DESCRIPTIVE ANALYSIS OF ACUTE FLACCID PARALYSIS (AFP) SURVEILLANCE DATA, SIERRA LEONE, 2018 TO 2022.

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ABSTRACT

Background: In 2020, Sierra Leone confirmed an outbreak of circulating Vaccine Derived Poliovirus type 2. However, information on the country's performance on AFP surveillance indicators is limited. We aimed to describe incidence of AFP and assess the AFP surveillance performance in Sierra Leone using the World Health Organization (WHO) performance indicators.

Methods: We conducted a descriptive analysis of the national AFP surveillance data, for 2018-2022. Data were extracted from the national AFP surveillance database and analyzed using Epi Info 7. Key AFP surveillance performance indicators reviewed include non-polio AFP rate (WHO target: ≥2/100,000), case notification within 7 days of symptom onset (Target: ≥80%), case investigation within 48 hrs. after notification (≥80%), stool condition and adequacy (≥80%). We compared the system's performance on those indicators and compared them with WHO targets.

Results: There were 668 cases of AFP reported, of which 55% (368/668) were males and 78% (521/668) were under 5 years of age. Of the total cases, 2% (15/668) were confirmed as cVDPV with zero WPV. The average annual non-polio AFP rate was 4 per 100,000 <15-year populations. The Proportion of cases notified ≤7 days of symptom onset was 70% (468/668), and cases investigated ≤48 hours was 90% (601/668). Though stool condition was 90% (601/668) good, the adequacy was 77% (450/585) and only 7% (41/585) arrived at the national laboratory within 3 days after collection. Majority of the cases, 91% (609/668), including confirmed cVDPV2, had received three or more doses of oral poliovirus vaccine (OPV).

Conclusion: The performance of the AFP surveillance system in Sierra Leone surpassed WHO indicators for annualized non-polio AFP rate, case investigation, and stool condition but failed to achieve the minimal target for stool adequacy, case notification, and sample transportation indicating the likelihood of missing a case. We recommend that the Ministry of Health strengthen the sample referral system.

Keywords: Acute flaccid paralysis, data, surveillance, Sierra Leone, poliovirus.

INTRODUCTION

The World Health Organization defines acute flaccid or floppy paralysis (AFP) as any case of new-onset hypotonic weakness in a child under 15 years of age. This includes possible diseases due to Poliomyelitis, Guillian-Barré syndrome, transverse myelitis, traumatic neuritis, and viral infections caused by other enteroviruses, toxins, and tumors. Acute flaccid paralysis (AFP) is a clinical syndrome serving as a proxy for poliomyelitis, a highly infectious disease that has been targeted for eradication. In the early stages of the disease, polio may be difficult to differentiate from other forms of AFPs. Therefore, to ensure that no case of polio goes undetected, AFP surveillance targets all forms of AFP rather than a specific disease such as polio (Almoayed et al., 2019a). Poliomyelitis mainly affects children under 5 years of age who are not vaccinated against the virus.

As of 2022, endemic wild poliovirus type 1 remains in two countries: Pakistan and Afghanistan, which shows considerable progress in the polio endgame strategy as summarized in **Error! Reference source not found.**. (World Health Organization, 2023).

Between 2005-2012, eight wild poliovirus cases were identified in Sierra Leone, of which, six were detected in 2009. The last WPV case in Sierra Leone was identified in Western Area Rural in 2010 (Sowa, 2014; and Ministry of Health and Sanitation-GoSL, 2020). In December 2020, the Ministry of Health declared an outbreak of circulating Vaccine Derived Polio Virus type2 (cVDPV2) after stool samples collected from three AFP cases came out positive (Ministry of Health and Sanitation-GoSL, 2020). The 2020 cVDPV2 outbreak is a clear indication that the country is still vulnerable to a reintroduction or re-emergence of the poliovirus if AFP surveillance is not heightened and monitored, and if routine immunization is not strengthened.

Several researches have been conducted on AFP surveillance data analysis in Sierra Leone and in the sub-region for different periods.

Periodic analysis of AFP surveillance data is critical to monitoring the performance of the surveillance system and progress made for eradication. This study aimed to determine the distribution of AFP cases and examine the country's progress in eradicating poliomyelitis using the WHO performance indicators. The findings of this study will provide updated information on the country's performance on the AFP surveillance and advise the government and policymakers on how to improve AFP surveillance system.

MATERIALS AND METHODS

Study Design

A cross-sectional retrospective secondary data analysis was done to analyse the AFP cases recorded in Sierra Leone from 2018 to 2022.

Study Setting

This study was conducted in Sierra Leone. Sierra Leone is situated on the west coast of Africa, sharing borders with Guinea and Liberia. Administratively, the country is divided into five regions comprising 16 districts. The districts are further divided into 196 chiefdoms (sub-district level). Sierra Leone has a total of 1,284 public and private health facilities, including 54 hospitals, organized into three levels of care; primary, secondary, and tertiary. On the average, there are 1.8 health

facilities per 10,000 populations. Only Eight districts (Bo, Bombali, Bonthe, Kambia, Kenema, Moyamba, Pujehun, and Tonkolili) have a health facility density at or above the recommended threshold of two facilities per 10,000 populations.

Study Population

The 2022 projected census population of Sierra Leone is 8,494,260 people, with a population annual growth rate of 3.2, of which 40% reside in urban areas. The study was conducted for a population under-15-years which accounted for 3,404,349 (Stats SL - Home | Statistics Sierra Leone, 2015). The study included all AFP cases under-fifteen years of age recorded from 2018 to 2022

Data Collection

We utilized secondary case-based data on AFP surveillance, collected and collated by the Sierra Leone Ministry of Health through its Surveillance program and the World Health Organization (WHO) Epi-Info database. Variables extracted for analysis were guided by a data analysis plan, specifically developed to address the research questions. Variables analyzed included Number of cases by district, Non-Polio AFP Rate, Stool Adequacy, Age, Sex, Date of Onset of Paralysis, No. of vaccine doses, Type of virus isolated.

Definition of Key Performance Indicators for AFP Surveillance

Non-Polio AFP Rate: This could be defined as the total number of AFP cases among the <15-year population whose sample results show negative of WPV, VDPV, and Compatible cases. The NP-AFP rate is an indicator of surveillance

"sensitivity". If it is <2 per 100,000 <15-year population per year, the surveillance system is likely missing cases (World Health Organization, 2022). In Sierra Leone, the annual threshold is ≥3/100,000 <15-year population per district (WHO Sierra Leone, 2022).

Stool Adequacy: This is defined as the number of AFP cases with two stool samples collected 24-48 hours apart and arriving at the national lab in good condition within three days. All AFP cases must have at least 80% adequate stools (World Health Organization, 2022).

Stool Condition: This indicator monitors the number of AFP cases with stools arriving at the lab in good condition. By WHO standards, stools in good condition are those arriving at the laboratory in sufficient quantity (8 grams or thumbnail size), and between 4-8ºC and without desiccation or leaking of specimen containers. At least 80% of stool samples collected from AFP cases must arrive at the national lab in good condition (World Health Organization, 2022).

Percentage of AFP cases notified to the system within 48% after onset of paralysis: At least 80% of all AFP cases identified among <15-year population must be notified to the surveillance system within 7 days after onset of paralysis (World Health Organization, 2022).

Percentage of AFP cases investigated by the system: At least 80% of AFP cases notified to the system must be investigated within 48hrs.

Non-Polio Enterovirus isolation: this indicator ensures that Non-Polio Enterovirus

are isolated in at least 10% of stools collected from AFP cases.

Percentage of stools received at the national lab within 3 days after collection: at least 80% of stool samples collected from all AFP cases must arrive at the national lab with 3 days after collection (World Health Organization, 2022).

Data Analysis

We downloaded the data from the WHO AFP surveillance database into Microsoft Excel, where it was cleaned and coded. The cleaned and coded database was uploaded into Epi-Info 7.0 for analysis. We analyzed the data using frequency distribution and proportions, and results were presented in text, tables, graphs, and charts.

Ethics

The study does not require ethics approval to analyze the data. However, approval for the use of the data was sort from relevant authorities including the ministry of health and the World Health Organization

RESULTS

Demographic and clinical characteristics of AFP cases

A total of 667 AFP cases were reported from 2018 to 2022. Of the total, males accounted for 55% (367/667). The median age was 2 years (range: 1 to 19 years). We observed that 78% (519/667) of the cases were children <5 years while 22% (145/667) were aged 5 -15 years. Of the total cases, only 25% (167/667) were admitted to hospital. Considering the clinical presentations, 94% (627/667) of the cases presented with fever at onset, while 93%

(623/667) presented with flaccid sudden paralysis. For vaccination status, 86.8% (579/667) had received at least three doses of Oral Poliovirus Vaccine (OPV), while 9% (58/667) had received less than three doses, and 4.5% (30/667) with unknown vaccination status. On the final classification of results, 90.4% (603/667) of the cases were negative, 2% (15/667) cVDPV, and 7% (49/667) unknown results (**Error! Reference source not found.**)

Incidence of AFP Cases

Annual Incidence of AFP cases reported, Sierra Leone, 2018 - 2022

The highest incidence of AFP cases was reported in 2021 (5.3/100,000). However, we observed a downward trend in the incidence in 2022 (4.2/100,000). Between 2018 and 2019, there was a steady pattern of cases reported (3.9/100,000 <15 pop.) each year (**Error! Reference source not found.**2).

Cumulative incidence of AFP cases per 100,000 <15 population by district, Sierra Leone, 2018 – 2022

The cumulative incidence of AFP cases per 100,000 <15 population distributed by districts for the period under review shows Kono District recorded the highest incident of cases (40.4/100,000) followed by Koinadugu (27.9/100,00), Bombali (23.4/100,000), Western Area Rural (22.1/100,000) and Kambia (20.9/100,000) districts. The least number of cases were reported from Falaba (13.4/100,000) Bo (13.7/100,000) and Moyamba (15.1/100,000) districts Figure 3.

Distribution of circulating Vaccine Derived Poliovirus type-2 cases (cVDPV2), Sierra Leone, 2018–2022 (N=15)

A total of 15 cVDPV2 cases were recorded during the study period. Our finding discovered that Western Area Urban district recorded 4 cases of cVDPV2 followed by Kenema and Tonkolili districts each recording 3 cases. While Bombali district recorded 2 cases, Kailahun, Kambia and Western Area Rural districts recorded 1 case each. No cVDPV2 case was reported in Bo, Bonthe, Moyamba, Pujehun, Karene, Kono and Port Loko districts **Error! Reference source not found.**.

AFP surveillance performance, Sierra Leone, 2018-2022

On the Annualized Non-Polio AFP Rate, the country's performance ranged between 3/100,000 in 2020 to 5/100,000 in 2021. Considering the proportion of AFP cases notified to the system within 7 days after onset of symptom, the highest performance was recorded in 2022 with 81%. The performance in each of 2019 and 2021 was 69%. The least score was recorded in 2020 with 62%. The Proportion of AFP cases investigated within 48 hours of notification ranged from 84% in 2020 to 96% in 2022. On the Proportion of AFP cases with 2 stool specimens both collected within 14 days after the onset of symptom, the highest performances were recorded in 2022 and 2021 with 97% and 91% coverage respectively. The lowest performances were recorded in 2019 and 2020 with each scoring 81%. The proportion of stool specimens arriving at the laboratory in good condition ranged from 67% in 2022 to 100% in 2018. The average performance for Proportion of AFP cases with two adequate stool specimens was 77% ranging from 65% in 2022 to 85% in 2018. The country's average non-polio enterovirus isolation rate was 13% with the highest performance of 16% recorded each in 2018 and 2021. The least performance was recorded in 2019 & 2022 each scoring 8%. On the Proportion of specimens that arrived at the national lab in <3 days of being sent, the country's performance ranged from 0% in 2018 and 2019 to 26% in 2022. The average performance was 7% (**Error! Reference source not found.**).

Non-Polio AFP Rate by districts, Sierra Leone, 2018-2022

The average Non-AFP Rate ranged from 3 per 100,000 <15-year populations each in Pujehun, Port Loko, Moyamba, Falaba, Bonthe and Bo to 8 per 100,000 <15 populations in Kono (**Error! Reference source not found.**).

Stool Adequacy

The figure below gives account of the adequacy of the stool samples that were collected and sent to the national lab. It could be noted that 31% (5/16) of the districts did not achieve the minimum 80% target. The highest performance was recorded in Falaba and Karene districts each scoring 100%. This was followed by Kenema (96%), Kambia (94%) and Bo and Moyamba (92% each) districts. The least performance was recorded in Kono district (70%), Bonthe district (73%), Western Area Urban (75%), and Western Area Rural (77%) respectively (Figure 5).

4. Discussion

The study aimed to describe the incidence of AFP and the distribution of confirmed polio

cases in Sierra Leone from 2018 to 2022. The study also assesses the AFP surveillance performance for Sierra Leone using the WHO AFP surveillance indicators.

Our findings revealed that all reported AFP cases were children under five. This suggests that children less than five years old are the most vulnerable to contracting AFP, even though older ages can be affected. This could be due to their social activities in the environment. Children within this age category are often found outside in the playing ground which increases their risk of contracting the virus. The study finding is consistent with studies conducted in Sierra Leone, Ethiopia, Nigeria, and South Sudan (Jil et al., 2022, 2022; Raji et al., 2021; Squire et al., 2020; Tesfaye et al., 2020) where higher proportion of AFP cases were observed among children less than five years. It was also observed that males accounted for the majority of the AFP cases, which was also supported by other studies in Sierra Leone, Nigeria, South Sudan, and Kenya (Jil et al., 2022; Raji et al., 2021; Squire et al., 2020; Tesfaye et al., 2020).

We also observed that a greater number of the cases presented with fever at onset of the paralysis, and more than half of all the AFP cases presented with asymmetrical paralysis. Our findings are consistent with a study in South Sudan, Nigeria, and Sierra Leone, where they reported similar findings (Jil et al., 2022; Raji et al., 2021; Squire et al., 2020). The findings show that more than two-thirds of the cases had received at least three doses of oral poliovirus vaccine. This was similar to (Jil et al., 2022), whose findings show that 72% of the cases had received three or more doses of Oral Poliovirus Vaccine.

Our finding showed a higher incidence of AFP cases reported in 2021. This could be due to the intensification of AFP surveillance after the 2020 cVDPV2 outbreak. However, the drop in the incidence of cases in 2020 could be associated with the impact of the COVID-19 pandemic on AFP surveillance. The Global Polio Eradication Initiative (GPEI) assessment of the impact of COVID-19 pandemic on global poliovirus surveillance observed a 33% decline in the number of AFP cases reported from 2019 to 2020 (Zomahoun et al., 2021). We found that Kono district recorded the highest incidence of AFP cases during the study period. This could be due to the implementation of the Auto-visual AFP Detection and Reporting (AVADAR) project in the district (WHO, 2022). Even though there was no Wild Poliovirus (WPV) isolated from the cases reported during the study period, 15 cVDPV2 were isolated in late 2020 and early 2021 with the highest incidence recorded in Tonkolili district. This could be due to the disruption of routine immunization service delivery during the COVID-19 pandemic leading to lower population immunity.

On the performance of Key AFP Surveillance indicators, the country exceeded the WHO performance target for Annualize Non-Polio AFP Rate per 100,000 <15-year population throughout the study period. We also observed a similar pattern of performances among the 16 districts when data was disaggregated at the district level. This is an indication that the AFP surveillance was sensitive and able to identify cases of AFP in Sierra Leone during the study period. The finding from this study is consistent with similar studies conducted in Yemen (Almoayed et al., 2019b) and Sokoto State, Nigeria (Raji et al., 2021), but disagree with

other studies conducted in Sierra Leone (Squire et al., 2020) and Uganda (Bo et al., 2022) which showed a sub-optimal and inconsistent performance at the district level.

Although most of the cases were notified to the surveillance system within 7 days of symptom onset, the overall performance of the country fell below the minimum 80% target. This could be due to the delay in the identification and/or classification of cases as AFP by both community and healthcare workers. This will contribute to delay in case investigation and possible miss of cases. However, the overall performance of AFP cases investigated within 48 hours after notification at national and district levels were above the WHO minimum 80% target throughout the study period. This could be associated with the capacity-building activities the Ministry of Health engaged in since post-Ebola. However, findings from this study is in contrast with similar study conducted in Yemen, where performance on AFP cases investigated within 48 hours after notification was more than 98% at the national level and 96% at the Governorate level (Almoayed et al., 2019b).

The findings of this study evidenced that the overall performance on the number of adequate stool samples collected within 14 days of symptom onset and arriving at the regional laboratory in good condition during the study period was slightly below the WHO minimal target of 80%. This could be due to the timing of the study whereas the COVID-19 pandemic disrupted the AFP surveillance during this study period (Zomahoun et al., 2021).

Similarly, most of the districts did not achieve the minimal set target for stool adequacy. This would likely lead to missed diagnosis of cases which would in return lead to paralysis and shedding of the virus in the environment. When our study finding was compared to other studies done in Africa, the findings from this study is in agreement with a study conducted in Sudan (Jil et al., 2022) where performance on stool adequacy at a national level was chronically low and most districts recorded below the WHO minimum target. However, findings from other studies done in Uganda (Bo et al., 2022), Soko State, Nigeria (Raji et al., 2021) and Sierra Leone (Squire et al., 2020) were not in agreement with the findings of this study.

This study discovers an abysmal performance on stool specimen transportation from the district to the national public health laboratory. The country failed to achieve the minimal set target throughout the study period. Like the country's performance, all 16 districts failed to achieve the minimal target for this indicator. This could be due to inadequate logistics at the district level to support sample movement on real real-time basis. Hence samples are mostly transported from the district to the national public health lab once every month leading to delays in sample transportation.

Limitation

The study did not analyse environmental sample results from environmental poliovirus surveillance. Hence the study findings cannot exclude the complete absence of poliovirus circulation in Sierra Leone.

CONCLUSION

The highest incidence of AFP cases was reported in 2021 with Kono district recording the highest. Sierra Leone exceeded the WHO minimum target for annualized Non-Polio AFP Rate per 100,000 <15-year population but failed to achieve the targets for Stool adequacy and sample transportation from district to national. We are therefore recommending to the Ministry of Health through the National Surveillance Program and its partners for additional support and investment to improve on the laboratory network for AFP surveillance in Sierra Leone.

What is known about this topic

- Acute Flaccid Paralysis (AFP) surveillance system is gold standard for detecting polio cases
- AFP surveillance has several indicators to assess the system performance
- For certification of Polio-Free Status, countries must demonstrate effective AFP surveillance

What this study adds

- The study will add to the body of knowledge in the following areas:
- Reported all AFP cases in the last five years in Sierra Leone
- Highlight the incidence of AFP and its distribution by person, place, and time in Sierra Leone
- The study assessed all the AFP surveillance performance indicators and identified the country's strength and weak areas for improvement.

- This study will also serve as a baseline for future researchers in similar areas.

Competing interest

The authors declare no competing interest.

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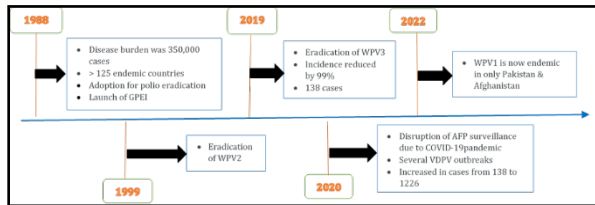
ANNEX

Figure 1: Global disease burden and gains made in Polio Eradication Initiative

Table 1: Demographic and clinical characteristics of AFP cases, Sierra Leone, 2018-2022

Variables	Frequency (667)	Percentage (%)
Sex		
Female	300	45.0
Male	367	55.0
Age (years)		
<5 years	519	77.8
5-15 years	145	21.7
Unknown	3	0.5
Admitted to hospital		
Yes	167	25.0
No	494	74.1
Unknown	6	0.9
Fever at Onset		

Variables	Frequency (667)	Percentage (%)
Yes	627	94.0
No	35	5.3
I don't know	5	0.7
Flaccid Sudden Paralysis		
Yes	623	93.4
No	24	3.6
I don't know	20	03.0
Asymmetrical Paralysis		
Yes	358	55.7
No	285	42.7
I don't know	24	3.6
Vaccination Status		
<3 doses	58	8.7
≥3 doses	579	86.8
Unknown status	30	4.5
Final Cell Culture Result		
Negative	500	75.0
Suspected Poliovirus	29	4.3
NPENT	84	12.6

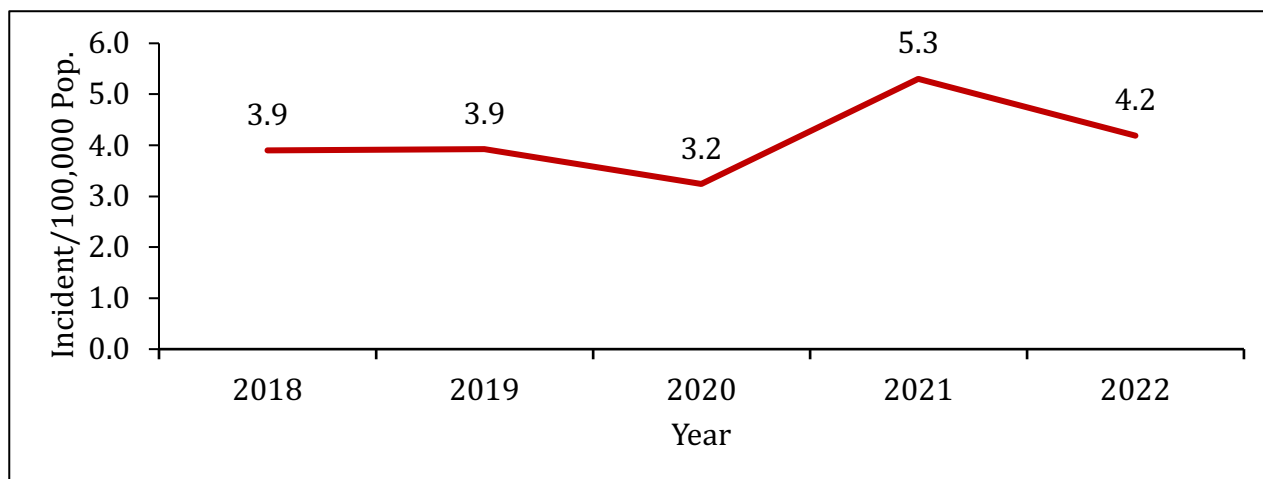| Variables	Frequency (667)	Percentage (%)
Unknown	54	8.1
Final Classification		
Negative	603	90.4
cVDPV2	15	2.3
Unknown	49	7.3

Figure 2: Incident of AFP cases in Sierra Leone, 2018 to 2022
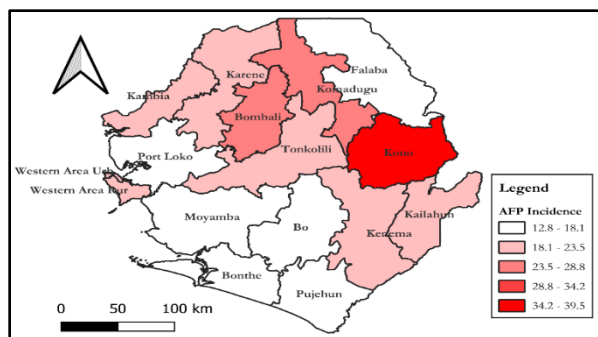
Figure 3: Cumulative incidence of AFP cases per 100,000 <15 population by district, Sierra Leone, 2018 – 2019
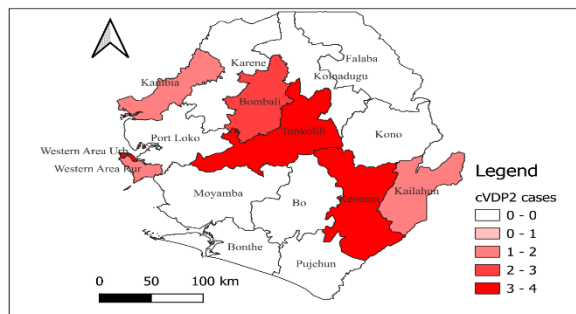
Figure 4: Distribution of circulating Vaccine Derived Poliovirus type-2 cases (cVDPV2), Sierra Leone, 2018–2022

Table 2: AFP Surveillance performance using WHO performance indicators, Sierra Leone, 2018-2022

Performance Indicators	Target	Country Performance					Ave.
		2018	**2019**	**2020**	**2021**	**2022**	
1. Annualized Non-Polio AFP Rate per 100,000 <15 yrs. Population	≥2	4	4	3	5	4	4
2. Proportion of AFP Cases Notified to the system within 7 days after onset of paralysis	≥80%	67%	69%	62%	69%	81%	70%
3. Proportion of AFP cases investigated within 48 hours after notification	≥80%	88%	90%	84%	89%	96%	89%
4. Proportion of AFP cases with 2 stool specimens both collected within 14 days after onset of symptom	≥80%	85%	81%	81%	91%	97%	87%
5. Proportion of AFP cases with stool specimens arriving at the lab in good condition	≥80%	100%	96%	95%	90%	67%	90%
6. Proportion of AFP cases with two adequate stool specimens	≥80%	85%	78%	78%	81%	65%	77%
7. Proportion of AFP cases followed up for 60 days after paralysis	≥80%		100%	100%			40%
8. Proportion of AFP cases from which non-polio enterovirus was isolated	≥10%	16%	8%	15%	16%	8%	13%

Performance Indicators	Target	Country Performance					Ave.
		2018	2019	2020	2021	2022	
9. Proportion of specimens that arrived at WHO accredited <3 days of being sent	≥80%	0%	0%	4%	3%	26%	7%

Table 3: Non-Polio AFP Rate per 100,000 <15 populations, Sierra Leone, 2018-2022

District	2018	2019	2020	2021	2022	Average Non-Polio AFP Rate
Bo	4	2	3	3	2	3
Bombali	2	3	3	8	8	5
Bonthe	1	4	2	7	2	3
Falaba	0	0	3	3	7	3
Kailahun	3	5	2	5	5	4
Kambia	5	3	1	7	4	4
Karene	0	0	3	8	7	4
Kenema	3	4	2	5	4	4
Koinadugu	7	7	3	3	8	6
Kono	12	9	7	8	4	8
Moyamba	3	3	3	2	4	3

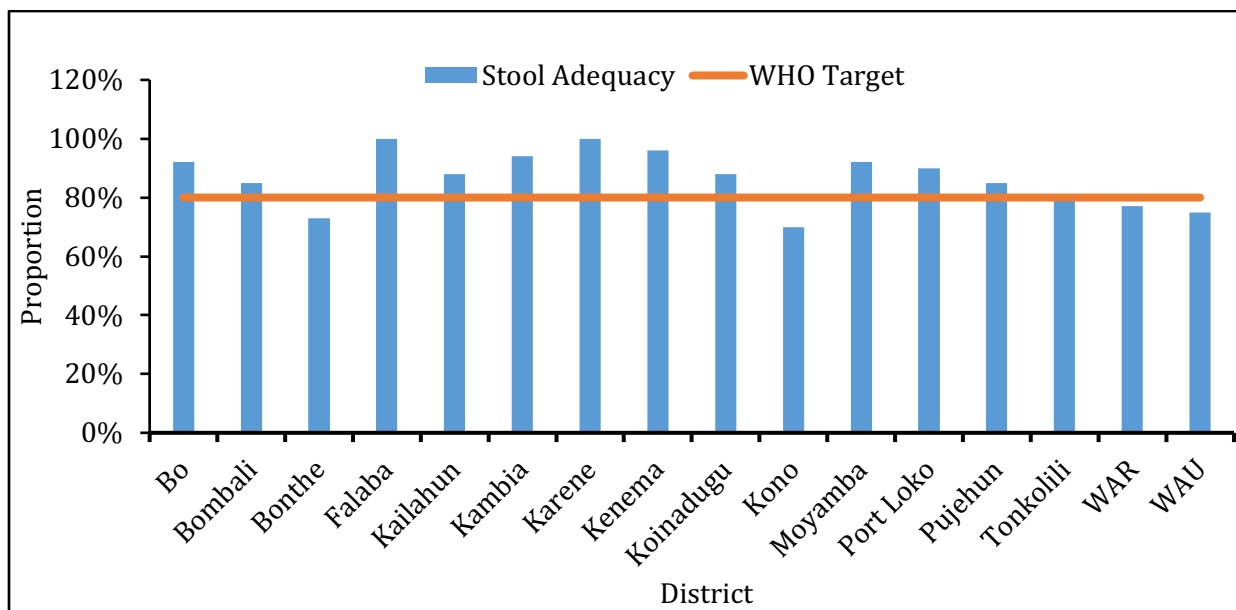|						
Port Loko	5	3	1	3	4	3
Pujehun	3	5	3	3	4	3
Tonkolili	2	3	3	8	3	4
WAR	4	5	5	6	3	4
WAU	5	4	3	4	3	4
Sierra Leone	4	4	3	5	4	4

Figure 5: Stool Adequacy of AFP cases, Sierra Leone, 2018-2022