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Performance and Trends in Measles Case-Based Surveillance in the North West Region of Cameroon, 2009 to 2015

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Abstract

Background: Measles is a highly contagious viral disease associated with high morbidity and mortality in developing countries. As an infection with no specific treatment, its control is most importantly through vaccination and adequate disease surveillance. National immunization coverage for the first dose of measles/rubella vaccine in 2019 was 71%. As a result, measles continues to rage with outbreaks not sparing the North West Region (NWR) of Cameroon, hence the need for proper surveillance. **Objective:** Assess performance of measles case-based surveillance in the NWR of Cameroon. **Methods:** This was a cross-sectional, descriptive study with retrospective collection of measles surveillance records carried out at the Regional Delegation of Public Health from 2009 to 2015. The data collected using a structured form were: number of persons suspected of measles; number of persons reported to district service; number of persons whose samples were collected and forwarded to the laboratory; number whose results reached the Expanded Programme on Immunization (EPI) Central unit and the time lapse between successive phases. **Results:** Although not all planned activities were carried out, a constant increase in planned and carried out monitoring activities was found. The average time taken from onset of signs and symptoms in a measles case to consultation at a health facility, from consultation to notification of case to district service, from notification to investigation, from investigation to receipt of biological sample at laboratory, from receipt of sample to provision of results to the EPI Central unit, and from collection of sample to reception of results at the Central EPI unit was 2.59 days, 1.5 days, 1.5 days, 2.6 days, 4 days and 6.6 days respectively. **Conclusion:** There was an overall rising trend in the performance of measles case-based surveillance, although the high priority site visits witnessed a stagnation during the period, a large scale measles epidemic occurred (2015). The duration between phases of the surveillance system was within acceptable limits of WHO standards for an effective system. However, the proportion of samples reaching the laboratory and whose results are received at EPI Central Unit was 77.6%, which is lower than ≥80% prescribed by WHO.

Keywords

Measles, Case-Based, Surveillance, Performance, Trends

1. Introduction

Public health surveillance is the continuous and systematic collection, analysis, interpretation, and dissemination of data regarding diseases or health-related events that have significant public health importance, and is used in public health action to reduce morbidity and mortality and to improve health [1] [2] [3] [4]. Data generated from such public health surveillance systems is used for guiding immediate public health action, program planning and evaluation, monitoring trends disease and formulating research hypotheses [2] [5]. Therefore, regular and relevant evaluations of surveillance systems are essential to improve their performance and cost-effectiveness [6]. With this in mind, several organizations have developed evaluation approaches to facilitate the design and implementation of these evaluations [6] [7]. Measles is one of the diseases targeted by the public health surveillance system and whose surveillance activities started in Cameroon in 2001. It is a highly contagious viral disease that is associated with high morbidity and mortality [8] [9]. Measles is caused by a virus of the myxoviruses group, and is characterized by fever and catarrh symptoms of the upper respiratory tract (coryza, cough), which is followed by a typical rash [8] [10]. Globally, more than 140,000 measles deaths occurred in 2018, affecting mostly children under 5 years, despite the availability of a safe and effective vaccine [11] [12]. In Africa, about 13 million cases, 650,000 deaths occur annually, with sub-Saharan Africa having the highest morbidity and mortality [9] [13]. Measles is equally an endemic disease in Cameroon like other developing countries as a whole, and the North West Region of Cameroon in particular [14]. According to Cummings and colleagues, distinct patterns of measles incidence were found in two different areas of Cameroon [15]. These were the three Northern-most regions (Extreme North, North and Adamawa) experiencing major epidemics every year; whereas the seven Southern regions (North West, South West, West, Center, East, Littoral and South) showed evidence of experiencing major epidemics every third year [15] [16]. They equally indicated that the length of this period (between epidemics) has been found to be dependent upon vaccination coverage, population density and birth rates and as such, differences in these factors across Cameroon could create different patterns of incidence [15]. As a viral infection with no specific treatment, the control of its occurrence is most importantly through vaccination with the measles vaccine and adequate disease surveillance [8]. Due to measles's highly infectious nature, when it is introduced into a virgin community (with no immunity), more than 90% of the total population will be infected [8] [17]. By 1980 before the use of the measles vaccine became widespread, about 2.6 million measles deaths occurred worldwide [8] [18]. This situation called for a need to accelerate the reduction of measles mortality. Thus, led to the decision by the WHO and UNICEF for delivering 2 doses of measles containing vaccine to every child through routine vaccination services and Supplementary Immunization Activities (SIAs), and equally improving disease surveillance [8]. The implementation of this decision (strategy) started in 2001and had reduced measles deaths from 733,000 in the year 2000 to 122,000 in 2012 [8]. According to UNICEF, since the year 2000, over 21 million lives have been saved through measles immunizations. Despite these achievements and the availability of a safe, effective and affordable measles vaccine, 367 children still die from measles every day [19]. Also, measles cases reportedly increased by more than 30% worldwide by 2016 [11], causing current wave of measles outbreaks, a situation the WHO blames on the gaps in the implementation of the control strategy for 2 doses of measles vaccines for routine immunization [20]. Despite this WHO's recommendation of 2001, stipulating that reaching all children with 2 doses of measles containing vaccine should be the standard for all national immunization programmes [19] [21], Cameroon only introduced a second dose of the measles vaccine in routine immunization in March 2020 [22]. Till then, measles control strategy in Cameroon was the first dose of measles vaccination administered during routine infant immunization at the age of 9 months [23], and second opportunity during SIA or during a routine service delivery schedule during the second year of life; high quality surveillance supplemented with laboratory confirmation; and case management [20]. Even with this, not every child is reached with the measles vaccine as the national coverage for the first dose of the MR vaccine in 2019 was reported to be 71% [22], and so, measles still continues to occur in epidemics in Cameroon. Inadequate surveillance and response capacity of a country's system can endanger its population especially where health resources are limited. The findings from a measles outbreak investigation from the Littoral Region of Cameroon indicated that 51.5% of measles cases would visit the health facility within 2 days of onset of measles signs and symptoms; and all samples collected from suspected cases will reach the Centre Pasteur Reference laboratory within 3 days according to the WHO standards for an effective surveillance system. This, therefore, pointed fact that the surveillance system in this region of Cameroon is effective in promptly detecting and responding to a measles epidemic [24]. According to available unpublished data at the Regional Delegation of Public Health for the North West Region of Cameroon, measles epidemics were reported in the NWR in 2012, 2013, 2014 and 2015. These frequent measles outbreaks in the region prompted the need to evaluate the measles case-based surveillance system's attributes and identify gaps in its operation.

2. Material and Methods

2.1. Study Design

The study design was cross-sectional with retrospective data collection.

2.2. Study Setting

The study was conducted at the Regional Delegation of Public Health (RDPH) for the North West Region which is classified as an intermediary level in the health system, where health policies are elaborated for implementation at the District level. It is also here that health data are submitted from the health districts for onward transmission to the Central level and also shared with health partners at the international level. This review was done at the RDPH for the North West Region, at the EPI data manager's office, where data are archived.

2.3. Study Duration and Period

The duration of the study was two months from March to April 2020 and the study covered the period from 2009 to 2015 (7 years). The study originally, covered reports on measles case-based surveillance in the North West Region from 2006 to 2015. This time period represented a span of ten years, that is, five (5) years after the initiation of Measles Surveillance activities by the WHO in 2001, to the year when a large scale measles epidemic occurred in the North West Region, 2015. It was supposed here that measles surveillance activity should have been established 5 years after initiation in all the health districts in the region. The reports from 2006 to 2008 did not meet the selection criteria and were not included in the study. Therefore, the review was to document measles case-based surveillance performance during this period till when the large scale measles epidemic occurred. With no available evidence of such an evaluation of the surveillance system, this could rightly be the first to have been done. This study was to document the performance of the surveillance system before the occurrence of the large scale measles epidemic of 2015 in the North West Region and therefore, could not be extended to a more recent date.

2.4. Selection Criteria

All cases of persons from age 0 and above, reported in the weekly and monthly reports for Routine Measles Surveillance were included in the review. A report to be included in the study should be at least 90% complete in all the required data variables. Therefore, reports that were less than 90% complete were excluded from the study. Only the health districts that have experienced at least one measles epidemic during the study period were included in the study.

2.5. Sampling Method

A Systematic Random Sampling method was used to select ten from a list of 16 health districts that experienced at least one measles epidemic during the study period according to measles surveillance reports. A health district was included if it had at least 90% completed data for the entire period of study. These health districts were: Bafut, Bali, Bamenda, Benakoma, Fundong, Kumbo West, Mbengwi, Nkambe, Santa, and Tubah Health Districts. Every person reported for suspected measles in routine measles surveillance reports was retained. In our study, no sample size was required as we did not know the number of persons that were reported over the study period.

2.6. Data Source

These were synthesis reports of surveillance activities of the District health service descend to the field; and Case-based measles surveillance reports of health areas/health facilities following the identification of suspected measles cases. These involved cases of individuals of all ages that presented with signs and symptoms that met the WHO measles case definition for surveillance.

2.7. Centers for Disease Control and prevention's (CDC) Updated Guidelines for Evaluating Public Health Surveillance Systems

The CDC in 1988, published the Guidelines for Evaluating Surveillance Systems, to promote the best use of public health resources through the development of efficient and effective public health surveillance systems. This surveillance system evaluation ensures that problems of public health importance are being monitored efficiently and effectively. This would ensure the integration of surveillance and health information systems; the establishment of data standards; the electronic exchange of health data; and make changes in the objectives of public health surveillance to facilitate the response of public health to emerging health threats like new diseases. This document therefore helps to spell out the reasons for this evaluation including:

- Guide immediate action for issues of public health importance;
- Measure the burden of a disease or other health-related event;
- Monitor trends in the burden of a disease or other health-related event;
- Guide the planning, implementation, and evaluation of programs to prevent and control disease, injury, or adverse exposure;
- Evaluate public policy;
- Detect changes in health practices and the effects of these changes;
- Prioritize the allocation of health resources;
- Describe the clinical course of disease;
- Provide a basis for epidemiologic research.

This document specifies that the evaluation of public health surveillance systems should involve an assessment of system attributes, including simplicity, flexibility, data quality, acceptability, sensitivity, predictive value positive, representativeness, timeliness, and stability. It is for the above reasons that the CDC therefore, recommends that to promote the best use of public health resources and also ensure that the surveillance system achieves its intended objective, all public health surveillance systems should be evaluated periodically and recommendations made. This is more so because no perfect system exists [25].

2.8. Data Collection Tool

Data was collected using a pre-tested structured form. The form was used to collect data on the number of persons suspected for measles; number reported to the district health service; number whose samples were collected and forwarded to the Reference laboratory; number whose results reached the EPI Central unit and the time lapse between one phase and the other.

The evaluation of the surveillance system's performance in the North West Region was conducted using the CDC's Updated Guidelines for Evaluating Public Health Surveillance System, published in 2001.

2.9. Data Collection Procedure

Data extraction was carried out manually in the office of the data manager for the EPI Programme, where data archives for routine measles case-based surveillance are kept. These data were mainly in hard copy.

2.10. Ethical Considerations

Ethical clearance was obtained prior to administrative authorization, from the Institutional Review Board of the Faculty of Health Sciences of the University of Buea. Administrative was sought and obtained from the North-West Regional Delegation and authorization were issued before data collection started.

2.11. Data Management

Data collected on daily basis were filed according to districts and date of collection and kept in a designated cupboard at the EPI data manager's office till extraction was completed. During weekends, the data was entered into an excel spread sheet and stored with a password in the researcher's laptop.

2.12. Data Analysis

The numerical variables were expressed by their means (±standard deviation). Categorical variables were presented as proportions and percentages. This analysis was performed using descriptive statistics of the Statistical Package for Social Sciences (SPSS) version 21.0.

3. Results

Overall, 1200 monthly District synthesis reports were reviewed for the study period. Out of this number, 1040 reports met the selection criteria and were retained, while 160 reports did not meet the selection criteria and were rejected for the review. These 160 reports were less than 90% completed with missing data points and parts. The results are presented in the figures below to demonstrate this gentle rise in the trend of surveillance activities for each priority level. From Figures 1-3, it can be clearly seen that for all the priority levels, High, Middle and Low, there was a general tendency that not all the planned activities were realized. A high priority site is one that has a very high probability of finding a

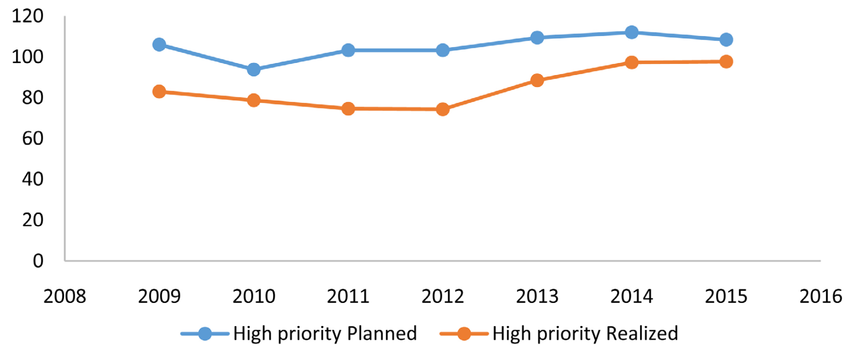

Figure 1. Graph of mean number of high priority site visits planned and realized over the years.

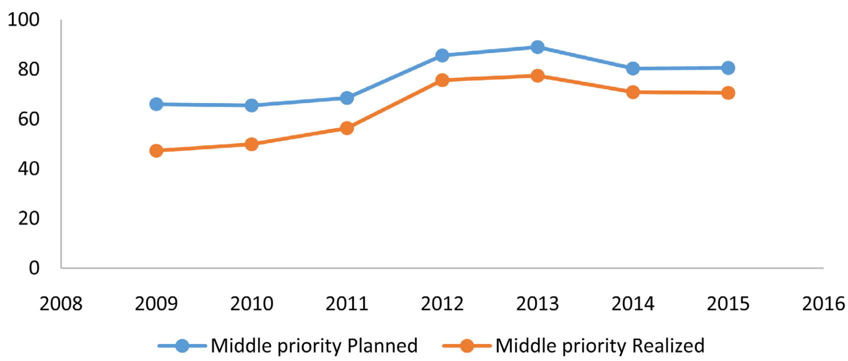

Figure 2. Graph of mean number of middle priority site visits planned and realized over the years.

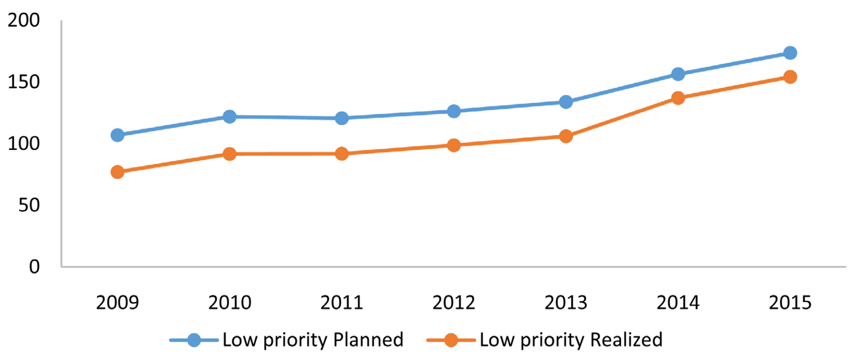

Figure 3. Graph of mean number of low priority site visits planned and realized over the years.

suspected measles case and is visited once a week; whereas, a middle priority site has a probable chance of finding a suspected measles case and is visited once every two weeks. On the other hand, for a low priority site, there is a less probable chance of finding a suspected measles case and is visited once per month or every two months. Examples of high priority sites are health facilities and highly populated communities; middle priority sites include moderately populated communities while low priority sites include sparkly populated communities. All the priority levels also witnessed a gentle rise in the number of planned and realized surveillance activities. The graphs in Figure 1, indicate a falling trend from 2009 to 2010 in both planned and realized activity. From 2010 to 2011, while the planned activity recorded an increase, the realized activity kept falling. Between 2011 and 2012, both the planned and realized activity were constant. This period of 2011 and 2012 registered the widest gap in the mean number of site visits of over 20 between planned and realized activity. From 2012 to 2014, both planned and realized activity registered a steady rise in the mean number of site visits of over 25. Between 2014 and 2015, planned activity registered a drop while the realized activity stagnated.

With regards to the graphs in Figure 2 on middle priority site visits planned and realized, the activity started off with a gentle rise between 2009 and 2011 with a wider margin between planned and realized activity. From 2011 to 2012, while the margin between both activities narrowed, there was equally a sharp rise. Between 2012 and 2013, both activities almost stagnated with little or no increase. From 2013 to 2014, both the planned and realized activity were decreasing constantly. Again, between 2014 and 2015, both activities stagnated with little or no increase. Despite the overall falling activities, the realized activity still remains lower than the planned.

As concerning Figure 3 for low priority site visits planned and realized, the graphs indicate that activity increased from 2009 to 2010. From 2010 to 2011, activity almost stagnated with little or no increase and both maintained a constant gap between the planned and realized activities. From 2011 to 2013, both activities registered a very small increase. Activities increased moderately between 2013 and 2014, as the gap between planned and realized activities narrowed. The period from 2014 to 2015 also registered some little increase in the activities. Again, not all planned activities were realized.

The quality of reporting was equally assessed by looking at the number of measles cases suspected on the field and the actual number reported on the Monthly reporting form for the Expanded Programme on Immunization EPI. This also took into consideration, the laboratory results of the suspected cases and completion of epidemiological reports. These results are presented in Table 1 below.

From Table 1 below, one can see that a mean total of 13.1 (SD 28.8) measles cases were suspected while only a mean total of 9.1 (SD 25.2) cases were reported on the monthly EPI form. Therefore, not all suspected cases of measles were actually reported on the monthly EPI reporting forms.

Table 1. Mean number of measles cases suspected, reported on EPI monthly statistics form and those diagnosed measles positive.

Year	Measles cases		
	Mean Number of Measles cases suspected	Mean Number of Measles cases reported on the EPI form	Mean Number of positive Measles cases
2009	5.6 (SD 3.7)	3.5 (SD 2.6)	0.3 (SD 0.7)
2010	4.9 (SD 5.1)	3.5 (SD 5.6)	0 (SD 0.0)
2011	3.1 (SD 2.2)	2.5 (SD 2.0)	0.8 (SD 0.9)
2012	8.1 (SD 4.7)	4.8 (SD 4.3)	0.2 (SD 0.6)
2013	6.8 (SD 5.9)	2.6 (SD 1.9)	0.2 (SD 0.4)
2014	14.1 (SD 9.9)	10.7 (SD 7.5)	0.1 (SD 0.3)
2015	49.4 (SD 66.2)	35.8 (SD 61.3)	0.5 (SD 0.7)
Grand Total	13.1 (SD 28.8)	9.1 (SD 25.2)	0.3 (SD 0.6)

The surveillance activities for the different health facilities which involves searching for suspected measles cases, collecting biological samples and forwarding to the WHO certified laboratory (Centre Pasteur Yaounde) for investigations to confirm for measles (Immunoglobulin IgM), recorded a number of cases during the study period from 2009 to 2015. These cases were also reported alongside the surveillance activities of the district health service to the regional level. The number of cases and their laboratory results are summarized and presented in Table 2 below.

From Table 2 below, a total number of 379 suspected measles cases were reported for the study period and their biological samples collected and forwarded to the laboratory to investigate for measles. Out of this number, 315 (83.1%) were diagnosed negative while 64 (16.9%) were diagnosed positive for measles. This gives a negativity rate of 83.1% for suspected measles cases.

To establish the trends in occurrence of measles cases in the region, data was also summarized according to the age group of cases, their sex and place of residence. The results of this summary are presented in Table 3 below.

From Table 3 below, a majority of suspected measles cases 146 (38.5%) were from the age group of 25 - 59 months. This was followed by the 5 - 14 years age group with 133 (35.1%) measles cases. With regards to the sex of suspected measles cases, there was a male dominance, with 196 (51.7%) cases giving a sex ratio of 1.07. Considering the residence of cases, a majority of them came from the rural area 196 (51.7%) of the suspected measles cases.

The reasons behind the above age grouping were because from age 0 to 6 months, it is believed that maternal antibodies against measles present in a child prevent it from contracting the disease. From age 7 to 12 months, a greater amount of these antibodies is lost and so, the child becomes more susceptible to contracting measles and this age group also involve the age that measles vaccine

Table 2. Number of suspected measles cases reported per year by health facilities and their laboratory results.

Year	Measles cases		
	Number of Positive cases and percentage	Number of Negative cases and percentage	Total Number of cases and percentage
2009	11 (25)	33 (75)	44 (100)
2010	8 (47.1)	9 (52.9)	17 (100)
2011	10 (32.3)	21 (67.7)	31 (100)
2012	18 (26.9)	49 (73.1)	67 (100)
2013	2 (5.0)	38 (95.0)	40 (100)
2014	7 (4.5)	147 (95.5)	154 (100)
2015	7 (26.9)	19 (73.1)	26 (100)
Grand Total	64 (16.9)	315 (83.1)	379 (100)

Table 3. Time interval between the different phases of the measles case-based surveillance system in the North West Region.

Variable	Measles cases
	Number of suspected cases (%)
Age group	
0 - 6 months	11 (2.9%)
7 - 12 months	26 (6.9%)
13 - 24 months	45 (11.9%)
25 - 59 months	146 (38.5%)
5 - 14 years	133 (35.1%))
15 years and above	18 (4.7%)
Sex	
Male	196 (51.7%)
Female	183 (48.3%)
Place of residence	
Urban	173 (45.6%)
Rural	196 (51.7%)
Total	379 (100%)

is administered in Cameroon (age 9 months). With the age group of 13 to 24 months, children have been vaccinated and therefore, have developed immunity against measles. Therefore, affected cases would mostly be those not vaccinated or those vaccinated but never develop immunity which could be d ue to vaccine failure. The age group of 25 to 59 months in most cases must have already received their second dose of measles vaccine, according to the WHO's recommendation to increase immunity and therefore, cases occurring in this group will indicate declining measles immunity from the first measles vaccine dose. Finally, the age group of 5 to 14 years indicates a much declined immunity if a second dose of measles vaccine was not administered.

The effectiveness of the surveillance system to promptly identify a suspected measles case was also measured in terms of the time lapse from one phase to the other. This involved the time from the appearance of signs and symptoms in a suspected measles case through the collection of biological samples for the laboratory, to the availability of the laboratory findings to health authorities. The different time intervals between these phases were calculated and presented in the table below.

Table 4 below indicates the mean duration in number of days from one stage to the other in the measles surveillance system for the detection and investigation of measles cases for measles control. From the table, the mean number of days from the onset of signs and symptoms in a suspected measles case to consultation in a health facility was 2.59 (standard deviation SD of 2.2). On the other hand, from consultation in a health facility to when the District health service is notified of the case, the mean duration was 1.5 days (SD 1.5). Whereas, from notification of the district health service to investigation, that is, collection of biological samples from the case, took a mean duration of 1.5 days (SD 1.2). Equally, the duration from investigation to reception of the biological sample at the EPI Reference laboratory took a mean duration of 2.6 days (SD 1.6). Whereas from the reception of the sample at the laboratory to when the results were made available at the Central Unit of the EPI, took a mean duration of 4 days (SD 4.8). Overall, from the collection of biological samples to the reception of results at the Central unit of the EPI took a mean duration of 6.6 days (SD 5.5).

Table 4. Time interval between the different phases of the measles case-based surveillance system in the North West Region.

Variable	Measles cases		
	Number of cases involved	Mean number of days	Standard deviation
Onset of symptoms to consultation	379	2.59	2.181
Consultation to notification	379	1.51	1.472
Notification to investigation	379	1.46	1.291
Investigation to reception of sample at the EPI laboratory	379	2.63	1.614
Reception of sample to results	379	4.06	4.814
Investigation to reception of results at EPI Central unit	379	6.61	5.511
Duration for reception of results at the RDPH NW	379	0	0
Total	379	NA	NA

Of the results from the laboratory investigations of cases suspected, notified, investigated and results made available to the Central unit of EPI, 91.6% of them were available at the Regional Delegation of Public Health for the NWR. The details are presented in Table 5 below.

From Table 5 below, the proportion of suspected measles cases whose samples were received at the EPI laboratory within 3 days from investigation (collection of specimens) was (1 to 3 days = 18.8 + 35.6 + 23.2) 77.6%. It also indicates that 16.9% of cases suspected and investigated for measles turn out to be positive whereas, 83.1% were negative. Out of a total 379 cases, 89 cases (23.5%) were not vaccinated against measles while 290 cases (76.5%) had received the measles vaccine.

Table 5. Number of measles suspected cases and the outcome from investigation to receptions of laboratory results.

Variables	Measles cases investigated	
	Frequency (n)	Percentage (%)
Number of days from investigation to reception of specimen at EPI laboratory		
1	71	18.8
2	135	35.6
3	88	23.2
4	59	15.6
5	12	3.2
6	9	2.4
7	2	0.5
10	1	0.3
15	2	0.5
Total	**379**	**100**
Results of laboratory test		
Negative	315	83.1
Positive	64	16.9
Total	**379**	**100**
Vaccination status		
Not vaccinated	89	23.5
Vaccinated	290	76.5
Total	**379**	**100**
Results received at the RDPH		
Not received	32	8.4
Received	347	91.6
Total	**379**	**100**

4. Discussion

The regular and relevant evaluation of a surveillance system is of public health importance in order to ensure its capacity to accurately describe the patterns of diseases under surveillance and ensure its performance [6]. The surveillance system therefore, provides essential information to plan, implement and evaluate measles immunization strategies and monitor progress towards measles elimination [24]. In this light, synthesis reports for the District health services and health areas/health facilities Case-based measles surveillance activities were reviewed to establish the trends of the activity in the region. Measles surveillance activity was conducted at the level of health facility (passive surveillance) as clients attend to seek health care services and following descend to the field (active surveillance) by health personnel in search of suspected measles cases. The biological samples (serum) of the suspected measles cases were collected and sent to the reference laboratory (Centre Pasteur Yaounde) for measles confirmation. A measles case was any person with generalized maculo-papular rash and fever plus one of the following cough or coryza (runny nose) or conjunctivitis (red eye); and any person in whom a clinician suspects measles. At the level of the community, a measles case was "any person with rash and fever" according to the WHO measles case definition for surveillance [19]. The data was collected from these reports to answer the research question: "What have the trends in measles surveillance been in the North-West Region?"

Surveillance site visit activity

Surveillance activities were conducted at High priority, Middle priority and Low priority levels. Analysis of the data from this activity revealed that not all the priority site visits for the various levels planned were realized across the study period. Overall, a mean total of 105 (SD 63.3) high priority site visits were planned and only 84.9 (SD 52.7) were realized for the study period. For the middle priority level site visits, a mean total of 76.5 (SD 52.7) were planned and 64 (SD 33.2) were realized. With regards to the low priority level, a mean total of 134.2 (SD 81.2) were planned and only 108 (SD 68.6) were realized.

There was a falling trend for the high priority site visits from 2009 to 2010 in both planned and realized activity. From 2010 to 2011, while the planned activity recorded an increase, the realized activity kept falling. Between 2011 and 2012, both the planned and realized activity were constant that is, neither increasing nor decreasing. This period of 2011 and 2012 registered the widest gap in the mean number of site visits of over 20 between planned and realized activity. From 2012 to 2014, both planned and realized activity registered a steady rise in the mean number of site visits of over 25. Between 2014 and 2015, planned activity registered a drop while the realized activity stagnated. A very little rise in the number of high priority site visits planned and realized, means some cases of measles could have been missed out unsuspected. This is further compounded by the fact that not all the planned site visits for this important priority level, which is supposed to have a high probability of meeting suspected measles cases were actually visited.

On the other hand, given that the activities for the middle priority site visits planned and realized started off with a gentle rise between 2009 and 2011 with a wider margin between planned and realized activity, this also was for a short time. For the activities from 2011 to 2012, while the margin between both planned and realized narrowed, there was a sharp rise. This was a positive achievement for that year. Rather, between 2012 and 2013, both activities almost stagnated with little or no increase. Still, from 2013 to 2014, both the planned and realized activity were decreasing constantly. Therefore, cases of measles could still be going unnoticed. Again, between 2014 and 2015, both activities stagnated with little or no increase. Despite the overall falling activities, the realized activity still remains lower than the planned. This lends more credence to the fact that the surveillance system could have been losing measles cases.

The activities of the low priority site visits noticed a gently rising trend from 2009 to 2015, even though the period 2012 to 2013 saw results that were almost stagnating. Surprisingly, a continuously rising trend was observed in the low priority site visit segment where the probability of seeing a measles case is rather low. The activities here maintained a constant gap between the planned and realized from 2009 to 2013. Meanwhile, from 2013 to 2015, the gap between planned and realized activities narrowed. Again, not all planned activities were realized.

Comparatively, the high priority site visits noticed an overall decrease in realization from 2009 to 2012, while the middle and low priority sites witnessed a gentle rise. This scenario in the high priority sites could favor non-identification of measles cases. All the priority site visits, high, middle and low, almost stagnated from 2012 to 2013. From 2013 to 2015 when the large scale measles epidemic occurred, the high priority site visits were stagnating while the middle priority site visits were decreasing therefore could favor measles transmission in the community.

Despite the fact that not all planned activities were realized, overall there was a rise in the number of activities for both planned and realized at all priority levels, even though this was not significant. The data from this review could not allow for the explanation of this phenomenon observed. Overall, the level of representativeness of the surveillance system was good as all the 19 health Districts were participating in the Measles Surveillance system, a scenario equally reported by Owusu and Dam-Park in Ghana [12].

Reporting of suspected measles cases

Reporting of suspected measles cases is done on weekly basis in the weekly epidemiological surveillance report form and summarized in the EPI routine vaccination reporting form at the end of the month. The analysis of these reports revealed that not all the suspected measles cases were reported on the EPI routine vaccination monthly reporting form. A mean total of 13.1 (SD 28.8) cases were suspected and only a mean total of 9.1 (SD 25.2) were actually reported on the EPI vaccination form. This pointed to poor data reporting practice and quality which could hamper the perception of the actual situation of surveillance on the field, and thus the need for education of health care workers on proper reporting of surveillance data. This finding is consistent with that of Owusu and Dam-Park in Ghana [12]. Following this surveillance activity, a total of 379 suspected measles cases were reported for the study period from 2009 to 2015. Out of the 379 cases suspected, a majority of them, 196 (51.7%) were males while 183 (48.3%) were females. These findings with males dominating in proportion to the females are consistent with those of a study in Bayelsa state in Nigeria (54.6%) by Aworabhi-Oki *et al.* [25] and that of Palamara *et al.* (54.0%) in Italy [26], but contradicts that of Mersha *et al.* in Ethiopia where males and females were equally affected [27]. It was also found that more cases suspected of measles came from rural areas 196 (51.7%) than from urban areas 173 (45.6%). This phenomenon could not be explained as well by this study given that it involved review of secondary data. The most cases occurred in the age group 25 to 59 months then followed by the age group 5 to 14 years. These findings with most measles cases occurring in the under 5 year's children conform to that of Aworabhi-Oki *et al.* of Bayelsa State in Nigeria [25]. Out of the total number of 379 measles cases suspected, 315 (83.1%) were diagnosed negative for measles by the reference laboratory, while 64 (16.9%) were diagnosed positive for measles. This gave a negativity rate of 83.1%.

Effectiveness of the surveillance system

With regards to the surveillance system's effectiveness to timely identify a suspected measles case in a bit to promptly identify an epidemic for timely intervention, a delay time from one stage to the other of the surveillance process was measured. Analysis revealed that from the time of appearance of signs and symptoms to when a patient consults in a health facility, took a mean duration of 2.59 (SD 2.2) days. From consultations in a health facility to when the district service is notified of the case took mean duration of 1.5 (SD 1.5) days. From notifying the district service to when the biological sample is collected (investigation) took a mean number of 1.5 (SD 1.2) days. Again, from investigation to when the sample is received at the reference laboratory took a mean number of 2.6 (SD 1.6) days. Following reception of sample to when results are made available at the Central unit of the EPI took a mean number of 4 (SD 4.8) days. This result contradicts that of He *et al.* (2017) in China that reported a mean duration of 1 day [28]. Overall, from collection of sample to reception of results at the Central EPI unit took a mean number of 6.6 (SD 5.5) days, which falls within the limits of 7 days prescribed by the WHO [5]. Of the results, 91.6% were available at the Regional delegation of public health for the North West Region. These results with good timing between different phases of the surveillance system are consistent with those of Choto *et al.* in Zimbabwe [5]. Of all the suspected measles cases, 77.6% had their samples received at the laboratory within 3 days. This timeliness of specimen reaching the laboratory and the proportion of specimens received at the laboratory with results sent to the Central EPI Unit timely were below the WHO recommended 80% [19]. This findings conforms to that of Aworabhi-Oki *et al.* in Bayelsa State of Nigeria and with those of Nsubuga *et al.*

in Uganda [25] [29]. This duration of 3 days indicates that the surveillance system is effective and can identify a suspected measles case on time to enable prompt intervention in epidemic prevention. This finding also conforms with that of Sume *et al.* in the Littoral Region of Cameroon even though late reporting of measles cases to health facilities during an outbreak investigation was noted with only 51.5% of cases coming within 2 days of onset and a range of 0 to 39 days [10].

On assessment of the vaccination status of suspected measles cases, 87 of the 379 (23.5%) were not vaccinated whereas, 290 (76.5%) were vaccinated, further confirming the low measles vaccination coverage recorded in the North West Region. These results with a majority of cases being vaccinated are similar to those found in Ethiopia by Endriyas et al in 2018 [30], Tsegaye *et al.* 2012 [31] in Southeast Ethiopia and by Bamidele *et al.* in Oyo State Nigeria with an annualized measles vaccination dose of 74.4% from 2012 to 2016 [32].

5. Conclusion

There was a rising trend in the overall performance of measles case-based surveillance system, even though not all activities planned were realized at all the priority levels. Since high priority site visits stagnated until the year 2015, when a large scale measles epidemic occurred. This might have contributed to this epidemic given the declining trend registered before this period. The duration of time between one phase to the other of the surveillance system was within the acceptable limits of the WHO standards for an effective measles surveillance system. Whereas, the proportion of samples reaching the laboratory and whose results are received at the EPI Central Unit was 77.6%, which is lower than the 80% prescribed by the WHO. The surveillance system was acceptable, useful, simple, flexible, and representative. Quality of data, timeliness, and the stability of the system were attributes that require improvement for the surveillance system to continue pursuing its core functions.

Limitations

The available data were all in hard copies as the soft copies could not be located at the EPI Unit of the Regional Delegation of Public Health. Some reports had missing data points that contribute to poor data quality. Archiving of reported data was equally poor.

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Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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