

Immunization campaigns during the COVID-19 pandemic

A rapid analysis of the additional operational cost

BREAKING
NEW GROUND

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Note: This is an update of a report published on the 14th of May. This update reflects newly published guidance from WHO on the implementation of campaigns in the context of COVID-19.

SUMMARY

This analysis estimates the potential additional operational cost of an immunization campaign held during the COVID-19 pandemic. Many mass immunization campaigns have been suspended due to the COVID-19 pandemic, but some campaigns will nevertheless need to go ahead, with additional precautionary measures in place to minimize COVID-19 transmission and ensure the safety of health workers and the community. With support from the Bill & Melinda Gates Foundation, ThinkWell has estimated the added cost per dose of several potential precautionary measures: personal protective equipment (PPE) for vaccination teams, additional infection prevention and control (IPC) measures at immunization sites, extra staff and supplies to ensure physical distancing and triaging at campaign sites, additional per diems due to potential changes in delivery strategies, and estimates of an increase of other operational cost components (such as additional social mobilization and training). The analysis uses data from 10 studies on the cost of conducting an immunization campaign to model each scenario at a low, medium and high intensity level, as well as the combined effect on the cost per dose.

The results of this analysis show that the operational cost of a campaign could increase by 5% when placing hand washing stations at campaign sites, 9-20% when adding PPE, by 10-26% when adding crowd controllers to manage physical distancing and triaging at campaign sites, by 8-32% due to additional per diems associated with a campaign extension, and by 10-40% when certain operational aspects of the campaign, such as social mobilization and transport were to increase. All protective measures and operational changes combined could increase the operational cost of a campaign by 49% in the low intensity and up to 154% in the high intensity scenario.

BACKGROUND

Many immunization campaigns have been suspended to prevent increased COVID-19 transmission, but some campaigns will nevertheless need to go ahead, with additional precautionary measures in place to ensure the safety of health workers and the community. In March, WHO's Strategic Advisory Group of Experts on Immunization advised countries to temporarily suspend any mass immunization campaigns in order to reduce the risk of spreading the virus.¹ As of the 19th of May, at least 99 immunization campaigns had been cancelled or postponed due to COVID-19, the majority of which are polio and measles campaigns.² However, in certain countries and settings, the risk of vaccine-preventable diseases may outweigh the potential increase in COVID-19 transmission. Following a careful risk-benefit analysis, as outlined in WHO's decision-making framework for the implementation of mass vaccination campaigns in the context of COVID-19,³ some countries will decide to resume the implementation of preventive and outbreak response campaigns. These campaigns should only go ahead if aligned with WHO guidance on minimizing COVID-19 transmission. With support from the Bill & Melinda Gates Foundation, ThinkWell has conducted an analysis to estimate the additional cost per dose of introducing a range of precautionary measures for conducting immunization campaigns in the context of COVID-19.

METHODOLOGY

The analysis used data reported in 10 campaign costing studies to calculate the additional cost of a number of potential operational changes due to COVID-19. The scenarios were developed based on a review of existing guidance and protocols on delivering essential health services in the context of COVID-19, data on campaigns conducted during COVID-19 and in similar settings (e.g. Ebola). From the campaign costing studies, input data were extracted to calculate the potential increases of certain cost components under each of the scenarios. All cost estimates were converted to 2020 US dollars using World Bank exchange rates⁴ and IMF inflation rates.⁵ The results are reported both as a USD increments per dose, as well as a percentage increase from the original operational costⁱ estimates.

DATA

This analysis used data from 10 out of the 12 campaign costing studies in the Immunization Delivery Cost Catalogue (IDCC).⁶ The IDCC is the result of a systematic review of over 17,000 resources that included immunization delivery costs (published and grey literature) published between January 2005 and March 2019. It includes over 600 unit costs from 68 resources and is the most comprehensive, current, and standardized global evidence on the cost of delivering vaccines in low and middle income countries. The database includes 17 unit costs from 12 studies reporting immunization campaign costs, which formed the starting point for this analysis. Two studies were excluded as one study only reported the cold chain cost per dose⁷ and another did not separate the campaign costs into cost activities.⁸ The full list of study references can be found in Annex A. Seven of the ten remaining studies costed oral cholera vaccine (OCV) campaigns, and the remaining three were meningitis A, measles and yellow fever (YF) vaccination campaign costing studies, respectively. All studies were single antigen campaigns; none co-delivered other vaccines or health interventions. Three of the ten campaigns were reactive, while the other seven were planned campaigns. The scope of the costs reported in the studies differed: three studies only reported the incremental cost of the campaign,ⁱⁱ six studies reported only the full costsⁱⁱⁱ and

ⁱ Operational costs or immunization delivery costs are defined as the costs associated with delivering vaccinations to target populations, exclusive of vaccine supply costs.

ⁱⁱ Additional cost required for the intervention (campaign), compared to the baseline cost (routine immunization program/broader health system).

ⁱⁱⁱ The sum of all costs associated with the campaign implementation, including the use of routine resources.

one study reported both. Financial costs were reported in four studies^{iv}, economic costs were reported in five^v, and for two studies the type of cost was unclear.^{vi}

From each study, relevant data were extracted including the number of vaccination days, vaccination posts, total number of vaccination team members and team size, the size of the target population and the number of doses delivered. In some cases, not all of these data were reported, or not in the format required for the analysis, so that assumptions had to be made. The number of vaccinators per team was not always explicitly stated and in that case, either the skilled health workers in a team were assumed to have been the vaccinators or the number of vaccinators per team was determined based on the number of doses delivered per hour and the size of the teams.

SCENARIOS & ASSUMPTIONS

The analysis evaluates the impact of four scenarios of potential operational changes to immunization campaigns that would have incremental fiscal cost implications. The scenarios and the cost assumptions used for these are based on guidance and protocols from WHO on implementing mass campaigns in the context of COVID-19,^{1 3 9 10} on other guidance on IPC measures related to COVID-19,^{11 12 13 14 15 16 17} measures put in place for campaigns held while the Western African Ebola epidemic was winding down in 2015, data from the polio, measles and cholera campaigns held in Kivu in 2019 during the Ebola outbreak and from the measles campaign held in Kinshasa in April 2020 in the context of COVID-19.

1. The first set of scenarios estimates the additional cost of fulfilling requirements to ensure the safety of health workers and the target population, and minimize the spread of COVID-19 during an immunization campaign.
2. The second set estimates the cost of added resources needed to observe physical distancing at campaign sites and screen the queue for COVID-19 exposure risk and symptoms.
3. The third set of scenarios estimates the costs of reducing the daily number of children vaccinated per day, and the additional labor costs and per diems for health workers due to the extended duration of the campaign.
4. The fourth category of scenarios models an increase of certain components of the operational cost of the campaign, such as additional social mobilization efforts to ensure communities are aware that vaccination sites are safe despite COVID-19, communication on IPC requirements at vaccination sites and additional transport costs associated with a change in delivery strategy.

1. Personal protective equipment (PPE) & infection prevention and control (IPC) measures

The low intensity scenario excludes PPE to reflect a scenario without widespread community transmission of COVID-19 or in the case of self-administered oral vaccines, while the medium and high intensity scenarios reflects the use of masks for high transmission settings. In areas without widespread community transmission of COVID-19, WHO guidance does not require medical masks for vaccinators. In addition, for oral vaccines for which self-administration is possible, and direct contact between the health worker and beneficiary can be avoided, no PPE is required. However, in areas with widespread community transmission of COVID-19 or in areas where transmission is not well known or surveillance systems are weak, WHO recommends to consider the extended use of medical/surgical masks during

^{iv} Financial outlays, usually with straight-line depreciation of capital items.

^v Financial outlays, with discounted annualization of capital items, plus opportunity costs such as volunteer time and any donated items such as vaccines.

^{vi} Evidence on what it costs to conduct a campaign is limited and due to the different methods used, is hard to compare. To address this, ICAN is developing methodological guidance on costing campaigns, through an iterative process of 2-3 country studies: <http://immunizationeconomics.org/ican-standardizing-campaign-costing>

vaccination shifts. The COVID-19 Risk Communication Package For Healthcare Facilities¹⁸ also recommends masks even for triaging staff at facilities, and several countries (e.g. Bangladesh,¹⁹ DRC,^{20 21} India,²² Kenya²³) require both vaccinators and other team members to wear masks. Therefore, the medium and high intensity scenarios include masks for all team members. The assumption is that team members would change their mask twice per day, as guidance indicates to replace masks as soon as they become damp.¹⁵

The low and medium intensity scenarios reflect WHO's recommendation not to use gloves unless the skin is not intact, while the high reflects practices in several countries to systematically use gloves during vaccination sessions. WHO recommendations do not require vaccinators to wear gloves, unless the skin of the recipient is not intact. If gloves are necessary, they should be changed between every recipient. During recent measles campaign in DRC, as well as during post-Ebola immunization campaigns in Liberia^{24 25} and Sierra Leone in 2015,²⁶ vaccination teams were provided with gloves for each child vaccinated, even if their skin was intact. Guidance from Guinea,²⁷ India²⁸ and Kenya all include a recommendation for vaccinators to wear masks and gloves. Therefore, the low and medium intensity scenarios do not include gloves, but they are included in the high intensity scenario.

The high intensity scenario also includes goggles for vaccinators. Although WHO's immunization-specific guidance does not prescribe the use of goggles, as WHO's list of Priority Medical Devices in the context of COVID-19 specifies gowns, goggles or face shields as part of the supplies required even for triaging. During the Ebola vaccination campaigns late last year in DRC, vaccinators also wore goggles.²⁹ WHO's protocol on the rational use of personal protective equipment (PPE) indicates its use around patients without respiratory symptoms should depend on a risk assessment. GPEI guidance mentions that eye protection for vaccinators, although not required, can be considered, and that a final decision should be based on country-specific policies.³⁰ The unit prices for PPE supplies used in the analysis equal those used in the WHO COVID-19 Essential Supplies Forecasting Tool (ESFT).³¹ Prices are exclusive of shipment costs.

To account for the cost of added infection prevention and control (IPC) materials, all scenarios include hand sanitizer and hand washing stations at the entrance and exist of campaign sites. WHO urges countries to make hand sanitizer and handwashing stations with soap and water available for use by recipients and their companions at all vaccination sites, and that health workers should perform hand hygiene between after each administered vaccine. In DRC, during the measles outbreak response campaign in Kinshasa in April and other campaigns held in late 2019, two simple handwashing stations (a bucket of water and 2 units of soap per day) were installed at each site.^{20 21} The low and medium scenarios include two simple handwashing stations to accommodate both the entry and exit points of each vaccination post. The high intensity scenario includes a more advanced handwashing station consisting of a tap and a basin. All prices are based on a WASH study in Kenya³², and have been converted to USD2020 values. These prices are in line with the latest UNICEF price ranges for low cost and low to medium cost hand washing stations.³³ To show the potential variation in some of the unit prices, Annex B shows a comparison of different prices for PPE and IPC supplies.

Table 1 – Scenario 1: infection prevention and control

Scenario 1: Personal protective equipment (PPE) & infection prevention and control (IPC) ^{vii}		
Low	Medium	High
<ul style="list-style-type: none"> – No PPE – Simple hand washing station for each fixed vaccination post (2 x 60 liter bucket and 2 units of soap per post per day) – One unit of hand sanitizer per vaccination site (or per team in case of mobile teams) 	<ul style="list-style-type: none"> – All team members receive two masks per day – One biohazard bag per team per day for disposal of PPE supplies – Simple hand washing station for each fixed vaccination post (2 x 60 liter bucket and 2 units of soap per post per day) – One unit of hand sanitizer per vaccination site (or per team in case of mobile teams) 	<ul style="list-style-type: none"> – All team members receive two masks per day – Vaccinators receive one set of reusable goggles per campaign, and one set of gloves per recipient – Other team members two sets of gloves per day – One biohazard bag per team per day for disposal of PPE supplies – Advanced hand washing station for each vaccination post (2 x 60 liter bucket, stand, basin and 2 units of soap per post per day) – One unit of hand sanitizer per vaccination site (or per team in case of mobile teams)

2. Physical distancing & screening

Vaccination teams may require additional support to maintain physical distancing, screen recipients, and ensure adequate hand washing practices are observed. WHO recommends to secure an outdoor large space where persons can be separated by at least 1 meter. Campaigns usually gather large crowds of people, and ensuring physical distancing at campaign sites will be challenging. Additionally, health workers should screen recipients and companions at the entrance to the vaccination site to prevent the spread of COVID-19, and a referral system should be in place for suspected COVID-19 cases. In the low intensity scenario, it is assumed that each vaccination team will require one additional crowd controller to ensure that physical distancing is observed and to screen the queue for potential COVID-19 cases. The high intensity scenario assumes two additional staff per team would be required. This is in line with what was done in DRC during the measles campaign in Kinshasa in April, where in addition to the regular five vaccination team members (two vaccinators, a person responsible for tallying, a crowd controller and a social mobilizer), two staff were added and dedicated to screening and monitoring the handwashing station.

The scenarios include the per diem costs for such additional staff at the rate similar to that of community health workers. The scenarios assume that such additional staff would require a level of training comparable to that of community health workers, and that they would be paid per diems equal to that of the lowest vaccination team member. Where data on the lowest level of per diems were not available, an average of all per diems in the team was used. The scenario assumes that the additional one or two crowd controllers are required irrespective of the original number of crowd controllers in the vaccination teams.

^{vii} Please note that this is in addition to all regular immunization campaign protocols regarding e.g. injection safety and waste management

The high intensity scenario also includes the provision of infrared thermometers for COVID-19 screening. WHO indicates that screening should include an assessment of the exposure risk and COVID-19 symptoms. However, some countries recommend temperature checks at immunization sessions (e.g. Guinea, Kenya). During the measles campaign in Kinshasa in April, and the polio, measles and cholera campaigns held in Kivu in 2019 during the Ebola outbreak, fixed sites were allocated Thermoflash thermometers. The price used for the thermometer comes from the UNICEF Supply Catalogue.³⁷

Table 2 – Scenario 2: physical distancing and screening

Scenario 2: Physical distancing and screening	
Low	High
<ul style="list-style-type: none"> – One extra staff for screening to ensure physical distancing is observed – No PPE (as per scenario 1) – No thermometer 	<ul style="list-style-type: none"> – Two extra staff for screening to ensure physical distancing is observed – Two masks and two sets of gloves per person per day (as per scenario 1) – One infrared thermometer per vaccination team

3. Campaign extension

Increased infection prevention and control measures, together with potential changes in delivery strategies may require the campaign to be completed over a longer period of time, and thus an increase in per diems for health workers. Campaigns targeting school-aged children usually recognize school-based delivery as the most time and cost-efficient strategy because targets for such days are high. For example, for the measles-rubella catch-up campaign conducted in India, operational guidelines estimated that a team could vaccinate 200 children per day in schools, compared to 150 during outreach to villages and hard-to-reach areas, and 50-100 at temporary fixed sites.³⁴ If schools have temporarily closed, the campaign may take several more days to achieve its total target. Additionally, physical distancing measures may slow down the process at vaccination sites, resulting in lower coverage per day. WHO recommends planning for small vaccination sessions and extending the duration of the campaign as one potential strategy to avoid crowded waiting areas. An alternative potential cause for an increase in per diems could be to compensate for the increased risk that health workers are exposed to while participating in a campaign during the pandemic.

Table 3 – Scenario 3: campaign extension

Scenario 3: Campaign extension	
Low	High
<ul style="list-style-type: none"> – Assuming an extended duration of the campaign due to a 80% reduction of the daily number of children vaccinated 	<ul style="list-style-type: none"> – Assuming an extended duration of the campaign due to a 50% reduction of the daily number of children vaccinated (i.e. the campaign takes twice as long)

4. Increase in other operational costs

This scenario assumes a cost increase of all activities and items that could reasonably be impacted by an extension of the campaign duration, a change in delivery strategy or other operational changes due to COVID-19, such as additional social mobilization efforts to ensure communities are aware that campaign sites are safe despite COVID-19, communication on IPC requirements at vaccination sites,

additional transport to reach an increased number of sites, etc. Lessons learned from the Ebola countries show that a reduction in demand for immunization services, a distrust in the health system and a fear for seeking healthcare are likely in the case of a disease outbreak,^{35 36} which must be countered with extra awareness campaigns. WHO recommends that in order to sustain community demand for vaccination services, a tailored communication strategy should be implemented to provide accurate health information, address community concerns, enhance community linkages and encourage continued use of immunization services. Additionally, covering a larger number of vaccination sites to reduce the number of people per site or additional outreach sessions will require additional travel costs and revisions to microplans. Using the cost categories as reported by the campaign costing studies, components that were assumed to be impacted by COVID-19 were isolated and increased. Examples included micro-planning, local transportation of staff and vaccines within the targeted area, social mobilization costs, supervision and vaccine storage fees. As the analysis assumes that the targeted number of children would not change, the costs that were assumed to remain fixed include vaccination-related supplies, international shipment of vaccines and insurance fees, stationery, etc.

Table 4 – Scenario 4: increase in other operational cost components

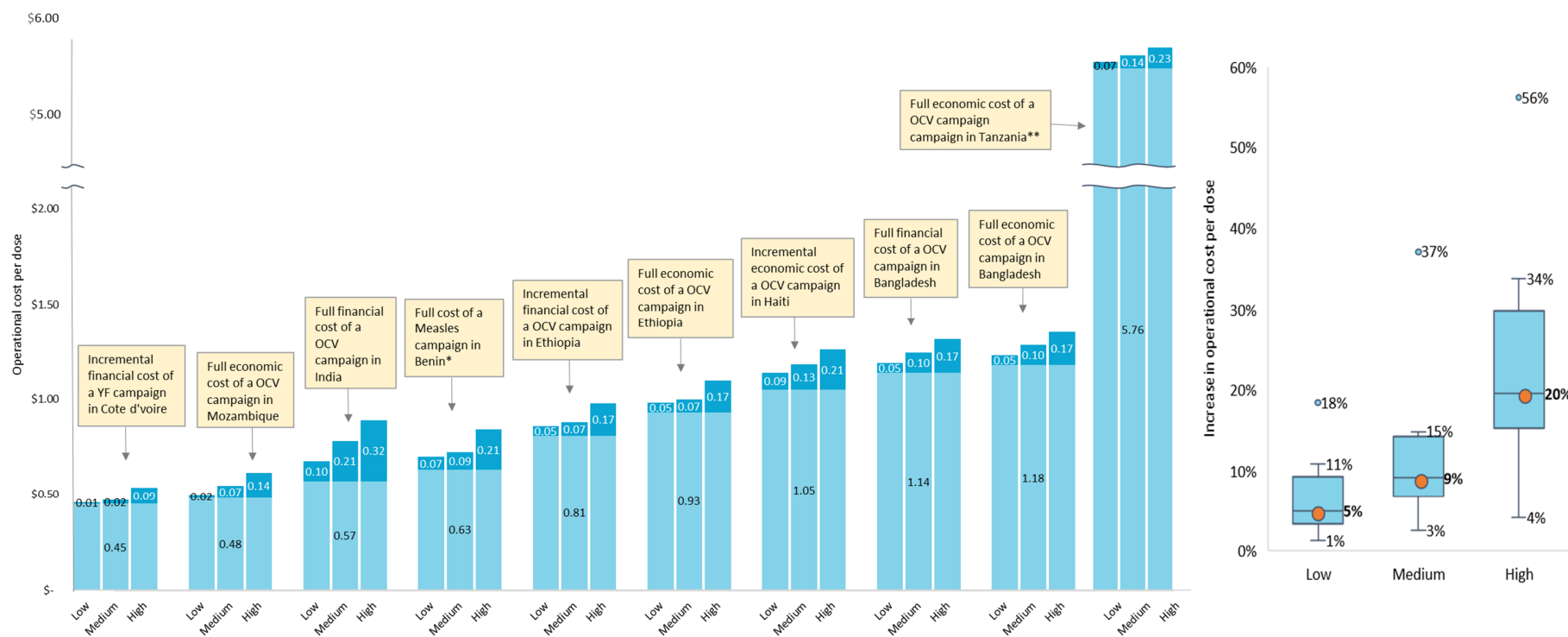
Scenario 4: Increase in other operational cost components		
Low	Medium	High
– An increase of 25% of all cost components potentially affected due to COVID-19	– An increase of 50% of all cost components potentially affected due to COVID-19	– An increase of 100% of all cost components potentially affected due to COVID-19

The 10 campaign costing studies were included in each scenario for which they reported sufficiently detailed data. Nine studies could be used for the infection prevention and control estimates (number 1). For the scenarios of adding crowd controllers (number 2), four studies had sufficient data, and for the staff cost increases (number 3), five studies could be included. Seven studies were used to estimate the impact of an increase in certain operational costs (number 4). Three studies could be used for all scenarios and were included in the estimates of the cumulative costs (see Annex A).

RESULTS

The results are shown in both absolute USD increments, as well as percentage increases compared to originally reported operational cost per dose. For each study, the graph shows what types of costs were included in the originally reported estimates (as explained in the Data section). Evidently, the percentage increase is higher for those settings where the original operational cost per dose was low. Some OCV studies reported the costs per fully immunized child as these campaigns administered two doses, and we have converted these results to cost per dose administered for comparability. Due to the differences in the methodologies used for each of the campaign costing studies, and the lack of sufficient comparable data points, it is not possible to develop pooled estimates from the results. No clear differences were observed between OCV campaigns and injectables, nor between planned and reactive campaigns, despite probable operational differences, which is likely due to the small number of studies included. Tables with the full results of the analysis can be found in Annex C. The four scenarios describe individual effects, and have been modelled separately first, and afterwards, for the studies for which it was possible, have been included in an analysis of combined effects.

Figure 1 – Scenario 1: additional infection prevention and control measures



* It is unclear whether the costs reported in this study represented the financial or economic costs.

** Tanzania's study included the cost of international consultants, which is why its baseline unit cost was much higher.

- **Low:** No PPE, simple hand washing stations and hand sanitizer
- **Medium:** Masks for vaccination teams, simple hand washing stations, hand sanitizer and biohazard bags
- **High:** Goggles for vaccinators, masks and gloves for all vaccination team members, advanced hand washing stations, hand sanitizer and biohazard bags

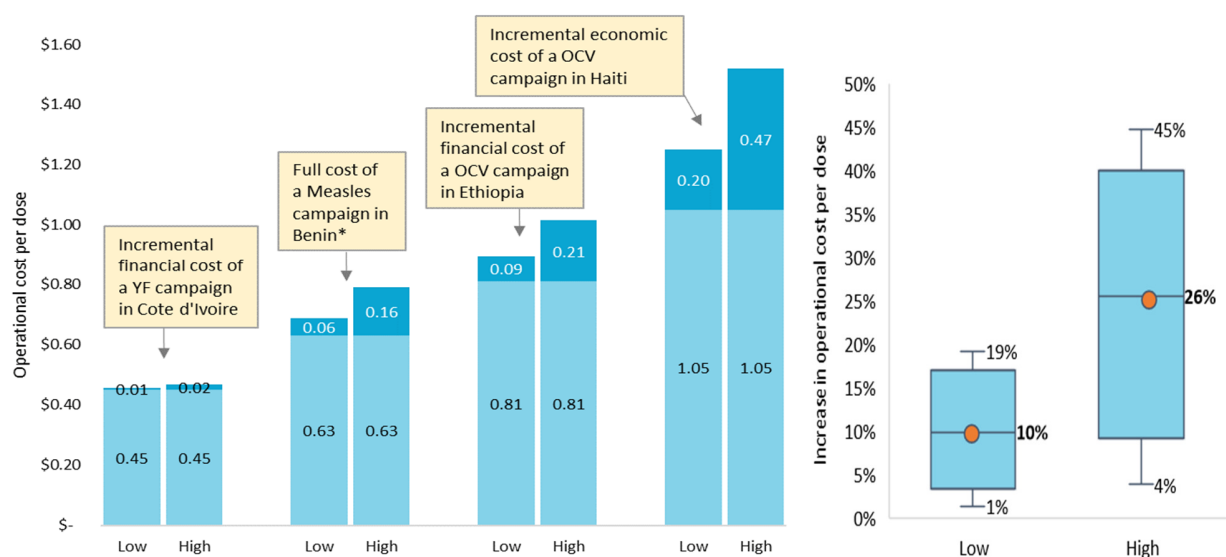
1. Personal protective equipment (PPE) & infection prevention and control (IPC) measures

Offering handwashing stations and hand sanitizer at campaign sites could increase the operational cost of a campaign by US\$0.01-0.10 per dose, adding masks would increase this to US\$0.02-0.21 per dose and up to US\$0.32 per dose if teams wear gloves and vaccinators wear goggles as well. Figure 1 shows the results in USD when adding several levels of PPE for health workers and IPC measures, as well as the percentage increase compared to the originally reported operational cost. In the low intensity scenario, where hand washing stations and hand sanitizer is made available at campaign sites, but health workers are not provided with PPE, the cost increase would only be 5%. This can be interpreted as the appropriate scenario for settings without widespread COVID-19 transmission in the community or if self-administration of oral vaccines is possible. Under the medium intensity scenario, health workers are equipped with masks, and the median increase in operational cost per dose is estimated at 9%. This can be interpreted as per WHO's guidance for settings with widespread community transmission of COVID-19 or in areas where transmission is not well known or surveillance systems are weak. Including a more advanced hand washing station, and if teams were provided with gloves, and vaccinators were provided with goggles as well, the median increase in operational cost per dose is 20%. The main driver of the jump from the medium to the high scenario is the cost of the gloves.

2. Physical distancing & screening

Adding two team members to a vaccination team (high intensity) could increase the operational cost of the campaign by US\$0.02-0.47, reflecting an increase in the operational cost of approximately 26%. The scenario assumes that crowd controllers would be added to existing teams (including masks and gloves in the high intensity scenario). The low intensity scenario added one additional staff to each vaccination team (usually consisting of around five members) to ensure that physical distancing is observed, to monitor the hand washing station and to manage the triaging process, which could increase the operational cost of the campaign by 10%. The high intensity scenario includes an infrared thermometer per team for the screening of recipients and companions, and with the additional team member and PPE, the operational cost per dose could increase by 26%. If the number of sites were to be increased to reduce the crowds at each site, even more crowd controllers may be needed.

Figure 2 – Scenario 2: additional staff at vaccination sites

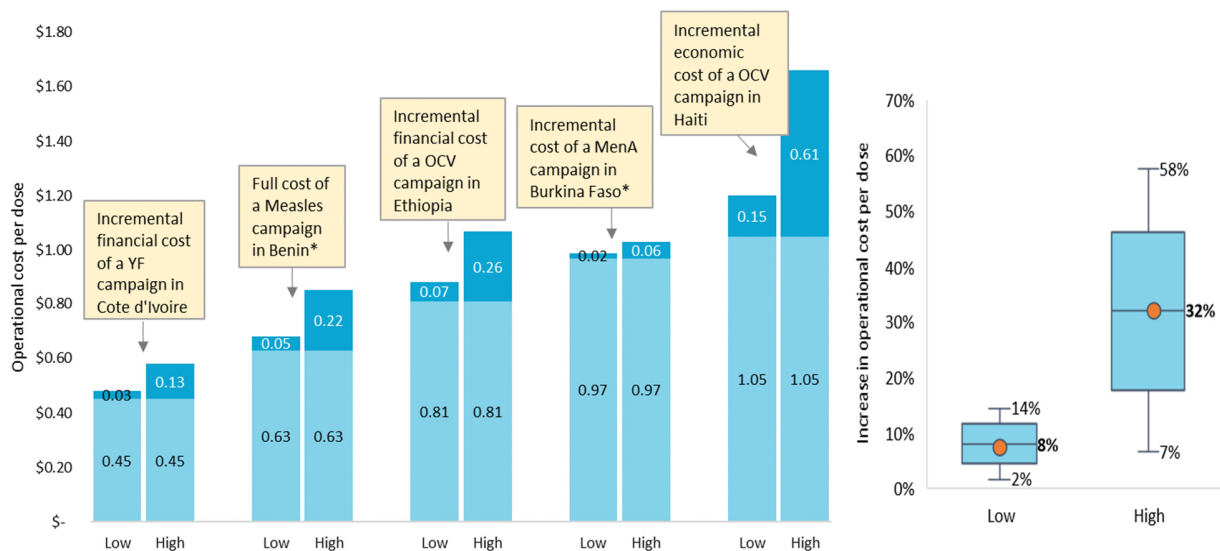


* It is unclear whether the costs reported in this study represented the financial or economic costs.

3. Campaign extension

If campaigns would take twice as long to complete (high intensity), the additional expenses on health worker per diems alone could already increase the operational cost of the campaign by 32%. Figure 3 summarizes the results of having to pay additional per diems if the duration of the campaign would have to be extended due to changes in the delivery strategy. If health workers would have lower daily targets due to physical distancing measures or a change in delivery strategy (from school-based to fixed sites, or increasing the number of sites to decrease the number of beneficiaries per site, for example), the impact on their required per diems could be significant. If the campaigns in this analysis would have been able to reach only 80% of their achieved targets each day (low intensity), and therefore spent more days on completing the campaign, the added per diem expenses would have been around US\$ 0.02-0.15 per dose or an increase of 2-14% (median 8%). The scenario looked only at health worker per diems, and so does not assume any implications on health workers' regular salaries or any recurrent hazard pay that they may receive during COVID-19 times. However, note that these scenarios do not consider a potential reduction in target population size to focus only on those geographic areas shown by surveillance data as most at risk of a vaccine preventable disease outbreak.

Figure 3 – Scenario 3: Additional per diem costs as a result of an extension of the campaign duration

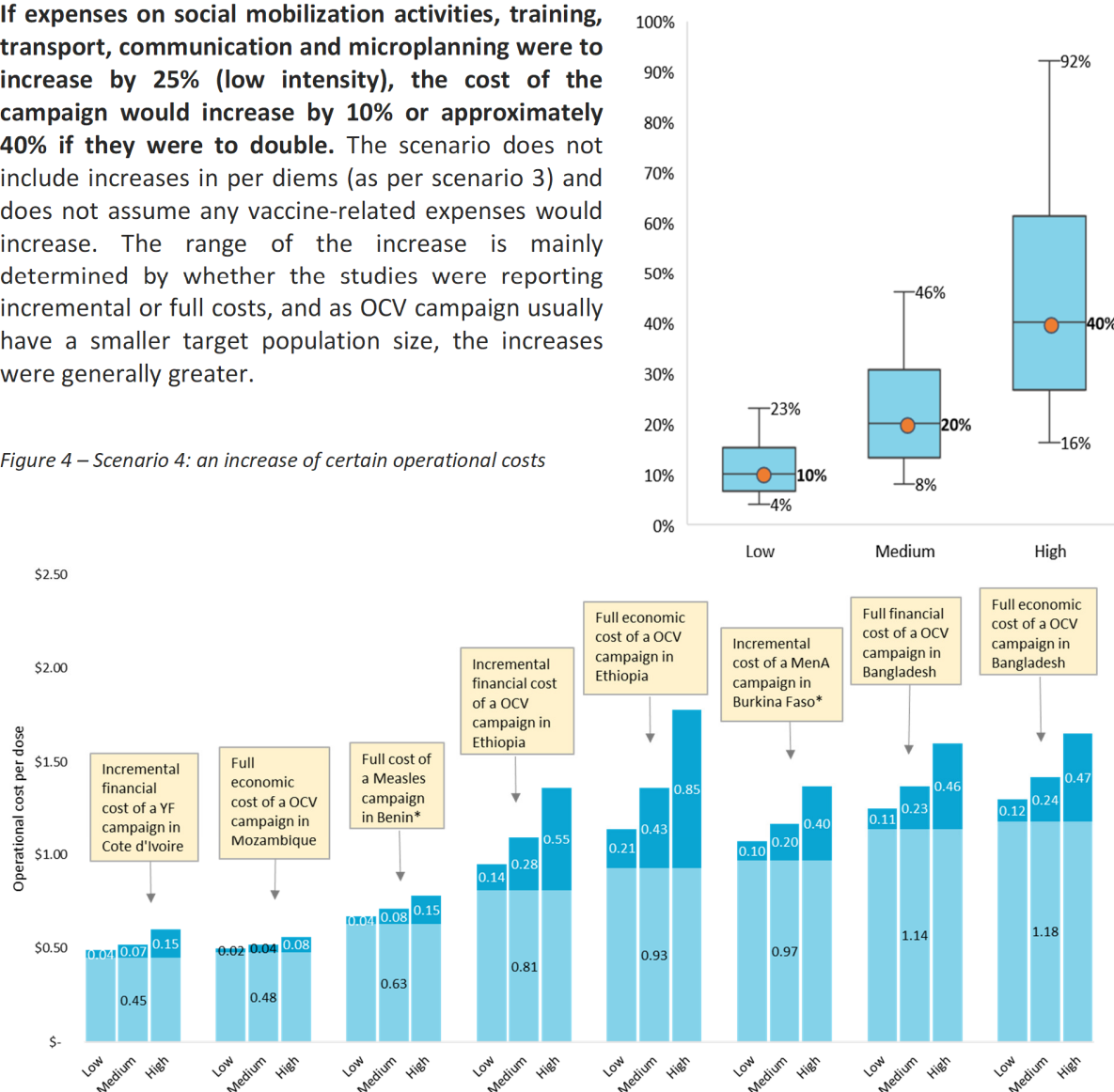


* It is unclear whether the costs reported in this study represented the financial or economic costs.

4. Increase in other operational costs

If expenses on social mobilization activities, training, transport, communication and microplanning were to increase by 25% (low intensity), the cost of the campaign would increase by 10% or approximately 40% if they were to double. The scenario does not include increases in per diems (as per scenario 3) and does not assume any vaccine-related expenses would increase. The range of the increase is mainly determined by whether the studies were reporting incremental or full costs, and as OCV campaign usually have a smaller target population size, the increases were generally greater.

Figure 4 – Scenario 4: an increase of certain operational costs

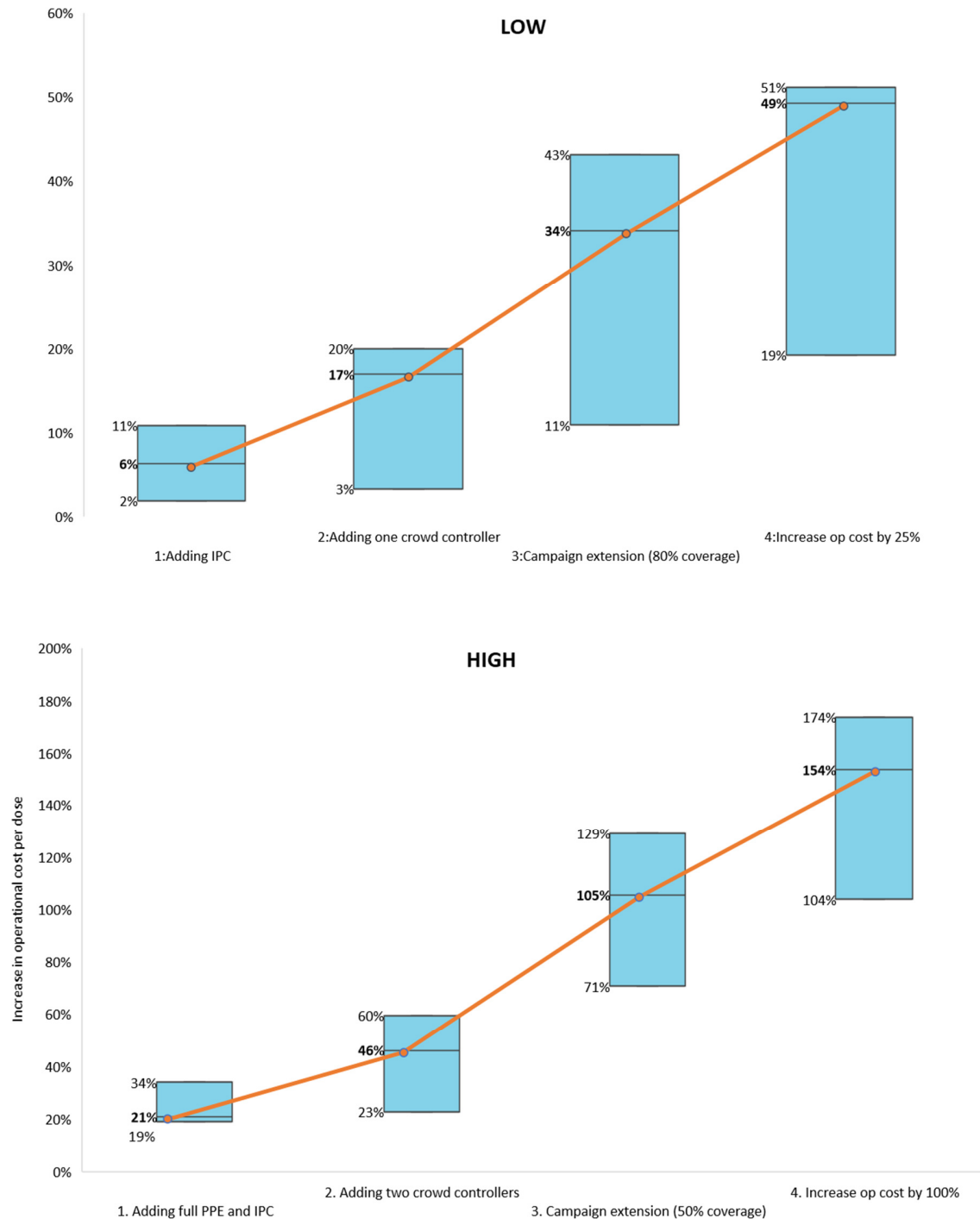


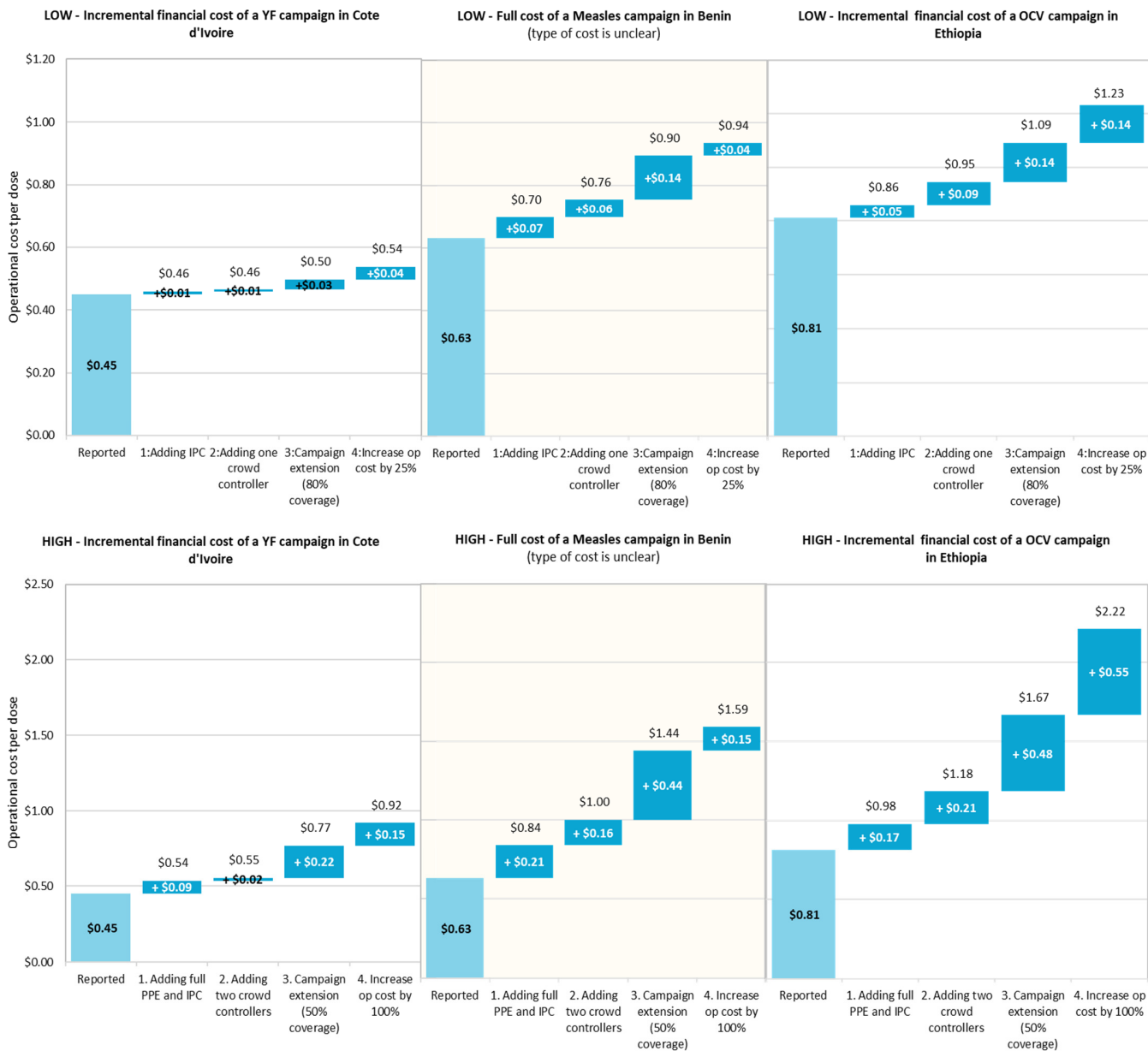
5. Combined effect

If hand sanitizer and basic handwashing stations are put in place at vaccination sites, one extra crowd controller is added to vaccination teams, daily coverage targets are reduced to 80% and other operational costs were to increase by 25%, this could increase the operational cost per dose by 49%. To estimate the effect of all four interventions side-by-side the same set of studies must be used, and only three studies offered enough data to be used in all scenarios. The full cumulative effect of the scenarios includes the additional costs of PPE, IPC and per diems required for the campaign extension of scenario 3. Under the high intensity scenario, with more elaborate PPE for vaccinators, two additional crowd controllers to support vaccination teams, and infrared thermometer per team, a doubling of the campaign duration, and a doubling of operational cost such as social mobilization, training and transport, the operational cost could jump to 154% of the original cost per dose. The graphs in Figure 5 show that adding hand washing stations to campaign sites has a relatively small impact on the cost of a campaign,

while the campaign extension has the largest effect on the operational cost increase, particularly because this effect includes the cost of additional crowd controllers, PPE and IPC for those days as well.

Figure 5 – Scenario 5: adding PPE & IPC, crowd controllers, extra per diems and added operational cost





LIMITATIONS

The results of this analysis are meant to offer general guidance but should be interpreted with caution, as several limitations apply. First, the analysis relied on the data as reported by the authors, and several assumptions had to be made in the classification of certain costs, in the estimations of per diems, etc. Second, the analysis did not consider changes in the size of the target population, while in reality countries might reduce the target population size to reduce the risk of increased COVID-19 transmission and target only those populations most susceptible to a vaccine-preventable disease outbreak. Third, some of the prices for COVID-19 response materials are changing rapidly, which will affect the accuracy of the results over time. Fourth, supply chain cost increases have not been taken into account, which may increase due to lockdown restrictions. Last, one could consider that if a campaign were to be conducted, that it would be co-delivered with other antigens or health interventions (such as nutrition supplements and bed net distribution or COVID-19 screening and testing), resulting in shared costs and efficiencies that have not been taken into account. A forthcoming study from ICAN on the Sierra Leone campaign during which MR, polio, Vitamin A supplements and deworming tablets were administered, will offer lessons on potential efficiencies associated with co-delivery. Overall, country-specific guidance and policies should be reviewed before translating these results to other country contexts.

CONCLUSION

This rapid analysis is meant to illustrate a range of potential cost implications to provide general guidance for the direction of policies and potential cost expectations that would require the mobilization of additional resources. The results indicate that adding masks and handwashing stations on their own will likely not drive up the costs of a campaign significantly, but that having to add staff, pay staff additional per diems to implement the work over a longer period of time or additional cost from e.g. intensified social mobilization efforts could potentially have a large impact on the operational cost of a campaign. Comprehensive risk-benefit analyses will be required for each specific setting to evaluate the trade-off between the risks of postponing immunization campaigns and the risks involved in accelerating the spread of COVID-19 during immunization campaigns. Follow-up analyses conducted by ThinkWell and the Harvard T.H. Chan School of Public Health are assessing the cost implications for routine and routine outreach immunization service delivery.

ANNEX A – IDCC STUDIES

Campaign description	Type of campaign	Study type	Reference	Scenarios for which the study was included
Cholera vaccination campaign in Mozambique	Planned (for feasibility study)	Full economic costs	Cavailler, P., Lucas, M., Perroud, V., McChesney, M., Ampuero, S., Guérin, P. J., ... Chaignat, C. L. (2006). Feasibility of a mass vaccination campaign using a two-dose oral cholera vaccine in an urban cholera-endemic setting in Mozambique. <i>Vaccine</i> , 24(22), 4890–4895.	1, 4
Meningococcal conjugate vaccine campaign in Burkina Faso ⁸	Reactive	Incremental costs (type not reported)	Colombini, A., Badolo, O., Gessner, B. D., Jaillard, P., Seini, E., & Da Silva, A. (2011). Costs and impact of meningitis epidemics for the public health system in Burkina Faso. <i>Vaccine</i> , 29(33), 5474–5480	3, 4
Cholera vaccination campaign in India	Planned pilot	Full financial costs	Kar, S. K., Sah, B., Patnaik, B., Kim, Y. H., Kerketta, A. S., Shin, S., ... Wierzbza, T. F. (2014). Mass Vaccination with a New, Less Expensive Oral Cholera Vaccine Using Public Health Infrastructure in India: The Odisha Model. <i>PLoS Neglected Tropical Diseases</i> , 8(2).	1
Measles campaign in Benin	Planned follow-up SIA	Full SIA delivery costs at vaccination posts only (type not reported)	Kaucley, L., & Levy, P. (2015). Cost-effectiveness analysis of routine immunization and supplementary immunization activity for measles in a health district of Benin. <i>Cost Effectiveness and Resource Allocation</i> , 13(1), 14	1, 2, 3, 4
Cholera vaccination campaign in Bangladesh	Planned (for feasibility study)	Full financial costs	Khan, I. A., Saha, A., Chowdhury, F., Khan, A. I., Uddin, M. J., Begum, Y. A., ... Qadri, F. (2013). Coverage and cost of a large oral cholera vaccination program in a high-risk cholera endemic urban population in Dhaka, Bangladesh. <i>Vaccine</i> , 31(51), 6058–6064.	1, 4
Cholera vaccination campaign in Haiti	Reactive	Incremental economic costs	Routh, J.A., Sreenivasan, N., Adhikari, B.B., Andrecy, L.L., Bernateau, M., Abimbola, T., ... Mintz, E.D. (2017). Cost evaluation of a government-conducted oral cholera	1, 2, 3

⁸ The cost per dose exclusive of the vaccine for this study was calculated using the average price of the 10 dose and 50 dose presentations

			vaccination campaign - Haiti, 2013. The American Society of Tropical Medicine and Hygiene, 97(4), 37-42	
Cholera vaccination campaign in Bangladesh	Planned (for feasibility study)	Full economic costs	Sarker, A. R., Islam, Z., Khan, I. A., Saha, A., Chowdhury, F., Khan, A. I., ... Khan, J. A. M. (2015). Estimating the cost of cholera-vaccine delivery from the societal point of view: A case of introduction of cholera vaccine in Bangladesh. <i>Vaccine</i> , 33(38), 4916–4921.	1, 4
Cholera vaccination campaign in Tanzania	Planned (to estimate cost-effectiveness in an endemic region)	Full economic costs	Schaetti, C., Weiss, M. G., Ali, S. M., Chaignat, C. L., Khatib, A. M., Reyburn, R., ... Hutubessy, R. (2012). Costs of Illness Due to Cholera, Costs of Immunization and Cost-Effectiveness of an Oral Cholera Mass Vaccination Campaign in Zanzibar. <i>PLoS Neglected Tropical Diseases</i> , 6(10).	1
Cholera vaccination campaign in Ethiopia	Planned (for feasibility study)	Full economic and incremental financial costs	Teshome, S., Desai, S., Kim, J.H., Belay, D., & Mogasale, V. (2018). Feasibility and costs of a targeted cholera vaccination campaign in Ethiopia. <i>Human Vaccines & Immunotherapeutics</i> .	1, 2, 3, 4
Yellow fever campaign in Cote d'Ivoire. ⁹	Outbreak response	Incremental financial costs	Zengbe-Acray, P., Douba, A., Traore, Y., Dagnan, S., Attoh-Toure, H., & Ekra, D. (2009). Coûts de la riposte vaccinale contre la fièvre jaune à Abidjan, 2001. <i>Sante Publique</i> , 21(4), 383–391.	1, 2, 3, 4

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ANNEX B – EQUIPMENT AND SUPPLIES COST

Unit costs of PPE and screening supplies (USD 2020)			
Item	WHO forecasting supplies tool (used for this analysis) ³¹	UNICEF catalogue ³⁷	PPE for Ebola in West Africa ³⁸
Face shield	-	-	0.63
Protective goggles	2.80	3.01	-
Gloves (pair)	0.06	0.08	0.18
Mask	0.70	0.22	0.08
Biohazard bag	0.15	0.72	-
Infrared thermometer	-	35.19	-

Cost of health worker PPE scenarios per day (USD 2020)			
Combination	WHO forecasting supplies tool (used in this analysis) ³¹	UNICEF Supply Catalogue (prices as of 4 th of June) ³⁷	PPE for Ebola in West Africa (2015 cost converted to USD2020) ³⁸
Goggles, two masks per day and one pair of gloves per beneficiary*	10.65	11.61	-
Goggles, two masks and two pairs of gloves per day	4.32	3.60	1.14**
Two masks and two sets of gloves	1.52	0.59	0.51

* Vaccinators are allocated one set of gloves per beneficiary, the estimated number of beneficiaries here is based on the median use across all studies included for the analysis in Scenario 1

** This study reported the use of a face shields instead of goggles

Unit costs of IPC supplies (USD 2020)			
Item	WHO forecasting supplies tool ³¹	UNICEF price categories (May 2020) ³³	Hand washing station costs in Kenya (2017 cost converted to USD2020) ³²
60-liter bucket	-	Low (<10)	6.20
Hand washing stand	-		31.20
Basin	-		2.30
Simple hand washing station (1 unit)	-		12.5
Advanced hand washing station (1 unit)	-	Medium low (<50)	79
Soap	0.90		
Hand sanitizer	8.30		

ANNEX C – RESULTS TABLES

1. Infection prevention and control: PPE for health workers & handwashing stations						
Study description	Type of cost reported		Original cost per dose without vaccine (2020 USD)	Additional cost per dose in each scenario (2020 USD)		
	Economic/financial	Full/incremental		Low	Medium	High
Outbreak campaign for YF in Cote d'Ivoire	Financial	Incremental	\$ 0.45 ¹⁰	\$ 0.01 (+2%)	\$ 0.02 (+4%)	\$ 0.09 (+19%)
Mass vaccination campaign for OCV in Mozambique	Economic	Full	\$ 0.48 (\$ 1.06 per person in the target population)	\$ 0.02 (+4%)	\$ 0.07 (+14%)	\$ 0.14 (+29%)
Mass vaccination campaign for OCV in India	Financial	Full	\$ 0.57	\$ 0.10 (+18%)	\$ 0.21 (+37%)	\$ 0.32 (+56%)
SIA for Measles in Benin	Unclear	Full	\$ 0.63 ¹⁰	\$ 0.07 (+11%)	\$ 0.09 (+15%)	\$ 0.21 (+34%)
SIA delivery of OCV vaccine in Ethiopia in a rural setting	Financial	Incremental	\$ 0.81	\$ 0.05 (+6%)	\$ 0.07 (+9%)	\$ 0.17 (+21%)
SIA delivery of OCV vaccine in	Economic	Full	\$ 0.93 ¹⁰	\$ 0.05 (+5%)	\$ 0.07 (+8%)	\$ 0.17 (+18%)

¹⁰ For these studies, no unit cost was given, number of persons vaccinated was used as proxy for doses delivered

Ethiopia in a rural setting						
SIA delivery of OCV vaccine in Haiti in urban and rural settings	Economic	Incremental	\$ 1.05	\$ 0.09 (+9%)	\$ 0.13 (+13%)	\$ 0.21 (+20%)
Mass vaccination campaign for OCV in Bangladesh	Financial	Full	\$ 1.14	\$ 0.05 (+4%)	\$ 0.10 (+9%)	\$ 0.17 (+15%)
Mass vaccination campaign for OCV in Bangladesh	Economic	Full	\$ 1.18 (\$ 2.52 per fully immunized person)	\$ 0.05 (+4%)	\$ 0.10 (+9%)	\$ 0.17 (+15%)
Mass vaccination campaign for OCV in Tanzania.	Economic	Full	\$ 5.76 (\$ 11.9 per person in the target population)	\$ 0.07 (+1%)	\$ 0.14 (+3%)	\$ 0.23 (+4%)
Median				5%	9%	20%

2. Additional crowd controllers at vaccination sites					
Study description	Type of cost reported		Original cost per dose without vaccine (2020 USD)	Additional cost per dose in each scenario (2020 USD)	
	Economic/financial	Full/incremental		Low	High
Outbreak campaign for YF in Cote d'Ivoire	Financial	Incremental	\$ 0.45 ¹¹	\$ 0.01 (+1%) ¹²	\$ 0.02 (+4%)
SIA for Measles in Benin	Unclear	Full	\$ 0.63 ¹¹	\$ 0.06 (+9%) ¹²	\$ 0.16 (+26%)
SIA delivery of OCV vaccine in Ethiopia in a rural setting	Financial	Incremental	\$ 0.81	\$ 0.09 (+11%)	\$ 0.21 (+25%)
SIA delivery of OCV vaccine in Haiti in urban and rural settings	Economic	Incremental	\$ 1.05	\$ 0.20 (+20%)	\$ 0.47 (+45%)
Median				+10%	+26%

¹¹ For these studies, no unit cost was given, number of persons vaccinated was used as proxy for doses delivered

¹² These two studies reported the per diem costs for each cadre of which the rate for the lowest cadre was used to calculate the additional costs of crowd controllers, the others assumed an equal per diem rate which may have led to an overestimation

3. Extended duration of the campaign & additional health worker per diems					
Study description	Type of cost reported		Original cost per dose without vaccine (2020 USD)	Additional cost per dose in each scenario (2020 USD)	
	Economic/financial	Full/incremental		Low	High
Outbreak campaign for YF in Cote d'Ivoire	Financial	Incremental	\$ 0.45 ¹³	\$ 0.03 (+7%)	\$ 0.13 (+29%)
SIA for Measles in Benin	Unclear	Full	\$ 0.63 ¹³	\$ 0.05 (+9%) ¹⁴	\$ 0.22 (+35%)
SIA delivery of OCV vaccine in Ethiopia in a rural setting	Financial	Incremental	\$ 0.81	\$ 0.07 (+8%)	\$ 0.26 (+32%)
Outbreak campaign for Meningitis in Burkina Faso	Not reported	Incremental	\$ 0.97 ¹⁵	\$ 0.02 (+2%)	\$ 0.06 (+7%)
SIA delivery of OCV vaccine in Haiti in urban and rural settings	Economic	Incremental	\$ 1.05	\$ 0.15 (+14%)	\$ 0.61 (+58%)
Median				+8%	+32%

4. An increase of certain components of the operational cost of the campaign						
Study description	Type of cost reported		Cost per dose without vaccine (2020 USD)	Additional cost per dose in each scenario (2020 USD)		
	Economic/financial	Full/incremental		Low	Medium	High
Outbreak campaign for YF in Cote d'Ivoire	Financial	Incremental	\$ 0.45 ¹³ Error! Bookmark not defined.	\$ 0.04 (+8%)	\$ 0.07 (+17%)	\$ 0.15 (+33%)
Mass vaccination campaign for OCV in Mozambique	Economic	Full	\$ 0.48 (\$ 1.06 per person in the target population)	\$ 0.02 (+4%)	\$ 0.04 (+8%)	\$ 0.08 (+16%)
SIA for Measles in Benin	Unclear	Full	\$ 0.63 ¹³	\$ 0.04 (+6%)	\$ 0.08 (+12%)	\$ 0.15 (+25%)

¹³ For these studies, no unit cost was given, number of persons vaccinated was used as proxy for doses delivered

¹⁴ Results for this study show the increase in cost in personnel costs for the vaccination team members only while others show the increase in cost for all personnel

¹⁵ The cost per dose exclusive of the vaccine for this study was calculated using the average price of the 10 dose and 50 dose presentations

SIA delivery of OCV vaccine in Ethiopia in a rural setting	Financial	Incremental	\$ 0.81	\$ 0.14 (+17%)	\$ 0.28 (+34%)	\$ 0.55 (+68%)
SIA delivery of OCV vaccine in Ethiopia in a rural setting	Economic	Full	\$ 0.93 ¹⁶	\$ 0.21 (+23%)	\$ 0.43 (+46%)	\$ 0.85 (+92%)
Outbreak campaign for Meningitis in Burkina Faso	Not reported	Incremental	\$ 0.97 ¹⁷	\$ 0.10 (+10%)	\$ 0.20 (+21%)	\$ 0.40 (+42%)
Mass vaccination campaign for OCV in Bangladesh	Financial	Full	\$ 1.14	\$ 0.11 (+10%)	\$ 0.23 (+20%)	\$ 0.46 (+40%)
Mass vaccination campaign for OCV in Bangladesh	Economic	Full	\$ 1.18 (\$2.52 per fully immunized person)	\$ 0.12 (+10%)	\$ 0.24 (+20%)	\$ 0.47 (+40%)
Median				+10%	+20%	+40%

5. Combination of PPE for health workers & handwashing stations, additional crowd controllers at vaccination sites, additional per diems due to a campaign extension, and an increase of certain components of the operational cost of the campaign

Study description	Type of cost reported		Cost per dose without vaccine (2020 USD)	Additional cost per dose in each scenario (2020 USD)		
	Economic/financial	Full/incremental		Low	Medium ¹⁸	High
Outbreak campaign for YF in Cote d'Ivoire	Financial	Incremental	\$ 0.45 ¹⁶	\$ 0.09 (+19%)	\$ 0.33 (+73%)	\$ 0.47 (+104%)
SIA for Measles with different strategies in Benin	Unclear	Full	\$ 0.63 ¹⁶	\$ 0.31 (+50%)	\$ 0.77 (+122%)	\$ 0.96 (+154%)
SIA delivery of OCV vaccine in Ethiopia in a rural setting	Financial	Incremental	\$ 0.81	\$ 0.42 (+51%)	\$1.04 (+127%)	\$ 1.41 (+174%)
Median				+49%	+122%	+154%

¹⁶ For these studies, no unit cost was given, number of persons vaccinated was used as proxy for doses delivered

¹⁷ The cost per dose for this study exclusive of the vaccine for this study was calculated using the average price of the 10 dose and 50 dose presentations

¹⁸ For scenarios which did not include a medium level of intensity, the high intensity was substituted

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