Cross-country study on vaccine wastage in Ghana, Mozambique and Pakistan

17 May 2022

PATH

Gavi The Vaccine Alliance

IQVIA

VillageReach

Agenda

Welcome and introductions

Study rationale and methods

Ghana findings and country-specific recommendations

Mozambique findings and country-specific recommendations

Pakistan findings and country-specific recommendations

Cross country highlights and global-level recommendations

Study rationale and methods

Rationale

Lack of accurate data on vaccine wastage is a **key barrier** to correct planning for vaccine procurement

Tracking wastage is difficult because it can occur at all points in the supply chain. Also, with wastage data there is:

- Inconsistent reporting
- Underreporting

Causes of wastage may be:

- **Avoidable,** such as exposure to out-of-range temperatures (closed-vial wastage)
- **Unavoidable** when a health worker cannot use all doses in a multidose vial before its discard point (open-vial wastage).

Lack of accurate data can lead to:

- Over or under estimation of demand resulting in:
  - Unnecessary vaccine procurement if wastage is overestimated
  - Stockouts and service delivery interruptions if wastage is underestimated

Study components

Study objectives and research components

Estimate vaccine wastage rates

Retrospective analysis of vaccine wastage and stock data in national electronic health information systems.

Prospective tracking of stock data related to vaccine use and wastage for 3 months.

Understand the context and identify key drivers of vaccine wastage

Cross-sectional surveys with EPI staff at health facilities, vaccine stores and warehouses.

In-depth interviews with EPI staff at health facilities, vaccine stores and warehouses; stakeholder workshops with EPI staff.

Provide recommendations to improve wastage monitoring and data use

Synthesis of learnings from the study

Site and vaccine selection

Study site selection

	Ghana		Mozambique		Pakistan	
	Total	Sample	Total	Sample	Total	Sample
National vaccine warehouse	1	1	1	1	1	1
Regional vaccine warehouses	16	14	11	10	8	2
District vaccine stores	260	24	162	23	153	4
Service delivery points	8,924	48	1,611	46	7,858	46

Study vaccine selection

	Vaccine presentation	Preservative?	Route of administration	Number of doses per vaccine vial		
				GH	MZ	PK
Pentavalent	Liquid	Yes	Injection	10	10	1
Pneumococcal conjugate	Liquid	Yes	Injection	4	4	4
Rotavirus	Liquid	No	Oral	5	1	1
Measles rubella	Dry	No	Injection	10	10	10

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Photo: Richard Franco

Selected findings from the Ghana vaccine wastage study

Retrospective analysis: Background on eHIS and vaccines in the routine EPI schedule – as of Feb 2020

- The WHO Stock Management Tool (SMT) is used for documenting vaccine transactions at the national level.
- The District Health Information Management System 2 (DHIMS2) is used for reporting at subnational levels (regions, districts, and health facilities).
- Period for the data extraction from these secondary sources:
  - Service delivery levels: March 2019 to February 2020 (1 year)
  - District vaccine stores and regional and central warehouses: March 2017 to February 2020 (3 years)

Vaccine	Presentation	Doses per vial	Doses in schedule
BCG	Lyophilized	20	1
PCV	Liquid	4	3
DTP-HepB-Hib (pentavalent)	Liquid	10	3
Rotavirus‡	**Liquid**	**1**	**2**
OPV	Liquid	20	4
IPV	Liquid	10	1
MR	Lyophilized	10	2
RTS,S (malaria)*	Lyophilized	2	4
Yellow fever	Lyophilized	10	1
MenA	Lyophilized	10	1
Td (15- to 49-year-old women)	Liquid	10	2

‡ Now changed to 5-dose vial with 3 doses in the schedule
*Pilot vaccine offered in selected districts.

Retrospective study: wastage related data availability and completeness in DHIMS - as of February 2020

Data available:

- Start balance
- Doses received
- Doses distributed (vaccine stores only)
- Doses wasted due to
  - Expiry
  - Heat/VVM indication
  - Other losses
- Number of children vaccinated
- End balance

Data not available:

- Reasons for closed-vial wastage:
  - Freezing
  - Breakage
  - Damaged labels
  - Missing inventory
- Total open doses wasted

Data completeness:

- Data on the indicators of interest were generally **incomplete**.
- In general, there was **not much variability in data completeness by vaccine**.
- **Data on closed-vial wastage was incomplete**, but it is impossible to distinguish non-occurrence of events from zero reporting.
  - Zeros are not entered into DHIMS2 in order to keep file sizes manageable.
- Data on number of children vaccinated had relatively higher completeness than other variables at the SDPs.
- We found **no seasonal variation in completeness** during our analysis period (using PCV as the proxy vaccine for this analysis).

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Retrospective study: Calculated wastage rates

Closed-vial wastage rates at vaccine storage levels – for the period March 2017 to February 2020

- For the regional and district vaccine stores, vaccine expiration was the largest cause of closed-vial wastage while missing inventory was the main cause at the national level.
- The proportional wastage in closed vials has been <1% for most vaccines at all levels of the supply chain in 2019 and 2020.

Vaccine wastage at service delivery points –for the period Mar 2019 to Feb 2020

- DHIMS2 calculates open-vial wastage rates at SDPs, so the uncleaned data show the estimates included in the database.
- Using uncleaned DHIMS data to estimate open-vial wastage rates would result in an underestimate, given that most of the inconsistencies were with negative wastage rates.
- Reconstituted vaccines in multidose vials, such as MR, yellow fever, and MenA, had relatively higher open-vial wastage rates than liquid vaccines with preservatives.
- Annual proportional vaccine wastage rates in closed vials is very low at SDPs (<1%) for the period March 2019 to February 2020.

	Using the data as is in the DHIMS - uncleaned	Using only data that are consistent for an average of 5,818 facilities (range 5,523 to 6,110 facilities per month)
	Average open-vial wastage rates	Average open-vial wastage rates
BCG	58%	60%
PCV	–0.52%	10%
Pentavalent	11%	18%
Rotavirus (single dose)	0.28%	3%
OPV	16%	26%
IPV	31%	35%
MR	23%	28%
Yellow fever	38%	41%
MenA	40%	43%
Td	22%	35%

Prospective data collection (Feb to Apr 2021)

Closed-vial wastage

- National level: No closed vial wastage was reported.
- Regional vaccine warehouses: Closed vial wastage due to damaged labels occurred only for yellow fever vaccine and the wastage rate was <1%.
- District vaccine stores: some closed vial wastage occurred with missing inventory and vial breakage being the main causes. Monthly proportional vaccine wastage rates in closed vials was less than 1% for all vaccines.
- SDPs: 10 of the 48 SDPs experienced at least one incidence of closed-vial wastage, with the main cause being vaccine expiration, and other causes being heat exposure, damaged labels, missing inventory, vial breakage and freezing.
- Closed vial wastage rates were <1% for PCV, rotavirus and yellow fever vaccines but were slightly greater than 1% for pentavalent (1.3%) and PCV (1.1%).

Open-vial wastage

- Open vial wastage rates for vaccines with preservatives are lower than for vaccines without preservative.
- The wastage rate for rotavirus vaccine is relatively high given that remaining doses in open vials are discarded within 6 hours of opening .
- Wastage of MR vaccine, which has a two-dose schedule, is lower than yellow fever vaccine with a one-dose schedule and thus more doses in the schedule reduce wastage rates.

	Penta	PCV	Rota	MR	Yellow fever
Mean open-vial wastage at SDPs in the sample	3%	2%	19%	31%	45%
Median (range)	0% (0%, 26%)	0% (0%, 17%)	14% (1%, 62%)	30% (3%, 73%)	46% (0%, 100%)

Selected context factors from cross-sectional surveys, learnings from IDIs and stakeholder meeting

- National and regional levels respondents all said that guidance to vaccinators prioritizes meeting coverage goals over reducing vaccine wastage: vials for any vaccine should be opened even if there is only one child present at a vaccination session.
- However, at district levels, not all respondents indicated that this is the guidance provided.
- SDP respondents said they wait to open a vial until more children are present, especially for vaccines without preservatives.
- Guidance on vaccine handling after vaccination sessions is consistent with WHO multi-dose vial policy.
- District level and SDPs: Supervision visits occur to lower-level facilities, but wastage rates are not always discussed at these visits.
- At SDPs, vaccination sessions are not conducted daily and vaccines without preservatives are generally not offered at every session, possibly to reduce open-vial vaccine wastage;
- 14 of the 48 SDPs in the sample did not have refrigerators for storing vaccines, potentially increasing open vial wastage rates because of the failure to store remaining doses in opened vials of eligible doses beyond the end of the session.
- Across all subnational levels: Knowledge questions and stakeholder meeting discussions indicated a desire for more training on monitoring vaccine wastage, and a majority find it challenging to keep vaccine wastage low while also trying to keep coverage high.

Selected recommendations to Ghana Health Service

- Consider updating reporting forms and systems to include all causes of wastage as this would help to better understand vaccine wastage.
- Consider data entry methods in DHMIS2 that can differentiate non-occurrence from missing data while keeping the electronic file sizes manageable.
- Include built-in consistency checks into the DHIMS2.
- Add cold chain equipment to health facilities that currently do not have any, enabling implementation of the MDVP to reduce vaccine wastage.
- Enhance training, sensitization, and supportive supervision of staff to improve transparency and trust around reporting with common goal to reduce wastage.
- Consider reducing the number of doses per vial vaccines without preservatives.

Ghana study team and acknowledgements

Ghana study team:

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Gavi Wastage Study Mozambique

Key Findings

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Retrospective Data Collection

No single routine information system in Mozambique has all data needed to calculate open- and closed-vial wastage rates so we relied on two sources: **Sistema Eletrónico de Logística de Vacinas (SELV)** & **Sistema de Informação de Saúde para Monitoria e Avaliação (SIS-MA)**

		Available	Not Available
SELV	Start Balance	✓	
SELV	Existing Balance	✓	
SELV	Vials Received	✓	
SELV	Total # of Unopened Vials Wasted	✓	
SIS-MA	Total # of Opened Vials at SDP	✓	
SIS-MA	Total # of Children Vaccinated	✓	
SIS-MA	End Balance	✓	
NONE	Vials Distributed (Warehouse)		✗
NONE	Reasons for Closed Vial Wastage		✗
NONE	Total # of Doses Administered		✗
NONE	Outreach Data		✗

Data Completeness

- **Overall:** completeness varied widely by variable but ultimately some significant gaps in the data
- **Lowest completeness:** unopened vials wasted
- **Highest completeness:** doses received
- **Completeness by vaccine:** little variation
- No seasonal variation in completeness observed

Retrospective Findings:
Open-Vial Wastage Rates (Mar 2019-Feb 2020)

Open-vial wastage rates at service delivery points

	Using the data as is in SIS-MA – uncleaned	Using only data that are consistent from SIS-MA
Vaccine	Mean (standard deviation)	Mean (standard deviation)
BCG	**56%** (29)	**57%** (28)
PCV	**4%** (231)	**12%** (19)
Pentavalent	**5%** (94)	**8%** (13)
Rotavirus (single dose)	**–15%** (718)	**1%** (5)
MR	**27%** (74)	**33%** (24)

Was there variation **by vaccine?**

YES: wide variation by vaccine (range from 1%-57%)

Vaccines with more doses per vial were the highest; rotavirus was the lowest (one dose per vial)

Was there variation **between urban and rural areas?**

MINIMAL: variation between urban and rural areas was minimal

Was there variation **by province?**

YES: variation by province was notable

Note: PCV came in two presentations during the study period (2-dose vial and 4-dose vial)

Retrospective Findings: Closed-Vial Wastage Rates

Period	BCG	Penta	IPV	PCV 13	bOPV 10	Rota	Measles	MR
	Service delivery points							
2019 *	0.07%	0.08%	0.17%	0.05%	0.65%	0.07%	0.36%	0.18%
2020 **	0.35%	0.1%	0.1%	0.17%	0%	0.02%	0.27%	0.04%
	District vaccine warehouses							
2017 *	NA	NA	NA	NA	NA	NA	NA	NA
2018 ***	0%	NA	0.38%	NA	NA	NA	0%	NA
2019 ***	0%	0%	0%	0%	0%	0%	0.19%	0.17%
2020 **	0.03%	0%	0%	0%	NA	0%	0%	0.02%
	Regional vaccine warehouses							
2017 *	NA	NA	NA	NA	NA	NA	NA	NA
2018 ***	NA	NA	NA	NA	NA	NA	NA	NA
2019 ***	0%	0.04%	0.29%	0%	0%	0%	4.9%	0.59%
2020 **	0%	0%	0%	0%	NA	0%	0%	0%
	National vaccine warehouse							
2017 *	NA	NA	NA	NA	NA	NA	NA	NA
2018 ***	NA	NA	NA	NA	NA	NA	NA	NA
2019 ***	0%	0%	0%	0%	0%	0%	0%	0%
2020 **	NA	NA	NA	NA	NA	NA	NA	NA

Data Source/Quality

Data for SDPs comes from SIS-MA, and data for vaccine warehouses comes from SELV

Significant missing data

Findings

Closed-vial wastage was generally <1% across all vaccines and all levels of the supply chain

* Mar-Dec
** Jan-Mar
*** Jan-Dec

Prospective Findings: Open- & Closed-Vial Wastage

		Average Monthly **Open Vial** Wastage Rates					Proportionate **Closed Vial** Wastage Rates				
Level	Vaccine	Penta	PCV	Rota	MR	BCG	Penta	PCV	Rota	MR	BCG
Service Delivery Points* (n=36)	Mean (SD)	0.13% (0.54)	0.11% (0.50)	0.08% (0.37)	33.15% (16.36)	51.92% (26.08)	3.61% (17.20)	0.99% (4.14)	1.32% (5.3)	0.20% (0.75)	0.07% (0.40)
	Median (range)	0.00% (0.00, 3.08)	0.00% (0, 2.78)	0% (0, 2.11)	31.55% (0, 67.81)	56.72% (0, 89.99)	0% (0, 100)	0% (0, 21.51)	0% (0, 31.37)	0% (0, 3.40)	0% (0, 2.42)
District Warehouses** (n=17)	Mean (SD)						0.03%	0%	0%	0%	0.02%
	Median (range)										
Provincial Warehouses** (n=10)	Mean (SD)						0%	0%	0%	0%	0%
	Median (range)										

*Data collection: March-May 2021; **Data collection: March-April 2021

large variation by vaccine type, with greatest wastage rates for vaccines in multi-dose vials without preservatives

largely driven by loss of significant quantities at a small number of facilities

cold damage or “other” damage were most common closed-vial wastage reasons at SDPs

Select Context Factors

From cross-sectional survey, in-depth interviews and stakeholder workshops

CLOSED VIAL WASTAGE

Closed-vial wastage perceived as rare

Routine practices largely in place for monitoring cold chain, storing, and dispensing vaccine

Cold chain capacity and functionality generally sufficient with contingency plans in place

Measures are taken to minimize wastage during transport, but some challenges persist

National and some provincial & district warehouses indicated they do not report on vials lost because of breakage, expiration, damage

OPEN VIAL WASTAGE

Proper post-session vaccine management is generally well understood and practiced, with a few exceptions

Mobile brigades and community mobilization seen as important strategies to reduce open-vial wastage

General adherence to and support for policy to open multi-dose vials when a single child presents

RECORDING & REPORTING VACCINE USAGE & WASTAGE

Instruments for reporting present challenges

Many provincial (20%), district (35%), and SDP (30%) respondents and find recording wastage challenging

Large variations exist in strategy for recording and reporting waste and accuracy of reports is inconsistent

MONITORING, SUPERVISION & ASSESSMENT

Existing supervision and training resources are highly valued but are not meeting needs fully

Strong desire across provincial, district and SDP levels for more training on monitoring vaccine wastage

Wastage rates sometimes perceived to reflect on staff performance

Select Recommendations

1 Reporting

- Consider simplifying and streamlining recording forms, so that there is a tool available to capture the amount of wastage and to specify the causes on a routine basis
- Standardize the reporting process so that all facilities and warehouses are submitting the same reports at the same frequency and through the same system.

2 Supervision & Training

- Increase frequency of trainings and supervision related to wastage reporting to ensure forms are being used consistently and correctly.
- Encourage open discussion of wastage during supervision discussions to reduce pressure staff feel to prevent all wastage and to encourage accurate reporting.

3 Multi-Dose Vials

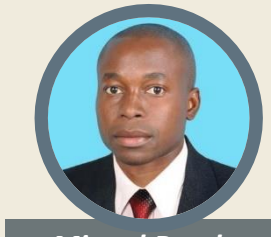
- Increase trainings to ensure all staff are aware of appropriate procedures for handling opened multi-dose vials.
- Explore options for smaller-dose vials for measles and BCG vaccines.

4 Cold Chain & Storage

- Equip district level warehouses with generators for use in case of power failure, in line with EPI policy.
- Ensure continued regular maintenance of CCE.
- Explore options to improve cold chain during transportation.

Mozambique Study Team & Acknowledgements


Felimone Amone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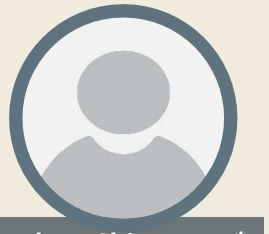
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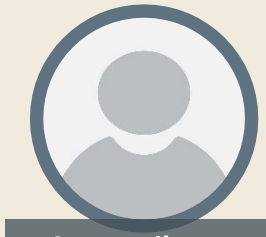
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Vaccine wastage study in Pakistan

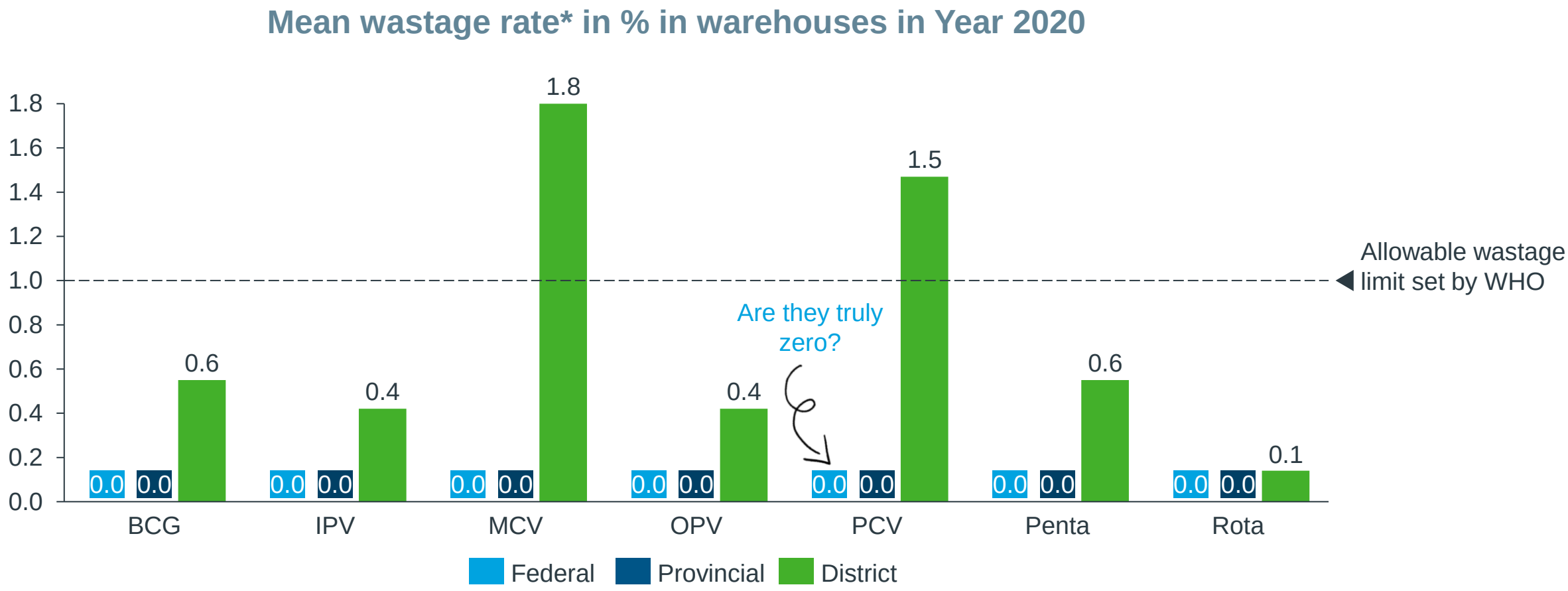
Country dissemination report

17 May 2022

Table of contents

Objective 1: Estimating open- and closed-vial vaccine wastage

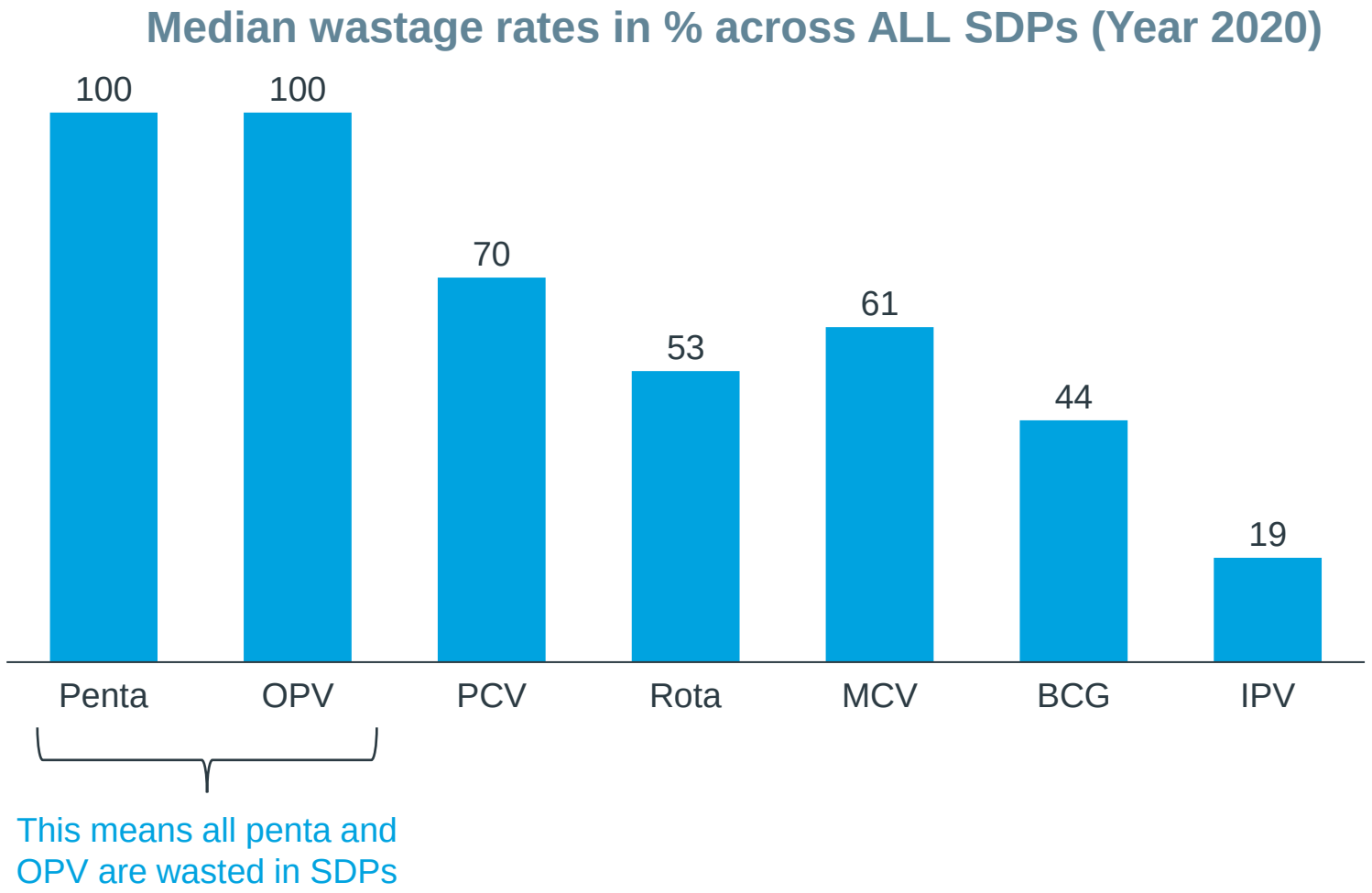
After cleaning the data from vLMIS, we found that almost all vaccine wastage rates in warehouses were below the allowable limit; results should be interpreted with caution



**Median wastage rate for all vaccines is 0.*

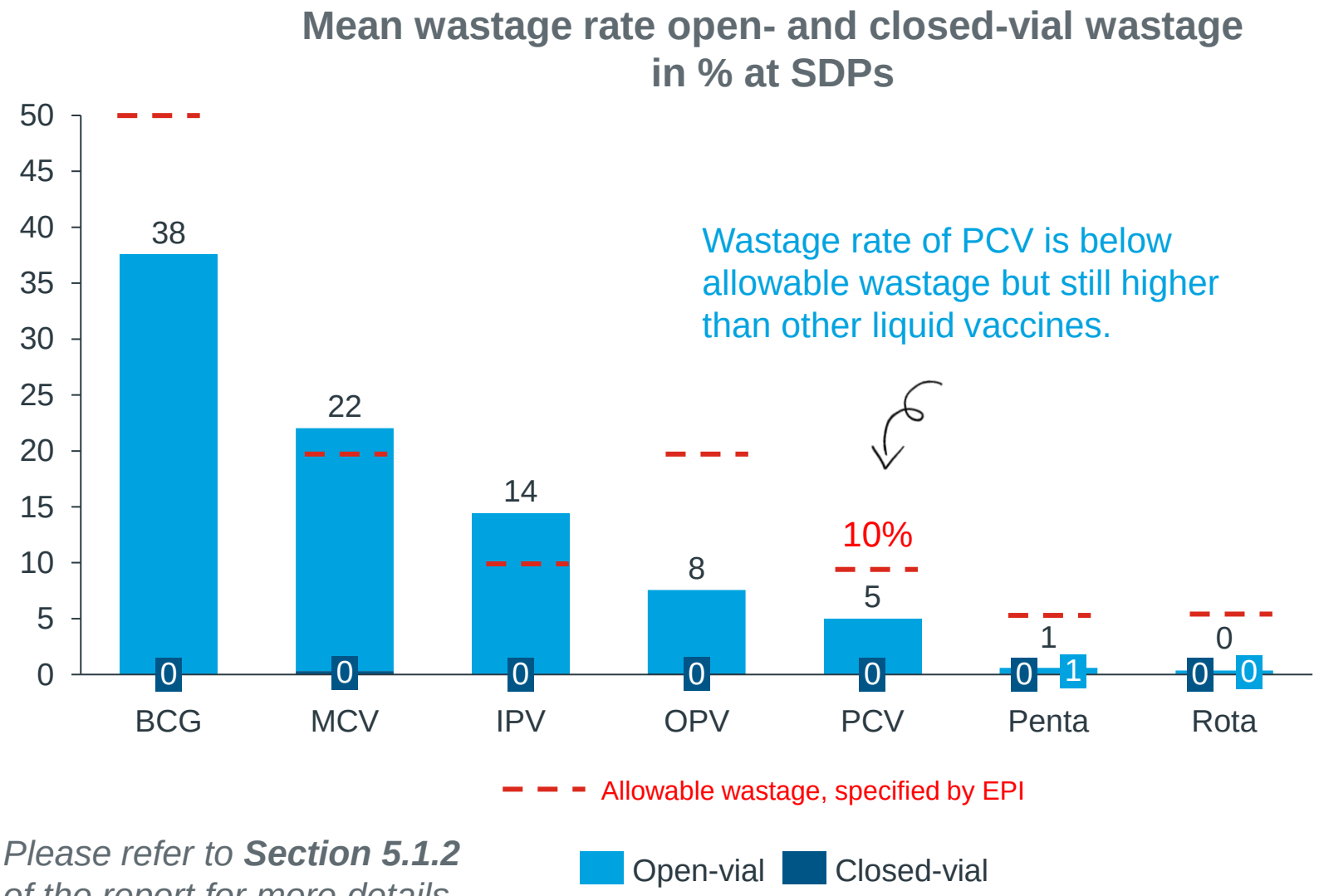
*Please refer to **Section 5.1.1** of the report for more details.*

Using clean data from vLMIS, we also found extremely high wastage rates for all vaccines across all SDPs



*Please refer to **Section 5.1.1** of the report for more details.*

We found more realistic wastage rates when we collected data from the field for 3 months



- Open-vial is the biggest driver of wastage
- Closed-vial wastage is <0.5% for all vaccines
- Wastage were around or within EPI allowable limits

*Please refer to **Section 5.1.2** of the report for more details.*

Recent PCV switches in Pakistan have not been updated on the EPI Vaccine Logistics manual

2019

PCV10 2-doses vial without preservatives
(EPI manual provides the right information of discarding the opened vial after 6 hours)

PCV10 4-doses vial with preservatives
(EPI manual currently providing the wrong information)

End 2020

PCV10 4-doses vial

PCV13 4-doses vial
**for which the EPI manual was also not updated*

Fixed sessions: keep open vials up to 28 days after opening
Outreach sessions: discard open vials within six hours after opening or at the end of the outreach sessions

Fixed and outreach sessions: keep open vials up to 28 days after opening

Issues with EPI Manual

1. EPI's online version of Vaccine Logistics Manual is not aligned with the latest country policy, nor with WHO/UNICEF recommendations, yet logisticians and vaccinators across the country are still accessing it
2. EPI Manual does not have a date/ version control

Our recommendations

1. Review and update the EPI Manual regularly whenever there are changes made in the policy
2. Further training required at health facility level

We found some learnings from field data collection that may help improve the data quality in vLMIS

Our recommendations

Require more detailed information in routine forms

- Disaggregate reasons for closed-vial wastage instead of categorizing them as “unusable” (e.g., breakage, freezing, VVM, expiry)
- Differentiate wastage rate between open- and closed-vial wastage

Educate health workers and technicians

- Educate health workers about the key definitions used as part of the vLMIS training
- Develop supplementary vLMIS reference manual (guidance document) with the key definitions of variables
- Instil regularity of reporting critical data pertaining to wastage

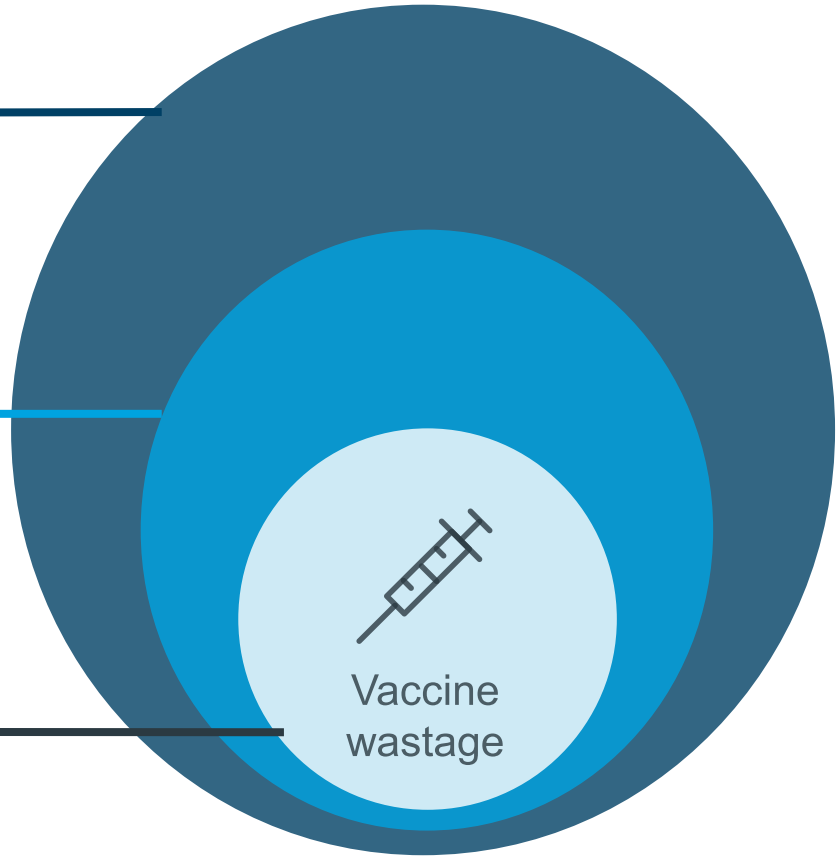
More checks and follow-ups with health workers and technicians

- Closer follow-ups visits with the workers by the supervisors / EPI
- For supervisors, use a checklist to identify common data issues

Objective 2: Understanding the drivers of vaccine wastage

Based on our interviews with SDP staff, we recommend the following strategies to address the high open-vial wastage

Recommendations	Policy drivers	Organization drivers	SDP staff drivers
1. Size of multi-dose vials based on type of sessions and area	• Wastage targets are not contextualized (e.g., impossible to keep wastage rates low in rural areas) • Inappropriate vial sizes for outreach sessions or remote areas		
2. Performance assessment to include coverage and wastage, tailored to district's characteristics and type of sessions		• Inadequate training on vaccine wastage from higher-levels • Assessing performance based on coverage only (excluding wastage)	
3a. More training, and if possible, by the same trainers 3b. Regular discussion on wastage during supervision meetings			• Do not know how to prepare MDV • Do not know how to store MDV after opening • Do not know how long all open vials should be kept • Not finding it important to discuss no. of discarded vials during supervision meetings • Opening BCG and MCV when only one child is present • Inappropriate management of unused doses in open vials (e.g., open PCV is not returned to refrigerators after sessions)



*Please refer to **Section 6** of the report for more details.*

We recommend the following solutions to address closed-vial wastage

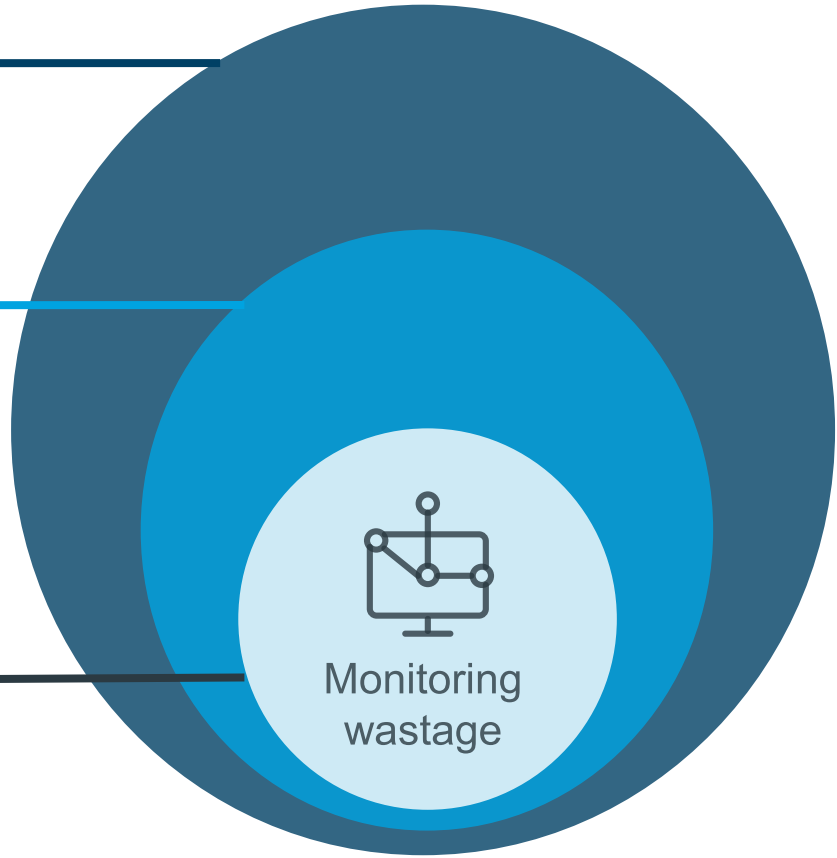
Drivers of closed vial wastage		Our recommendations
Gap 1: Indications that the supply chain infrastructure for vaccines was weak	• Participants highlighted a lack of maintenance of cold chain equipment, lack of spare parts for their equipment, and lack of proper transportation facilities to distribute the vaccines to SDPs as examples.	• Strengthen vaccine supply chain infrastructure.
Gap 2: Staff's ability to carry out corrective actions were hampered	• Although staff were aware of what they should do, their ability to carry out corrective actions were hampered and they had to improvise e.g. use bikes/ public transport. • Thus, there could be negative impacts on the quality of the vaccine if the infrastructure is not well-maintained.	• Increase maintenance and monitoring of the supply chain infrastructure.

- We note that there is high knowledge and compliance to minimize closed-vial wastage
- Most of the wastage might be accidental (e.g., vials broken during transportation or vaccination sessions, inadequate transport or extreme weather conditions)

Objective 3: Gaps in monitoring wastage

We recommend the following strategies to address wastage monitoring gaps

Recommendations	Policy issues
1. State in the guidelines on what wastage-related information needs to be recorded	• Lack of guidance on recording of wastage
	Organization issues
2. a. Increase support staff b. Digitalize recording system (e.g., using auto-calculation) c. Set up a team to check on compliance d. Increase compensation?	• Lack of proper forms and system for monitoring • Excessive forms on vaccine use • Lack of reliable monitoring system and checking
	SDP staff issues
3. a. Add a section on wastage and its reasons in the record forms or monthly report b. Provide training on monitoring wastage	• Do not view monitoring wastage as important



*Please refer to **Section 7** of the report for more details.*

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Summary of the cross-country analysis

Recap: vaccine wastage at SDPs in the three study countries

Closed-vial wastage

- Across all three countries, 17% to 50% of SDPs in the sample experienced at least one incident of closed-vial wastage during the prospective period.
- The closed-vial wastage rate for some vaccines was above the standard assumption of <1%.

Open-vial wastage

- As mentioned, open-vial wastage rates for vaccines with preservatives are lower than for vaccines without preservatives.
- The wastage rate for rotavirus vaccine is higher for Ghana because of the multi-dose presentation and the inability to keep remaining doses after 6 hours of opening – Mozambique and Pakistan are using a single dose presentation for this vaccine.
- In Pakistan, as mentioned, wastage rate for PCV is higher than in the other two countries as remaining doses in open vials were being discarded after outreach sessions.
- MR vaccine has the highest wastage rates across the three countries.

		Ghana	Mozambique	Pakistan
Penta	Open-vial (mean)	3%	0.1%	0.5%
	Closed-vial (mean)	**1.3%**	**3.6%**	0.1%
PCV	Open-vial (mean)	2%	0.11%	**5%**
	Closed-vial (mean)	**1.1%**	**1%**	0%
Rota	Open-vial (mean)	**19%**	0.1%	0.3%
	Closed-vial (mean)	0.3%	**1.3%**	0.04%
MR	Open-vial (mean)	**31%**	**33%**	**22%**
	Closed-vial (mean)	0.1%	0.2%	0.3%

PATH

Summary of other findings across the study countries (1)

- From the analysis of the retrospective data in eHIS – as of February 2020:
  - Data on the indicators of interest to estimate open and closed vial wastage were generally incomplete across all levels of the health system in the three countries.
  - Quality of eHIS data for Pakistan was particularly poor as shown in the abnormally high open-vial wastage rates calculated.
- Closed-vial wastage is occurring at each level of the supply chain, including at SDPs, but rates are low. However, when these events leading to closed vial wastage occur, they can lead to a relatively large loss of the stock at the affected facility.
- We identified some known drivers of open-vial vaccine wastage and also found that newer vaccines may have higher open-vial vaccine wastage.
- The MDVP is now being implemented correctly at most SDPs in the study countries, though at the time of the prospective data collection, it was not being implemented correctly in Pakistan for PCV vials taken for outreach sessions.
- Across the three countries, there is evidence of the tradeoffs between meeting coverage versus wastage goals; hence vaccinators sometimes deviate from the national guidance of opening a multi-dose vial when only one child is present.
  - Vaccines without preservatives tended also not to be offered at all vaccination sessions.
- Estimated open-vial wastage rates from the prospective analyses across the three countries were lower than those generated by the WHO wastage rates calculator.

Summary of other findings across the study countries (2)

- There are gaps in the cold chain system across countries:
  - Cold chain equipment at vaccine storage facilities are not available at all SDPs, especially in Ghana.
  - In Pakistan cold chain maintenance was reported as not routinely done.
  - These gaps in the cold chain system could increase open-vial wastage or necessitate workaround by facility staff to reduce vaccine wastage.
- There is a desire for more training on vaccine wastage at all levels of the health system in all three countries.
- Supervision visits occur to lower-level facilities, but wastage rates are not always discussed at these meetings.
  - These supervision visits may provide an opportunity for on-the-job training around monitoring vaccine wastage.

Identification of statistical drivers of vaccine wastage for MR vaccine

- We pooled the data from the three countries and cross-tabulated subgroups of the variables from the cross-sectional survey with the closed and open-wastage rates estimated from the prospective data.
  - The analysis was done separately for each vaccine and aimed to test if there was a statistical difference in the wastage rates between subgroups of each variable. A non-parametric test (Mann-Whitney U test) was used.
  - Variables that were statistically significant at the 20% level were included as independent variables in the linear regression analysis.
- Regression results indicated a few statistically significant variables for MR vaccine open-vial wastage rate:
  - SDPs serving catchment sizes in the first quartile had higher wastage rates compared to those serving population sizes in other quartiles.
  - Wastage rates were statistically lower at SDPs where respondents said that they wait for more than one child to be present before opening a vial.
  - However, the wastage rates were higher at SDPs where they said MR vaccine was not offered at all fixed sessions.
- Similar analyses were done for closed-vial wastage rates, but the regression models had poor fit given these wastage rates were low or zero. Most variables were not statistically significant in these regressions.

Independent variables	Coefficient	p-value (p>|t|)
Constant	**0.26**	0.002
Rural	0.03	0.54
Facilities with EPI target population below 1st quartile	**0.11**	0.005
Facilities holding >0 but ≤4 fixed sessions per month	0.07	0.16
Facilities holding >0 but ≤4 outreach sessions per month	-0.01	0.78
Facilities waiting for more than one child to be present before opening a vial of [vaccine] at fixed sessions	**-0.09**	0.05
Vaccine not offered at all fixed sessions	**0.09**	0.07
Facilities with refrigerators for storing vaccines	-0.05	0.31
Agreed: I find it challenging to consistently record open-vial vaccine wastage	0.06	0.12
Agreed: I find it challenging to keep to the target wastage rate	0.007	0.84

Adjusted R^2=17%;
Key: bold is where P>|t| is less than or equal to 10% and hence 20% for two-tailed test.

Study limitations

- The onset of the COVID-19 global pandemic right before data collection was scheduled to begin created a large disruption for the conduct of this study and delayed study timelines.
- The collection of the three-month prospective data proved to be challenging as daily reporting of vaccine usage and wastage was not part of the regular routine for many health workers.
- Prospective data were collected over a three-month period due to budget constraints. Thus, the wastage rate estimates generated may not be representative of the annual wastage rates if there are seasonal variations in these rates.
- The study did not seek to evaluate the impact of the pandemic on vaccine wastage rates, though the most likely direct impact would be on open-vial wastage and less on closed-vial wastage. It is possible that open-vial wastage rates are underestimated in this study as vaccination session sizes could have increased due to catch-up vaccinations after the COVID-19 waves had subsided. However, it is also possible that wastage rates were overestimated due to vaccine hesitancy and lower session sizes.
- Research sites were selected using random sampling by the EVM sampling methodology but still we have relatively small sample sizes compared with the number of SDPs in the country, therefore our results may not be robust or statistically conclusive.

Recommendations to the global stakeholders

1

Provide updated guidance to countries on which variables to monitor for vaccine wastage

2

Continue efforts to change vaccine packaging, change presentations and or vial sizes which can reduce vaccine wastage

3

Validate vaccine wastage estimation tools such as the WHO wastage rates calculator using country level data

4

Continue to make functional cold chain equipment available at SDPs through CCEOP and other mechanisms and encourage consistent equipment maintenance

Thank you!

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