mainly for service delivery, vaccine storage and distribution, and social mobilization, though at the implementation level, our study found limited costs for many of these activities. We found limited transport costs for service delivery or supervision, and instead use of personal vehicles, walking, and fuel costs incurred by staff that had not been reimbursed. Respondents indicated that unpaid allowances sometimes resulted in a shortage of human resources, and a lack of funding resulted in mobile delivery being discontinued.

The much higher economic cost per dose highlights the important role of both existing paid staff as well as volunteers

The economic cost per dose is reflective of a program that made do with the resources that were available, which is an unsustainable approach in the long run. Côte d'Ivoire was already on the WHO health workforce support and safeguard list before the C19 pandemic, due to its critical shortage of human resources for health (HRH), and it remains on this list in 2023.[21] Respondents indicated the challenges around having to deliver C19 vaccines alongside other services, and although this was not assessed as a part of this study, it is possible that the delivery of C19 vaccines resulted in disruptions in the delivery of other health services.

Generally, the unit cost of delivery was higher at sites that delivered a low volume of C19 vaccines, which should be taken into consideration when planning for future delivery, which is likely to involve low delivery volume

Our study found that financial delivery costs were mainly driven by vaccination supplies and allowances for volunteers, while the economic costs were overwhelmingly driven by the value of labor. With paid labor being the largest economic cost driver, the number of C19 vaccines that health workers can deliver over a given period of time is the key driving factor of the unit cost of delivery. The next phase of Côte d'Ivoire's C19 vaccination program is likely to involve reduced delivery volume, given that it has already reached relatively high coverage levels (with at least 65% of the target population fully vaccinated), and the country should consider ways to reduce the burden on health workers and keep the unit cost of delivery low. WHO and UNICEF recommend countries explore integration options.[22] Unfortunately, this study could not estimate the difference in cost between outreach and facility-based delivery, which will likely have an important impact on the cost of future delivery strategy mixes.

The country must think critically about the role of volunteers in the next phase of C19 vaccination program

So far, the program has relied heavily on volunteers, and the inability to pay them allowances has increased uncertainty and sometimes led to disrupted services. In the short term, volunteers should be regularly compensated to ensure the continuity of services. In the longer term, if this support would need to be provided by regular staff, this could have significant cost implications. Our estimations showed that offering these roles a regular, low-grade salary could increase costs by 15%.

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ANNEX 1: PROGRAM ACTIVITIES, RESOURCE TYPES & ESTIMATION METHODS

DEFINITIONS OF PROGRAM ACTIVITIES

Table 5. Definitions of program activities

Activity	Description
Program management	Planning, budgeting, managing the C19 vaccination program.
Vaccine collection, distribution, and storage	Collecting vaccines at the airport or other distribution points, storing vaccines in national or provincial cold stores, distributing vaccines down to district, facilities and to delivery sites.
Cold chain maintenance	Maintaining and repairing the cold chain for the purpose of the C19 vaccine rollout.
Training	Attending and/or providing C19 vaccination-related training, including topics such as administering vaccines, storage and logistics, record keeping, pharmacovigilance, social mobilization, planning, supervision, etc.
Social mobilization and advocacy	Mobilizing and sensitizing the community and households, conducting social mobilization events, and advocating for C19 vaccination.
Supervision	Supervising subordinate or peer health or community workers.
Service delivery: all strategies (fixed site including mass vaccination site, outreach, mobile delivery)	Administering the vaccine to people within the hospital/facility/compound, during outreach (outside the facility) or using a medical mobile unit. Combined due to lack of data on volumes delivered using each strategy
Waste management	Time and resources spent on disposing sharps and infectious non-sharp wastes. Contracted out at national level and we were unable to obtain the contract value. However, staff time reported on this activity is included.
AEFI management	Following up on post-vaccination events following C19 vaccine administration.
Record-keeping, HMIS, monitoring and evaluation	Data entry and analysis, reporting, monitoring.

Table 6. Definitions of resource types

Resource type	Description	Estimation method and allocation to the C19 vaccination program	Economic/ financial costs
Paid labor	Allocation of salaried labor to C19 vaccination activities.	Time spent on C19 vaccination activities as a share out of the regular month * monthly salary.	Economic: salaries of all existing staff Financial: salaries of all newly appointed staff for C19 vaccination
Volunteer allowances	Value of allowances/incentives.	Hours spent on C19 vaccination activities * estimated daily rate based on volunteer allowances (volunteers work in intensification periods only).	Economic: value of all unpaid allowances Financial: all paid allowances
Per diem and travel allowances	Any per diems and travel allowances paid to health workers (non-volunteers) for C19 vaccination activities.	100% specific to the C19 vaccine rollout.	Financial: all paid per diems and travel allowances
Workshops, trainings and meetings	Costs related to workshops, trainings and meetings, including the venue and refreshments provided on the day, but not including related transport costs (which are captured under the transport and fuel resource type).	Only C19 vaccination-specific events.	Financial
Vaccines	Cost of C19 vaccines, including wastage.	Vaccine doses (differentiated by product) administered or wasted at the vaccination sites * price at which they were procured (or in case of donated vaccines, estimation of an equivalent price).	Excluded from delivery costs
Vaccine injection and safety supplies	Cost of auto-disabled syringes, diluent, reconstituting syringes, safety boxes and other supplies used for administration of C19 vaccines.	Supplies used or wasted at the vaccination sites * price at which they were procured (or in case of donations, estimation of an equivalent price).	Financial
Cold chain equipment	Value of all newly acquired cold chain equipment used to store and transport C19 vaccines.	For total start-up costs: full procurement cost. For study period: 3-month apportioned value, without discounting. Cost related to cold chain equipment were incurred only at national level and not allocated to lower levels.	Financial

Resource type	Description	Estimation method and allocation to the C19 vaccination program	Economic/ financial costs
Cold chain repairs and energy costs	The cost of repairing existing cold chain equipment and running the cold chain (butane, gas, electricity, etc). Rental of cold chain equipment and related equipment (such as generators) also included here.	Allocation based on cold chain space usage in terms of physical volume taken up by C19 vaccines vs. routine EPI vaccines at facility (where applicable), district and national level. Vaccines are not stored at regional level.	Financial
IEC and other printing costs	The cost of printing immunization cards, training materials, radio and tv appearances and other IEC materials that are related to the C19 vaccination program.	Total expenditure on these items	Financial
Transport and fuel	Cost of bus fare, plane travel, boat travel/hire vehicle hire, and the cost of fuel for transport.	Expenditures on C19 vaccination-related activities or meetings. C19 vaccination specific.	Financial
Vehicle maintenance	Cost of maintaining vehicles (of all types) used for activities related to C19 vaccination.	Captured only if any were undertaken specifically to support the rollout of C19 vaccines in conjunction with one of the main cost drivers.	Financial
Vehicle maintenance	Cost of maintaining vehicles (of all types) used for activities related to C19 vaccination.	Captured only if any were undertaken specifically to support the rollout of C19 vaccines in conjunction with one of the main cost drivers.	Financial
Vehicles	Cost of newly purchased vehicles.	For total start-up costs: full procurement cost. For study period: 3-month apportioned value, without discounting.	Financial
Stationery and other supplies	Cost of stationery and other supplies used for C19 vaccine delivery.	Based on actual expenditure noted for C19 vaccination activities specifically.	Financial
Utilities	Costs related to building overheads, including maintenance, and utilities with some portion of these costs allocated to C19 vaccination.	Data not readily available at country-level, therefore excluded.	Financial
Other recurrent	Other notable recurrent costs for C19 vaccination activities that are not included in the above resource types.	Based on actual expenditure noted for C19 vaccinations activities specifically. These included expenditure on the C19 database and only incurred at facility level.	Financial

ANNEX 2: IMPUTATION METHODS AND COST ALLOCATION RULES

IMPUTATION METHODS

Table 7 summarizes the data elements for which imputation methods were employed, the imputation method used and the number of sites the data element was imputed for, for facility-level data, district-level data and regional-level data.

Table 7: Facility-level data imputed, method used and number of affected facilities

Data element	Imputation method	Number of facilities/districts /regions where data element was imputed
Facility-level data		
EPI doses delivered (data for 1 month from March – May 2022 missing)	Based on daily average computed from available 2 months	2
EPI doses delivered (March – May 2022)	Average of comparable sites: urban (n=3) vs rural (n=27)	3
C19 doses delivered (March – May 2022)	Average of comparable sites: low, medium, and high EPI volumes (March – May 2022) • Low (n=10): <4,000 EPI doses • Medium (n=8): 4,000-8,000 EPI doses • High (n=6): >8,000 EPI doses *6 facilities were C19 only facilities	1
C19 vaccine vials used	Based on number of doses delivered, number of doses per vial and normative wastage rate [1]. Doses per vial: • Oxford-AstraZeneca: 10 (10% wastage) • Sinopharm: 1 (3% wastage) • Pizer: 6 (10% wastage) • Johnson & Johnson: 5 (10% wastage)	2
Number of syringes used	Based on number of doses delivered, assumed 1:1.	All

[1] COVAX (2021); Assumption was lowered for Sinopharm given that is it one-dose vial.

Data element	Imputation method	Number of facilities/districts /regions where data element was imputed
Supplies used	Average per dose based on facilities where data was reported. • Security boxes (n=16) • Disinfectant (n=6) • Masks (n=4) • Cotton wool (n=12) • Black bags (n=3) • Vaccination cards (n=6)	27*
Fuel cost (vehicles)	During preparation phase: Average hours travelled per vehicle based on facilities where data was reported (n=10). During study period: Average kms travelled per vehicle based on facilities where data was reported (n=11).	1 3
Fuel cost (generator)	Based on average number of hours operated per day and average fuel cost per hour based on facilities this data was reported (n=2).	1
District-level data		
Fuel cost	During study period: Average fuel cost across all districts where data provided (n=2)	2
Regional-level data		
Staff complement and utilization	Based on staff complement & allocation to C19 vaccination activities as noted in region where this was completed (n=1)	2

*Number of facilities where the quantity of supplies used was imputed for at least one or more supplies.

ASSUMPTIONS IN CASE OF MISSING DATA

Table 8 summarizes the data elements for which assumptions were made, what these assumptions were based on the number of sites where the data element was imputed, for facility-level data, district-level data and regional-level data, respectively.

Table 8: Assumptions made for missing data at all health system levels

Data element	Assumption	Health system level for which assumption was made	Number of affected sites
Cold chain energy usage	Used manufacturer specifications about storage volumes of vaccine vials and energy consumption to calculate cold chain energy usage. Electricity cost per kw/hr was obtained from a global electricity price comparison website.[23] At national level it was reported the cold chain is powered 80% by electricity and 20% by generator, but due to lack of data to calculate generator costs we assumed 100% electrical power.	Facility, district and national [2]	All facilities, districts and DCPEV at national level
Human resource costs	Estimated staff salary levels and staff time spent during the preparation phase using information obtained in interviews.	National	National: DCPEV & INHP
Vehicle procurement price	Assumed average market price for vehicle type purchased or donated.	Facility, district and regional	Facilities: 1 Districts: 2 Regions: 2
Vehicle rental costs	Assumed average market price for vehicle rental per day.	National	National: DCPEV
Vehicle fuel costs	Assumed number of kilometers travelled per vehicle during preparation phase and study period. Assumptions were based on information obtained in interviews including types of activities conducted (e.g., supervisory visits, vaccine distribution) and data on distances between DCPEV and district centers obtained from the NDVP.	Regional and national	Regions: 3 National: DCPEV
Vaccine prices	For donated vaccines, we assumed the same price as those purchased by the MOH. All Sinopharm vaccines were provided at zero cost to the Ministry, so we valued them using the average price paid by other countries internationally ($18.34), based on the UNICEF C19 Market Dashboard.[24]	National	National: DCPEV

[2] There is no storage of vaccines at the regional level.

ALLOCATING SHARED RESOURCES

Resources that were shared between the C19 vaccination program and the immunization program or broader health system were allocated based on indicators that best reflected how the resource was used (see Table 9). Allocation rules were also used to allocate costs to the study period. Start-up costs (such as initial one-off meetings and trainings) were annualized with the assumption that they would have a useful life of a year, and subsequently apportioned to the three-month study period.

Table 9. Methods for allocating shared resources

Resources	Allocation methods
Paid labor	Time allocation based on self-reporting by interviewed staff
Fuel, vehicle maintenance, vehicle capital costs	Vehicle usage was allocated based on responses from staff on usage
Cold chain equipment costs	Allocated based on the proportional share of C19 to EPI doses
Cold chain maintenance	Difference between the 2021 contract value (pre-C19) and the 2022 contract value (including C19).
Printing	Partially allocated to C19 vaccination based on the time spent working on each of C19 vaccination activities
Waste disposal fuel	Partially allocated to the C19 vaccination program based on the estimated vaccination waste weight

ANNEX 3: COST OF VACCINES

Although not in scope for this study, we estimated the value of all vaccines administered during the study period at our sampled facilities (Figure 9). We used the unit cost paid by the MOH, as reported by DCPEV, and we valued donated vaccines at the same purchase price paid by the MOH where available. Because all Sinopharm vaccines were provided at zero cost to the MOH, we valued them using the average price paid by other countries internationally, based on the UNICEF C19 Market Dashboard. The final prices used for this analysis are shown in Table 10.

Figure 9: Total vaccine cost per facility (March - May 2022)

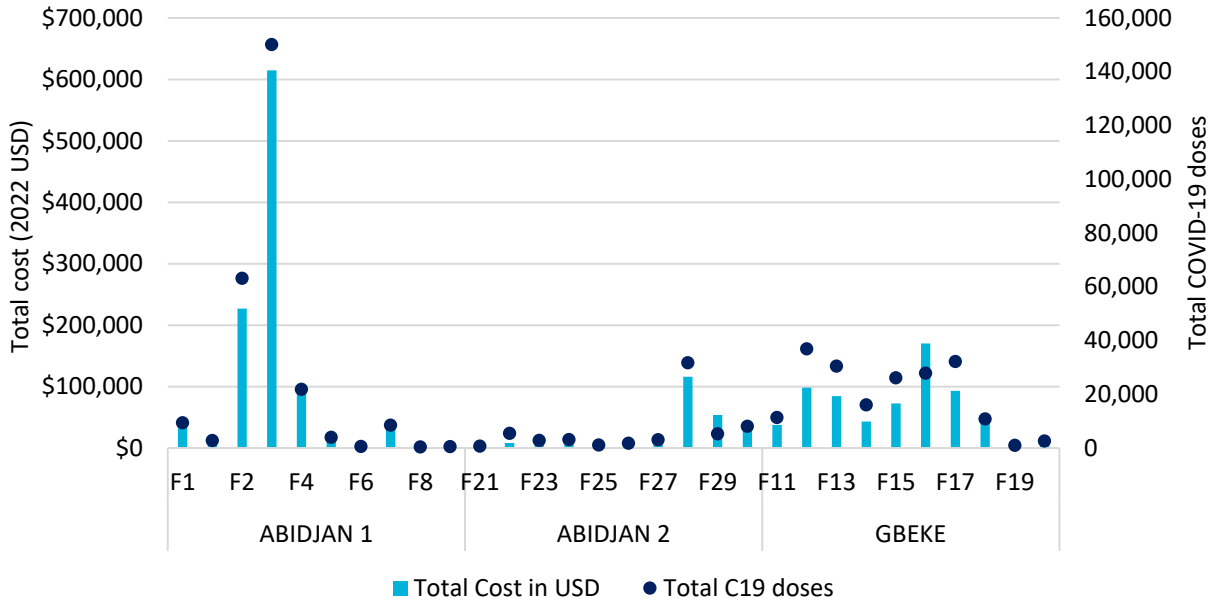


Table 10: Vaccine unit cost assumptions per dose (2022 USD)

Vaccine	Unit cost per dose (2022 USD)
AstraZeneca	$4.00
Pfizer	$16.60
Sinopharm	$18.30
Johnson & Johnson	$7.50

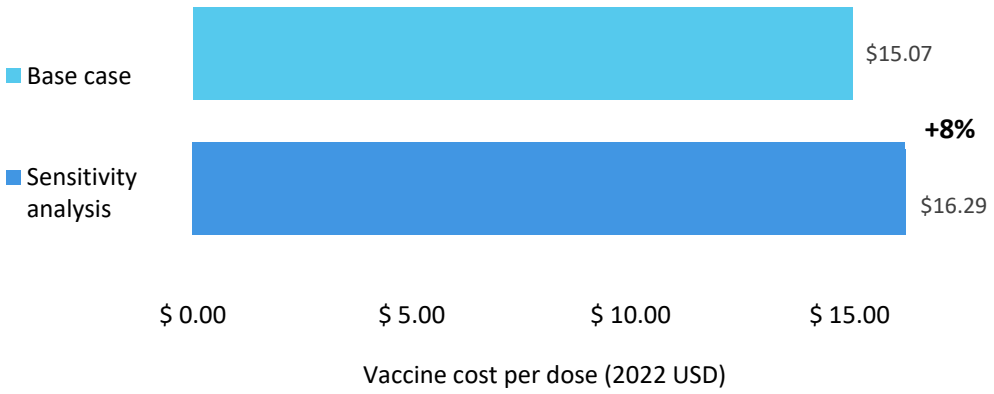
ANNEX 4: SENSITIVITY ANALYSES ON WASTAGE RATES

Reported data from facilities on vial usage often yielded very inconsistent wastage rates, and we explored the impact of assuming normative wastage as a sensitivity analysis. The analysis explored normative usage of vials based on the number of doses delivered and the wastage rates used for COVAX's model (see Table 11).[16] For the two facilities where the data on vials used and wastage were missing, we imputed these values based on the number of doses delivered, number of doses per vial, and the normative wastage rate. Therefore, these were not included in the comparison between the base case and the sensitivity analysis. The use of normative wastage rates increased the average cost per dose delivered by 8%, from $15.07 to $16.29 (Figure 10). In addition, we assessed the impact of increasing the wastage rate for syringes from 0% to 3%, which only had a 0.1% effect on the economic cost per dose.

Table 11: Normative assumptions used for sensitivity analysis on vaccine vial usage

Vaccine	Doses per vial	% Wastage assumption (sensitivity analysis)
Oxford-AstraZeneca	10	10%
Sinopharm	1	3%
Pfizer	6	10%
Johnson & Johnson	5	10%

Figure 10: Impact of one-way sensitivity analysis on vaccine cost per dose



ANNEX 5: DETAILED COST BY PROGRAM ACTIVITY

Table 12: Financial cost per dose, all health system levels, by program activity (USD 2022)

Program activity	Financial cost per dose (all health system levels)					
	Apportioned start-up costs	% Apportioned start-up costs	March-May 2022 costs	% March-May 2022 costs	Total cost per dose	% Total cost per dose
AEFI management	$0.004	3%	$0.001	0.2%	$0.005	1%
Cold chain maintenance	$0.00001	0.01%	$0.01	2%	$0.01	1%
Other activities	$0.01	8%	$0.01	1%	$0.01	2%
Program management	$0.0005	0.4%	$0.02	3%	$0.02	2%
Record keeping, HMIS, M&E	$0.002	2%	$0.04	8%	$0.05	7%
Service delivery - all strategies	$0.01	10%	$0.29	51%	$0.30	44%
Social mobilization and advocacy	$0.01	6%	$0.04	6%	$0.04	6%
Supervision	$0.004	3%	$0.01	3%	$0.02	3%
Training	$0.001	1%	$0.002	0.3%	$0.003	0.4%
Vaccine collection, distribution, and storage	$0.07	66%	$0.04	7%	$0.11	17%
Waste management	$0.00002	0.02%	$0.11	19%	$0.11	16%
Financial cost per dose (all levels) and % of cost per dose	**$0.11**	**17%**	**$0.56**	**83%**	**$0.67**	**100%**

Table 13: Economic cost per dose, all health system levels, by program activity (USD 2022)

Program activity	Economic cost per dose (all health system levels)					
	Apportioned start-up costs	% Apportioned start-up costs	March-May 2022 costs	% March-May 2022 costs	Total cost per dose	% Total cost per dose
AEFI management	$0.004	3%	$0.06	2%	$0.06	2%
Cold chain maintenance	$0.0001	0.1%	$0.03	1%	$0.03	1%
Other activities	$0.01	8%	$0.05	2%	$0.06	2%
Program management	$0.003	2%	$0.26	9%	$0.27	8%
Record keeping, HMIS, M&E	$0.003	2%	$0.26	8%	$0.26	8%
Service delivery - all strategies	$0.01	9%	$1.54	51%	$1.55	49%
Social mobilization and advocacy	$0.007	6%	$0.34	11%	$0.35	11%
Supervision	$0.006	5%	$0.12	4%	$0.13	4%
Training	$0.007	5%	$0.12	4%	$0.13	4%
Vaccine collection, distribution, and storage	$0.08	59%	$0.11	4%	$0.19	6%
Waste management	$0.00002	0.02%	$0.13	4%	$0.13	4%
Economic cost per dose and % of cost per dose	**$0.13**	**4%**	**$3.03**	**96%**	**$3.16**	**100%**

ANNEX 6: DETAILED COST BY HEALTH SYSTEM LEVEL

Table 14: Economic delivery cost per dose by activity and health system level

	Facility level	District level	Regional level	National level
Cold chain maintenance	$ 0.01	$ 0.004	$ 0.004	$ 0.01
AEFI management	$ 0.02	$ 0.04	$ -	$ 0.0003
Other activities	$ 0.05	$ 0.01	$ -	$ -
Waste management	$ 0.12	$ 0.002	$ -	$ -
Supervision	$ 0.05	$ 0.07	$ 0.005	$ 0.01
Training	$ 0.10	$ 0.03	$ 0.00006	$ -
Vaccine collection, distribution, and storage	$ 0.04	$ 0.03	$ 0.02	$ 0.10
Record keeping, HMIS, M&E	$ 0.19	$ 0.03	$ 0.03	$ 0.01
Program management	$ 0.14	$ 0.13	$ -	$ 0.001
Social mobilization and advocacy	$ 0.32	$ 0.03	$ -	$ -
Service delivery - all strategies	$ 1.50	$ 0.04	$ -	$ 0.002

Table 15: Share of start-up and recurrent March – May 2022 costs by health system level

	Financial costs			Economic costs		
Health system level	**Apportioned start-up**	**March-May 2022**	**Total cost per dose**	**Apportioned start-up**	**March-May 2022**	**Total cost per dose**
Facility level	33%	86%	**77%**	38%	83%	**81%**
District level	13%	5%	**6%**	14%	13%	**13%**
Regional level	5%	0.3%	**1%**	5%	2%	**2%**
National level	48%	9%	**16%**	43%	2%	**4%**

Table 16: Start up vs recurrent financial and economic delivery cost per dose by health system level

	Financial costs (start-up)	Financial costs (March-May 2022)	Economic costs (start-up)	Economic costs (March-May 2022)
Facility level	$ 0.04	$ 0.48	$ 0.05	$ 2.50
District level	$ 0.01	$ 0.03	$ 0.02	$ 0.40
Regional level	$ 0.01	$ 0.002	$ 0.01	$ 0.06
National level	$ 0.05	$ 0.05	$ 0.05	$ 0.07
TOTAL	$ 0.11	$ 0.56	$ 0.13	$ 3.03

Table 17: Lump sum start-up costs incurred by health system level (2022 USD)

Health system level	n	Financial start-up costs	Economic cost of labor	Economic start-up costs
National	-	$ 7,551,379	$ 11,214	$ 7,562,593
Regional	3	$ 9,767	$ 877	$ 10,643
District	6	$ 98,033	$ 4,237	$ 102,270
Facility	30	$ 101,407	$ 5,348	$ 106,755

Table 18: Start-up costs by resource type and by level (2022 USD)

Resource type	Financial start-up costs	%	Economic cost of labor	%	Economic start-up costs	%
Facility level						
IEC and other printing costs	$22	0.02%	-	-	$22	0.02%
Paid labor	$245	0.3%	$5,348	100%	$5,603	5%
Per diem and travel allowances	$36	0.03%	-	-	$36	0.03%
Transport and fuel	$2,336	2%	-	-	$2,336	2%
Vehicles	$97,349	96%	-	-	$97,349	91%
Workshops and meetings	$1,410	1%	-	-	$1,410	1%
TOTAL	**$101,497**		**$5,348**		**$106,755**	
District level						
Paid labor	-	-	$4,237	100%	$4,237	4%
Per diem and travel allowances	$254	0.3%	-	-	$254	0.2%
Transport and fuel	$430	0.4%	-	-	$430	0.4%
Vehicles	$97,349	99%	-	-	$97,349	95%
TOTAL	**$98,033**		**$4,236**		**$102,093**	
Regional level						
Paid labor	-	-	$877	9%	$877	8%
Transport and fuel	$32	0.3%	-	-	$32	0.3%
Vehicles	$9,735	99.7%	-	-	$9,735	91%
TOTAL	**$9,767**		**$843**		**$10,610**	
National level						
Cold chain equipment	$7,551,379	100%	-	-	$7,551,379	99.9%
Paid labor	-	-	$11,214	100%	$11,214	0.2%
TOTAL	**$7,551,379**		**$11,214**		**$7,562,593**	

ANNEX 7: DETAILED COST BY FACILITY

Table 19: Facility level delivery cost (2022 USD)

	Total financial cost	Total economic cost	Total C19 doses (March – May 22)	Financial cost per dose	Economic cost per dose	Number of FTEs for the C19 vaccination program during March-May 2022
Abidjan 1						
F1	$870.31	$2,868.58	2,337	$0.37	$1.23	226
F2	$6,580.17	$18,180.65	15,777	$0.42	$1.15	960
F3	$22,512.00	$22,556.86	37,531	$0.60	$0.60	797
F4	$4,755.64	$14,906.97	5,449	$0.87	$2.74	444
F5	$666.35	$6,368.27	995	$0.67	$6.40	240
F6	$687.45	$10,162.93	148	$4.64	$68.67	600
F7	$723.38	$2,941.97	2,128	$0.34	$1.38	216
F8	$34.73	$1,531.73	96	$0.36	$15.96	200
F9	$176.63	$1,034.09	120	$1.47	$8.62	60
F10	$288.26	$2,157.30	695	$0.41	$3.10	140
Regional volume-weighted average				**$0.57**	**$1.27**	
Gbêkê						
F11	$1,023.64	$11,659.15	2,839	$0.36	$4.11	468
F12	$2,951.14	$14,772.00	9,226	$0.32	$1.60	308
F13	$2,435.17	$25,500.43	7,614	$0.32	$3.35	468
F14	$1,275.71	$16,389.41	4,016	$0.32	$4.08	356
F15	$2,210.14	$26,743.63	6,523	$0.34	$4.10	556
F16	$2,295.09	$21,509.75	6,957	$0.33	$3.09	552
F17	$2,597.33	$17,320.76	8,050	$0.32	$2.15	436
F18	$866.19	$6,643.19	2,702	$0.32	$2.46	184
F19	$93.40	$4,150.72	253	$0.37	$16.41	88
F20	$214.02	$1,868.81	643	$0.33	$2.91	84
Regional volume-weighted average				**$0.33**	**$3.00**	
Abidjan 2						
F21	$960.26	$4 944.08	164	$5.86	$30.15	328
F22	$789.17	$6,219.38	1,359	$0.58	$4.58	240
F23	$883.06	$7,627.96	714	$1.24	$10.68	196
F24	$738.15	$6,711.53	780	$0.95	$8.60	148
F25	$166.03	$11,130.29	270	$0.61	$41.22	250
F26	$528.18	$22,060.74	446	$1.18	$49.46	800
F27	$383.22	$7,751.75	773	$0.50	$10.03	412
F28	$7,677.48*	$26,056.97	7,923	$0.97	$3.29	404
F29	$912.13	$5,663.94	1,313	$0.69	$4.31	160
F30	$959.77	$4,086.97	2,023	$0.47	$2.02	156
Regional volume-weighted average				$0.89	$6.49	
Overall volume-weighted average facility cost per dose				**$0.52**	**$2.55**	

*F28 was the only facility where two newly procured vehicles were reported

Table 20: Economic delivery cost per dose by program activity (USD 2020)

	Service delivery	Social mobilization & advocacy	Record keeping, HMIS, M&E	Program management	Training	Supervision	Waste management	AEFI management	Vaccine collection, distribution & storage	Other activities	Cold chain maintenance
Abidjan 1											
F1	0.47	0.19	0.19	0.25	0.01	0.01	0.13	-	0.06	0.05	0.03
F2	0.60	0.41	0.03	0.07	0.02	0.02	0.10	0.00	0.04	0.01	0.00
F3	0.36	0.03	0.11	0.09	0.01	0.03	0.10	0.00	0.04	0.00	0.00
F4	1.13	0.66	0.03	0.17	0.01	0.01	0.12	-	0.05	0.67	0.05
F5	2.46	0.52	2.32	0.09	0.35	0.01	0.28	-	0.13	0.39	0.01
F6	36.51	26.21	0.52	0.99	3.64	0.07	0.10	0.09	1.00	-	0.01
F7	0.60	-	0.63	0.16	0.04	0.07	0.15	0.09	0.12	-	0.01
F8	8.49	5.11	0.55	0.97	0.70	0.07	0.13	0.09	0.19	-	0.14
F9	6.69	0.41	0.80	0.13	0.31	0.07	0.12	0.09	0.47	-	0.01
F10	1.66	0.40	0.33	0.25	0.19	0.07	0.29	0.09	0.17	0.01	0.12
Gbêkê											
F11	3.07	0.25	0.09	0.06	0.01	0.01	0.58	0.06	0.13	-	0.15
F12	1.22	0.09	0.14	0.23	0.00	0.01	0.11	0.06	0.04	-	0.00
F13	2.63	0.19	0.14	0.46	0.01	0.01	0.11	0.06	0.04	-	0.00
F14	2.81	0.82	0.10	0.06	0.01	0.01	0.18	0.06	0.11	-	0.22
F15	1.24	1.49	0.46	0.95	0.01	0.01	0.13	0.06	0.04	-	0.00
F16	2.48	0.15	0.19	0.10	0.03	0.33	0.12	0.11	0.24	0.02	0.03
F17	1.70	0.11	0.13	0.10	0.01	0.34	0.10	0.11	0.24	0.01	0.03
F18	2.23	0.10	0.09	0.10	0.01	0.29	0.10	0.11	0.11	0.01	0.03
F19	14.67	0.33	0.37	0.10	0.04	1.23	0.11	0.11	0.12	0.02	0.03
F20	2.13	0.22	0.26	0.10	0.01	0.54	0.10	0.11	0.11	0.01	0.03
Abidjan 2											
F21	10.11	0.57	13.92	2.66	2.75	0.12	0.19	0.56	0.05	0.16	0.01
F22	2.40	0.29	0.33	0.84	0.68	0.71	0.10	0.02	0.05	0.09	0.01
F23	5.38	0.94	1.20	1.62	1.35	0.12	0.10	0.01	0.10	0.52	0.29
F24	3.08	0.13	1.02	0.81	1.82	0.12	0.05	2.31	0.05	0.15	0.01
F25	14.70	6.24	2.93	5.17	3.90	8.85	0.09	0.01	0.05	0.23	0.01
F26	36.22	6.39	3.70	2.39	1.64	0.21	0.01	0.05	0.05	0.09	0.01
F27	5.70	0.45	3.85	0.26	0.54	0.21	0.11	0.05	0.05	0.09	0.01
F28	1.90	0.36	0.26	0.40	0.65	0.21	0.11	0.13	0.27	0.27	0.01
F29	2.29	0.25	0.60	0.39	1.21	0.21	0.42	0.05	0.05	0.12	0.01
F30	1.35	0.14	0.56	0.36	0.37	0.21	0.11	0.05	0.05	0.09	0.01

Table 21: Economic delivery cost per dose by resource type (USD 2020)

	Cold chain equipment	Paid labor	Volunteer allowances	Vaccine injection and safety supplies	Transport and fuel	Other recurrent	Cold chain repairs and energy costs	Vehicles	Per diem and travel allowances	Stationery & other supplies	Workshops and meetings	Vehicle maintenance	IEC and other printing costs
Abidjan 1													
F1	-	0.11	0.86	0.37	0.01	-	0.00	0.03	0.00	0.00	0.00	-	-
F2	-	0.48	0.36	0.38	0.03	-	0.00	0.03	0.01	0.00	0.02	-	-
F3	-	0.13	0.20	0.38	0.02	-	0.00	0.03	0.00	-	0.00	-	-
F4	-	1.56	0.42	0.39	0.10	-	0.00	0.03	0.40	0.01	-	-	-
F5	-	4.88	0.97	0.40	0.08	-	0.08	0.03	0.03	0.05	0.00	0.00	0.04
F6	-	50.70	13.91	0.34	3.22	-	0.94	0.01	0.00	-	0.01	-	-
F7	-	0.45	1.04	0.34	0.01	-	0.00	0.01	0.00	0.00	-	-	-
F8	-	9.37	6.67	0.36	0.01	-	0.00	0.01	0.00	-	-	-	-
F9	-	6.45	1.14	0.40	1.08	-	0.00	0.01	0.00	-	-	-	-
F10	-	2.55	0.59	0.38	0.01	-	0.00	0.01	0.01	0.01	0.02	-	-
Gbêkê													
F11	-	3.64	0.41	0.36	0.00	-	0.00	-	-	-	-	-	-
F12	-	1.48	0.11	0.32	0.00	-	0.00	-	-	-	-	-	-
F13	-	3.23	0.10	0.32	0.00	-	0.00	-	-	-	-	-	-
F14	-	3.91	0.15	0.32	0.00	-	0.00	-	-	-	-	-	-
F15	-	3.79	0.28	0.34	0.00	-	0.00	-	-	-	-	-	-
F16	-	3.28	0.15	0.33	0.00	-	0.00	0.04	0.00	0.01	-	-	-
F17	-	2.33	0.16	0.32	0.00	-	0.00	0.04	0.00	0.01	-	-	-
F18	-	2.70	0.09	0.32	0.00	-	0.00	0.04	0.00	0.01	-	-	-
F19	-	16.09	0.60	0.37	0.00	-	0.00	0.04	0.00	0.01	-	-	-
F20	-	2.64	0.59	0.33	0.00	-	0.00	0.04	0.00	0.01	-	-	-
Abidjan 2													
F21	-	24.12	1.53	0.60	0.10	4.47	0.00	0.01	0.11	0.07	0.04	0.00	0.02
F22	-	4.74	0.14	0.38	0.07	-	0.00	0.01	0.03	0.13	0.01	0.00	-
F23	-	9.41	0.90	0.32	0.76	-	0.00	0.01	0.01	0.05	0.10	0.05	-
F24	-	8.52	0.06	0.78	0.10	-	0.00	0.01	0.03	0.02	0.00	0.01	0.00
F25	-	34.71	6.76	0.37	0.18	-	0.00	0.01	0.10	0.02	-	0.00	-
F26	-	38.13	11.39	1.18	0.01	-	0.00	0.01	0.01	0.00	-	-	-
F27	-	8.82	1.96	0.39	0.01	0.11	0.00	0.01	0.01	0.00	-	-	-
F28	-	3.50	0.07	0.36	0.09	0.01	0.00	0.51	0.02	0.00	-	0.02	-
F29	-	4.80	0.07	0.66	0.01	-	0.00	0.01	0.04	0.00	-	-	-
F30	-	2.75	0.04	0.34	0.01	-	0.00	0.01	0.01	0.12	0.01	-	-

ANNEX 8: DETAILED COST BY DISTRICT, REGIONAL & NATIONAL LEVEL

Table 22: District-level cost estimates (USD 2022)

		Total costs		C19 doses (March – May 2022)	Cost per dose	
Region	**District**	**Financial**	**Economic**		**Financial**	**Economic**
Abidjan 1	Abobo Ouest	$3,575	$10,946	98,130	$0.04	$0.11
	Anyama	$256	$11,603	27,369	$0.01	$0.42
Gbêkê	Bouake Nord-Ouest	$54	$16,971	67,871	$0.001	$0.25
	Bouake Sud	$2,169	$25,987	39,250	$0.06	$0.66
Abidjan 2	Cocody-Bingerville	$5,672	$32,178	38,446	$0.15	$0.84
	Treichville-Marcory	$947	$24,328	20,659	$0.05	$1.18

Table 23: Regional-level cost estimates

	Total costs (March – May 2022 & apportioned start-up, 2022 USD)		C19 doses (March – May 2022)	Cost per dose (March – May 2022 & apportioned start-up, 2022 USD)	
Region	**Financial**	**Economic**		**Financial**	**Economic**
Abidjan 1	$2,879	$19,050	401,667	$0.01	$0.05
Abidjan 2	$2,883	$17,434	169,964	$0.02	$0.10
Gbêkê	$449	$12,566	224,691	$0.002	$0.06

Table 24: National-level cost estimates

Total costs (March – May 2022 & apportioned start-up, 2022 USD)		C19 doses (March – May 2022)	Cost per dose (March – May 2022 & apportioned start-up, 2022 USD)	
Financial	**Economic**		**Financial**	**Economic**
$455,582	$543,982	4,347,327	$0.11	$0.13

ANNEX 9: NEWLY PURCHASED COLD CHAIN EQUIPMENT

DCPEV reported acquiring the following cold chain equipment in 2021 and 2022. Where available, we have noted how these purchases were financed. The total cost of newly purchased equipment amounts to $7,551,379.

Cold chain equipment acquired in 2021:

- 128 refrigerators donated to the DCPEV by GAVI ($438,216)
- 50 x 2,000 AC refrigerators in the field, 70 still at the level of the DCPEV not yet redeployed (donated by USAID) ($171,178)
- 3,500 vaccine carriers donated by partners at the same time as the refrigerators
    - 2,500 x RCW 12 cooler ($1,385,100)
    - 1,000 x RCW 25 cooler ($1,289,570)

Cold chain equipment acquired in 2022:

- 237 x 3,000 AC freezers (procured by government of Côte d'Ivoire) ($843,756)
- 1,000 x TCW 2,000 AC refrigerators installed in the field in health centers and districts (donated by World Bank) ($3,423,560)