Article One

Evaluation of measles and acute flaccid paralysis surveillance systems in Southern Province, Zambia, 2022 - 2024

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Abstract

Background: The Vaccine-Preventable Disease (VPD) surveillance system in Zambia integrates routine immunization monitoring with disease surveillance to guide control measures. In 2022, Zambia recorded 422 measles cases and 37 deaths, with Southern Province recording the highest case fatality rate (11.2%), suggesting possible weaknesses in surveillance performance and outbreak response systems. This evaluation assessed the measles and acute flaccid paralysis (AFP) surveillance systems in Southern province of Zambia from 2022 to 2024.

Methods: We conducted a cross-sectional surveillance system evaluation following the Centers for Disease Control and Prevention (CDC) guidelines. We purposively selected three districts and three facilities from each district, based on measles and AFP case burden and vaccination coverage. We collected data on system's simplicity, usefulness, and acceptability from 27 participants using structured questionnaires. We also collected data from the electronic Integrated Disease Surveillance and Response (eIDSR) system and World Health Organization databases to assess, data completeness, timeliness, and accuracy. Results were summarized using frequencies and percentages.

Results: The measles and AFP surveillance systems comprised both passive and active surveillance operating across community, health facility, district, and provincial levels. The systems demonstrated high levels of simplicity (mean score: 84.6%), usefulness (90.5%), and acceptability (90.8%). However, surveillance performance was limited by suboptimal data quality, with mean completeness of 66.7%, timeliness of 51.1%, and data accuracy of 50%. We also identified key operational challenges of inadequate specimen transportation and insufficient program funding.

Conclusion: The measles and AFP surveillance systems in Southern Province are functional, simple, acceptable, and well-integrated into routine services. However, significant gaps in data quality limit their effectiveness for early outbreak detection and timely public health response. Strengthening data management, specimen transport, and sustainable program financing will be critical to improving surveillance performance and accelerating progress toward vaccine-preventable disease control and elimination targets.

Keywords: Acute Flaccid Paralysis (AFP), measles, surveillance systems, vaccine-preventable disease, Zambia.

Introduction

Vaccine-preventable diseases (VPDs) remain a major cause of morbidity and mortality, particularly among children under five years, despite reductions in disease burden through immunization (1). Globally, an estimated 14.5 million infants remained zero-dose in 2023, while the World Health Organization (WHO) African Region continues to experience recurrent outbreaks of measles and circulating vaccine-derived poliovirus (cVDPV), largely driven by declining immunization coverage and disruptions following the COVID-19 pandemic (2–4).

Comprehensive VPD surveillance integrates country, regional, and global systems to meet WHO standards (5). In Zambia, VPD surveillance was historically embedded within the Health Management Information System, focusing on measles and acute flaccid paralysis (AFP) surveillance for polio to enable rapid outbreak response (6,7). Its purpose has since evolved to include monitoring immunization performance, including identifying zero-dose children, evaluating interventions, and informing vaccination strategies and policy (7,8).

In Zambia, routine immunization coverage declined from 75% (2018) to 65% (2024), fueling recurrent outbreaks (9,10). In 2022, the country reported 422 measles cases and 37 deaths, while circulating vaccine-derived poliovirus type 2 (cVDPV2) continued to be detected through environmental surveillance (11,12). Southern Province recorded the highest measles case fatality rate (11.2%) (11). These outbreaks suggest weaknesses in surveillance that may delay case detection and response. Although surveillance system evaluations have been conducted in several African countries, evidence from Zambia, particularly at the subnational level, remains limited. We therefore evaluated the measles and AFP surveillance systems in Southern Province to assess their performance and identify strengths, gaps, and opportunities for improvement.

Methods

Study Design Setting

A descriptive, cross-sectional evaluation of surveillance system attributes was conducted in February 2026 using the CDC surveillance system evaluation approach for Field Epidemiology Training Program (FETP) to obtain contextual and in-depth explanations to the observed performance indicators (13,14).

Study site and setting

Southern Province is one of Zambia's ten provinces, with a projected total population of 2,804,849 people and bordering two countries; Zimbabwe and Botswana. Both AFP and measles case-based surveillance is implemented across all 15 districts (7,15). The fully immunized under 1 and under 2 coverages in Southern Province in 2024 were 80% and 66%, respectively (16).

Study population and sampling techniques

A multi-stage stratified purposive sampling was used to select three districts (Choma, Pemba, Siavonga), and three facilities from each district. This selection was done to represent varying disease burden and surveillance performance levels, including vaccination coverage. Participants included surveillance focal persons and clinical staff per facility (27 total), plus district surveillance officers.

Data Collection

Data for this evaluation were collected using quantitative methods. This involved extraction of measles and AFP data from the registers, case investigation forms, Notification of disease form 2 (ND2) reports and Integrated Disease Surveillance and Response (IDSR) reports to obtain report timeliness, data completeness and accuracy. Data on the demographic variables (age, sex and residence), date of symptom onset, vaccination status (for measles), and stool collection dates (for AFP) were collected to check data completeness. Additional data were collected from the facility staff using structured questionnaires, with a 5-point Likert-scale. Similarly, supplemental observations of facility surveillance operations and practices, documents and walls were made.

Data analysis

Data were analysed using quantitative methods. Surveillance data from District Health Information System-2 (DHIS2)/electronic-IDSR were used to assess completeness (measured as proportion of expected reports submitted, and completed case investigation forms), timeliness (number of reports submitted meeting weekly deadlines; measles 48hr investigation, 72-hr specimen transit time, 7-day results turnaround time; AFP: 7-day notification, 48hr investigation, and stool adequacy). Accuracy was calculated as percentage agreement between source documents and eIDSR records. Simplicity, usefulness, and acceptability were evaluated using with weighted mean Likert-scale scores. Analyses were conducted using R version 4.6.0 (R Foundation for Statistical Computing, Vienna, Austria). Findings from structured observations and checklist assessments were summarized descriptively to document surveillance processes, available resources, operational challenges, and inform recommendations for strengthening the surveillance system.

Ethical considerations

Written consent was obtained from the Provincial Health Director, and verbal permission from participants. Data were de-identified. The evaluation was conducted as part of routine public health surveillance system assessment. Formal letter of introduction from the Director General ZNPHI was provided.

Results

Description of participants

From the twenty-seven (27) facility participants, the mean age (SD) was 35.7 years (6.0) (Table 1). The majority were female (55.6%) and Registered Nurses (40.7%), who are more clinical oriented than surveillance. The majority of facilities included were rural health centres (88.9%).

Table 1: Characteristics of study participants (N = 27) from 3 facilities in Choma, Pemba, Siavonga districts in 2026

Characteristics	Number (%)
Age in years [Mean (SD*)]	35.7 (6.0)
Gender	
Male	12 (44.4)
Female	15 (55.6)
Position	
Registered Nurse/Midwife	11 (40.7)
Clinical Officer (General)	3 (11.1)
Environmental Health Technologist	10 (37.0)
Public Health Nurse	1 (3.7)
Laboratory Technologist	1 (3.7)
Community Health Assistant	1 (3.7)
Experience in surveillance [Median years (IQR)]	4 (2,8)
Level of facility	
Health Post	3 (11.1)
Health Centre	24 (88.9)

*SD – Standard Deviation; †IQR – Inter-quartile Range

Description of the Surveillance system structure for Measles and AFP in Southern Province

The Measles and AFP surveillance systems in Southern Province have similar workflow, and are integrated in the routine health service delivery, utilizing the same staff at all levels. They are mixed (both active and passive), starting from lower community levels leading up to the Provincial level, which links up to the National level (Figure1).

Community Level

At community level, the community-based volunteers (CBVs) gather surveillance data from the community through event-based surveillance (EBS) and report to the health facility, where the surveillance focal person makes follow up on these events for confirmation. The CBVs send alerts through phone calls, and submit weekly reports to the facility surveillance focal point person.

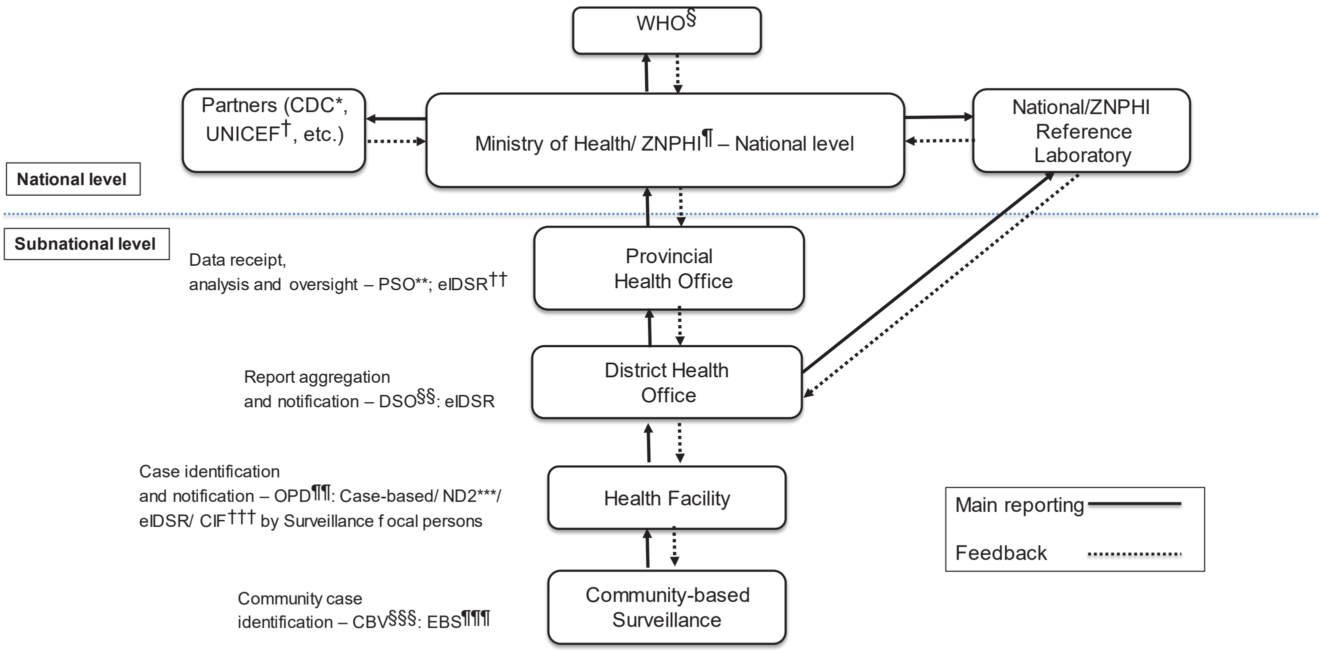

Figure 1: Flow Diagram of the VPD surveillance systems reporting and feedback structure in Southern Province.

*CDC – Centres for Disease Control and Prevention; †UNICEF – United Nations International Children's Fund; §WHO – World Health Organization; ¶ZNPHI – Zambia National Public Health Institute; **PSO – Provincial Surveillance Officer; ††eIDSR – electronic Integrated Disease Surveillance and Response; §§DSO – District Surveillance Officer; ¶¶OPD – Out-patient department; ***ND2 – Notifiable disease form 2; †††CIF – Case investigation form; §§§CBV – Community-based volunteer; ¶¶¶EBS – Event based surveillance

Facility Level

At health facilities, clinicians screen patients and record suspected cases in Outpatient department (OPD)/ In-patient department (IPD) registers. Surveillance focal persons immediately enter data into eIDSR. Case investigation forms guide measles/AFP investigation, and samples are collected from suspected cases. Measles samples are transported by the district laboratory to Lusaka, while AFP samples are handled by Environmental Health Technologists (EHTs). Notifications are made via phone text/WhatsApp to district surveillance officers, supported by weekly ND2 reports which are entered into eIDSR. Before 2024, facilities sent scanned ND2 reports via WhatsApp.

All the health facilities visited had at least one qualified staff who was trained or oriented in measles and AFP surveillance, and all the facilities have Measles and AFP case definitions stuck on walls in the OPD, but the surveillance system flow charts were seen only in a few facilities. Similarly, all sampled health facilities had copies of IDSR (physical or electronic). All staff at facilities were involved in the surveillance system at one or more steps of the cycle.

District and Provincial Levels

The district surveillance officer was responsible for aggregation of the situation reports and sending them to the provincial surveillance officer for onward submission to the National level. Currently, facilities are able to enter the weekly reports directly into the electronic IDSR, which are viewed and accessed by the district, provincial and National levels.

IDSR Reporting Performance

Siavonga was the least performing district with an average weekly reporting rate and timeliness of 67.8% and 61%, respectively. Majority of the districts were above 80% reporting rate and timeliness, with a provincial average of 91.5% completeness and 81.7% timeliness (Figure 2).

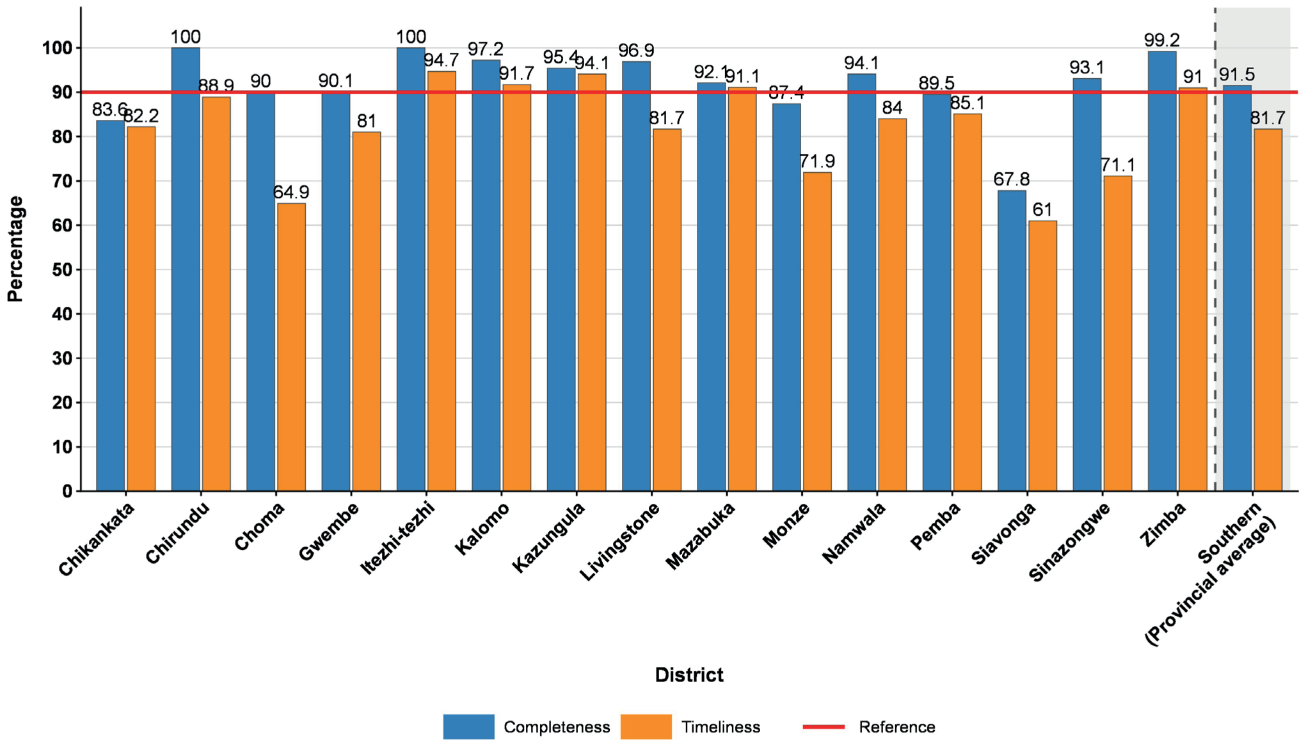

Figure 2: Completeness and timeliness of reporting by district in Southern Province, 2024.

Measles case detection timeliness, 2022 - 2024

Table 2 shows a summary of the provincial performance of measles case detection timeliness. The province performed poorly in case identification within 48hrs of onset of symptoms, averaging at 33%. Only 2 districts had reached at least 50% timeliness. This finding suggests delays in care-seeking or case detection especially at community level. Sample transportation timeliness to the reference laboratory was also low at 73%, with only 6 districts reaching over 80%. The results turnaround time at the reference laboratory was good, with nearly all districts receiving results within 7 days.

Table 2: Measles case detection summary for Southern province, 2022 – 2024

District	Case detection within 48hrs of onset of symptoms (%) (Target: 80%)	Sample transportation within 72hrs (%) (Target: 80%)	Results TAT within 7 days (%) (Target: 80%)	Overall timeliness (%) (Target: 80%)
Chikankata	25	75	100	75
Choma	35	97	97	100
Gwembe	0	67	100	100
Kalomo	55	64	90	81.8
Kazungula	31	69	81	81.3
Livingstone	22	56	100	66.7
Mazabuka	39	85	89	84.6
Monze	20	70	90	90
Namwala	38	86	88	95.2
Pemba	9	64	100	63.6
Siavonga	25	100	100	100
Sinazongwe	45	36	100	59.6
Itezhi-tezhi	10	86	86	95.2
Chirundu	32	65	71	67.1
Zimba	50	100	100	100
Provincial	**33**	**73**	**89**	**82**

Key:
Green: ≥ 80%
Yellow: 50 – 79%
Red: < 50%

AFP surveillance timeliness performance, 2022 - 2024

The sensitivity for AFP cases in the province, as depicted by the annualized non-Polio AFP rate had increased from 3/ 100,000 population in 2022 to 8/ 100,000 population in 2024 with all the districts being above 3/ 100,000 in 2024. In 2022, however, Pemba, Zimba, Itezhi-tezhi and Chirundu were silent. Stool adequacy, on the other hand, was noted to be the biggest challenge for the province, with majority of the districts being below 80% in all the 3 years, putting the provincial average at 61%, 72% and 80% in 2022, 2023 and 2024, respectively. However, the provincial picture showed a steady increase in performance over the years under review. The province had performed well in timeliness of case notifications, at 97% in 2022, before dropping to 70% in 2024. Table 3 gives a performance summary across all the districts.

Data Timeliness

The timeliness of both AFP and measles detection and notification were poor, with an average score of 45.2% (Tables 4 and 5). The majority of the districts in the province (60%) reported AFP cases after 7 days of onset of paralysis, and the majority did the investigation after 48 hours of notification.

Table 3: AFP surveillance and notification summary for Southern province, 2022 – 2024

District	2022				2023				2024			
	Annualized NP AFP rate/1,000 (Target: 3)	Stool adequacy (%) (Target: 80%)	Cases reported <=7 days onset of paralysis (%) (Target: 80%)	Investigated <=48 hours of notification (%) (Target: 80%)	Annualized NP AFP rate/1,000 (Target: 3)	Stool adequacy (%) (Target: 80%)	Cases reported <=7 days onset of paralysis (%) (Target: 80%)	Investigated <=48 hours of notification (%) (Target: 80%)	Annualized NP AFP rate/1,000 (Target: 3)	Stool adequacy (%) (Target: 80%)	Cases reported <=7 days onset of paralysis (%) (Target: 80%)	Investigated <=48 hours of notification (%) (Target: 80%)
Chikankanta	5	50	100	100	12	40	40	100	14	100	100	100
Choma	1	100	0	0	1	0	0	0	8	90	90	100
Gwembe	6	0	100	100	8	67	67	60	8	67	67	100
Kalomo	2	100	100	50	3	75	50	25	8	50	40	80
Kazungula	2	67	100	67	8	83	83	33	6	40	20	100
Livingstone	2	50	50	50	1	100	100	100	6	100	100	100
Mazabuka	3	67	100	100	11	69	38	69	4	100	75	100
Monze	3	50	25	25	1	100	50	50	5	67	50	100
Namwala	3	50	100	100	7	80	40	60	4	100	100	100
Pemba	0	0	0	0	6	100	67	33	22	91	91	100
Siavonga	27	75	0	25	7	0	0	100	3	0	0	100
Sinazongwe	3	50	100	100	8	67	67	83	10	100	88	100
Itezhi-tezhi	0	0	0	0	9	100	100	100	12	88	50	100
Chirundu	0	0	0	0	9	67	67	100	21	75	63	100
Zimba	0	0	0	0	4	100	50	100	4	50	50	100
Provincial	**3**	**61**	**60**	**55**	**5**	**72**	**55**	**68**	**8**	**80**	**70**	**98**

Key:

Data Completeness

A review of the records (case investigation forms, registers and ND1/ND2 reports) showed an above average data completeness at 66.7%. Majority (7/10) of the sampled case-based forms had missing fields, mostly on vaccination status (Tables 4 and 5).

Data Accuracy

For data accuracy, the case-based entries in registers which were compared with IDSR/ DHIS2 reports in the last 12 months, showed that the majority were not matching (75%) (Table 4).

Simplicity

The mean simplicity score was 84.6%, representing a generally easy to use surveillance system. All facilities had case definitions for both AFP and measles stuck on their walls in the OPD/ screening rooms. However, 78% reported a moderately considerable amount of time was spent analyzing, preparing and disseminating surveillance data and information (Table 4).

Usefulness

The mean score of systems' usefulness was 90.5%, with the majority finding the system very useful for early detection of outbreaks (83%), for monitoring disease trends over time (78%), and for identifying and monitoring high-risk and the under-immunized communities (56%). Nearly all participants (94%) reported that they had used surveillance data to inform public health action in the last 12 months, and most of them cited the utilization in mapping children for measles and Polio vaccination campaigns (Table 4).

Acceptability

Facility staff were mostly self-motivated and understand the importance of measles and AFP surveillance, despite no incentives being provided for such activities. With a mean score of 90.8%, surveillance for measles and AFP was generally acceptable among facility staff (Table 4).

Table 4: Summary of surveillance system attribute assessment findings from 3 facilities in Choma, Pemba, Siavonga districts between 2022 and 2024

Attribute	Positive Finding	Negative Finding
Usefulness		
Outbreak detection	94.4% very/extremely useful	5.6% not useful
Feedback mechanisms	94.5% very/extremely useful	5.6% moderately useful
Identification/monitoring high-risk communities	83.3% very/extremely useful	16.7% moderately/ not useful
Data used for public health action	94.4% yes	5.6% no
Simplicity		
Case definition/ identification of cases	94.4% easy	5.6% not easy
Completing forms	77.8% easy	22.2% not easy
Reporting flow	94.5% easy/very easy	5.6% very difficult
Time spent analyzing/ preparing data	88.9% moderate to little time	11.1 % too much time
Data completeness, timeliness and accuracy		
Completeness of case-based forms	30% above 90%	70% below 80%
Weekly report completeness	66.7% above 90%	6.7% below 80%
Monthly report completeness	86.7% above 90%	6.7% below 80%
Timeliness of weekly reports	33.3% above 90%	26.7% below 80%
Measles cases detected ≤48h	0% above 90%	100% below 80%
AFP cases reported ≤7 days	13.3% above 90%	60% below 80%
AFP records matching (ND2 vs IDSR)	25% matched	75% unmatched
Acceptability		
Value for routine work	83.3% extremely valuable	5.6% moderately valuable
Integration into routine workflow	83.3% fully integrated	16.7% partially
Reasonable addition to workload	61.1% yes	38.9% no
Motivation to participate	88.9% yes	11.1% no
Willingness to continue participating	100% yes	0% no

Table 5: Summary of surveillance performance attributes (N =27) from 3 facilities in Choma, Pemba, Siavonga districts between 2022 and 2024

Key

Attribute	Average Percent	Grade
Mean Usefulness score	90.5%	Very good
Mean Simplicity Score	84.6%	Good
Mean Data Completeness score	66.7%	Poor
Mean Timeliness score	51.1%	Poor
Mean Data Accuracy score	50%	Poor
Mean Data Quality score	55.9%	Poor
Mean Acceptability score	90.8%	Very good

Grading

S/N	Score (%)	Grade
1	90–100	Very good
2	70–89	Good
3	< 70	Poor

Overall system performance rating: 80.5% – Good

Discussion

This VPD surveillance system evaluation assessed the performance of the measles and Acute Flaccid Paralysis (AFP) surveillance systems in Southern Province, Zambia, from 2022 to 2024. Overall, the system demonstrated a number of strengths, including high acceptability among health workers, strong perceived usefulness, and relatively good reporting completeness. However, there were still a number of important gaps identified in data quality, timeliness of case detection and investigation, and operational resources.

The surveillance systems were found to be relatively simple and well-integrated into routine health service delivery. The case definitions were easy to understand and reporting tools easy to complete. Simplicity is critical for effective surveillance systems because complex reporting procedures often discourage timely reporting and reduce system participation (14). Similar findings have been reported in surveillance system evaluations conducted in Ghana and Nigeria, where standardized case definitions and integrated reporting systems improved usability among frontline health workers (17,18). However, a lot of participants reported spending a considerable amount of time analyzing and disseminating surveillance data, signaling a call for more improvements in digital reporting tools and connectivity to further streamline reporting processes and reduce the reporting burden on health workers.

Surveillance data had reportedly been used for public health action within the previous 12 months, including identifying high-risk communities and guiding vaccination campaigns. These findings demonstrate that the surveillance system is capable of generating actionable information for disease control efforts. This is in keeping with the central role of VPD surveillance systems in informing immunization strategies and outbreak responses highlighted in earlier studies (5). In Zambia, surveillance data have been increasingly used to guide supplementary immunization activities (SIAs) and identify zero-dose populations, particularly following disruptions to routine immunization services in the wake of the COVID-19 pandemic (8).

Despite the strengths in simplicity and usefulness, substantial weaknesses were identified in data quality. Data completeness for case-based investigation forms was below acceptable standards. Additionally, a large proportion of discrepancies were identified between facility registers and electronic IDSR/DHIS2 reports. Data quality challenges are a common limitation in surveillance systems across many low- and middle-income countries and significantly affects the reliability of epidemiological analyses (19,20). In Tanzania, incomplete reporting and discrepancies between paper-based and electronic reporting systems were identified to reduce the accuracy of surveillance data (21). Some of the identified causes of identified system causes include inadequate staffing, resource-limitation and limited feedback and capacity building from higher levels.

The timeliness of case detection and reporting for both measles and AFP were sub-optimal, with only one-third of measles cases detected timely and majority of AFP cases notified late. Despite the AFP surveillance sensitivity (non-polio AFP rate) being adequate, stool adequacy remained below the 80% threshold in most districts. Stool adequacy is a critical indicator of timeliness for confirming poliovirus infection, and low performance may compromise the ability of the system to detect poliovirus circulation promptly (20).

These delays in case detection could point to gaps in community awareness, delayed care-seeking practices, transportation barriers, and weak community-based surveillance, despite the reported functional EBS systems. This poses a risk of continued disease transmission before public health interventions are implemented. Similar delays in case detection have been seen in other surveillance system evaluations in sub-Saharan Africa (5).

Resource availability also emerged as one major operational challenge affecting surveillance performance. Health workers frequently reported using personal funds to purchase airtime and internet bundles to submit surveillance reports. In addition, transportation constraints were frequently reported for both specimen transportation and supervisory activities. Most facilities reported no deliberate fund allocation towards surveillance activities and neither functional motorbikes nor fuel allocations were made available. These negatively impacts on the utilization of the surveillance systems. An earlier study on the implementation of IDSR in Lusaka also highlighted these transportation barriers (6). These challenges are consistent with other evaluations done in Africa, where transportation constraints frequently delay specimen shipment and investigation activities (18,20). Operational challenges have been documented in surveillance system evaluations across sub-Saharan Africa. Inadequate funding, weak data management systems, and limited trained workforce have been identified as major barriers to optimal surveillance performance (20,22). Addressing these logistical barriers is essential to ensure timely laboratory confirmation and effective outbreak response. Sustainable financing mechanisms will therefore be necessary to ensure consistent surveillance system functioning.

The perceived acceptability of the surveillance system among health workers was very high (90.8%), amid the highlighted operational shortfalls. This indicates strong willingness among staff to continue participating in surveillance activities, mostly due to self-motivation and understanding the importance of the surveillance. High acceptability is an important attribute because it promotes consistent participation and reporting within the surveillance system (14). However, there was notable discrepancy between high acceptability and poor data quality, which would be explained by inadequacy in both human and financial resources indicators. This suggests that motivation alone may not be sufficient to ensure optimal system performance. Continued training, supportive supervision, and improved resources will therefore be necessary to translate staff commitment into improved surveillance outcomes.

Limitations
This evaluation had some limitations. Firstly, there was limited generalizability: the study included a relatively small sample of districts and health facilities, which may limit the generalizability of the findings to the entire province. We used purposive sampling to capture districts with different epidemiological profiles, which helped ensure a good degree of representation of diverse surveillance experiences. Secondly, the reliance on self-reported responses from health workers on some indicators especially usefulness and acceptability, may be subject to reporting bias and/ or social desirability bias. Lastly, there was potential data quality bias due to missing and/ or incomplete records. Despite these limitations, the evaluation used findings from multiple data sources, including document reviews, and data audits, which strengthened the reliability of the results.

Conclusion
From this evaluation, it was concluded that the core surveillance framework for measles and AFP in Southern province is operational, and capable of supporting public health decision making. However, key weaknesses in data quality, delays in case detection and investigation, logistical challenges in specimen transportation, and limited financial and operational support limit their ability to fully support early outbreak detection and response. Measures for improved data quality, strengthened supervision and training, enhanced transport and digital infrastructure, and reinforced community level surveillance are paramount. Without addressing these gaps, the system risks delayed outbreak detection and sustained transmission, jeopardizing the global and national VPD elimination goals.

Recommendations
Arising from the evaluation findings, a prioritized list of targeted recommendations was made for the province.

Data Quality: The Provincial Health Office (PHO) should mandate all District Surveillance Officers (DSOs) to conduct quarterly data quality audits in 100% of health facilities by April, 2026. This is to achieve >95% agreement between source registers (e.g., ND2) and DHIS2/eIDSR for key variables (e.g., vaccination status, age) and 100% completeness on case investigation forms. The DSOs should also conduct quarterly mentorship of clinical staff on case definitions and notification protocols to improve case detection timeliness and reporting. To improve sample transit times, the PHO should consider establishing a dedicated specimen transport fund by the end of 2026; a recommendation to submit a costed operational plan to the Ministry of Health and partners (e.g., WHO, CDC) to secure a dedicated budget line should also be considered.

Information and Technology Infrastructure: The PHO, in partnership with the MOH IT department, should conduct an audit of facility-level digital infrastructure by quarter 2, 2026. The immediate priority will be to ensure 100% of high-burden facilities have reliable internet connectivity (e.g., via upgraded modems or negotiated data bundles) to support real-time eIDSR reporting.

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