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EPIDEMIOLOGICAL ANALYSIS OF MENINGITIS, SUNYANI MUNICIPALITY, BONO REGION OF GHANA, 2015-2019: (A SECONDARY DATA ANALYSIS)

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ABSTRACT

Background: Meningitis is a vaccine-preventable disease yet it remains a global public health issue that causes long-term disability and death. Ghana being located within the meningitis belt of African, the occurence of consistent outbreaks of Meningitis in different parts of Ghana has been a peculiar surveillance challenge. We analyzed the Sunyani Municipal meninigitis surveillance data to determine the incidence, describe disease pattern, fatality, and identify the Meningitis strain.

Methods: We extracted meningitis surveillance data for January 2015 to December 2019 from the District Health Information Management System. We reviewed the annual meningitis line-list of the Sunyani Municipality Bono Region. Data were identified, cleaned and analysed using Microsoft Excel. We performed descriptive statistics on quantitative variables and estimated incidence rate and case fatality rates and determined the predominant strains.

Results: From 2015-2019, 84 suspected cases were recorded with 17 laboratory confirmed in Sunyani and seven meningitis deaths. The overall incidence rate was 2/100,000 population, with a 7/17 (41.2%) case fatality rate. the highest incidence rate (8 per 100,000 population) was reported in 2016 while 2018 recorded the highest fatality rate of 2/2 (100%). We identified 12/17(70.6.%) of Streptococcus pneumoniae as the predominant Meningitis strain. Weekly reporting timeliness and completeness were below the World Health Organization recommended 80% reporting target.

Conclusions: There was a high case fatality rate of Meningitis among the residents in Sunyani Municipality, and Streptococcus pneumoniaee was the predominant strain identified. The highest incidence was recorded in 2016 within the period studied. The timeliness and completeness of weekly reporting for the five years was also below the World Health Organization target. The Sunyani Municipal Health Directorate intensify their active case search of Meningitis, implement vaccination campaigns in high-risk areas and ensure prompt reporting to prevent future epidemics.

Keywords: Meningitis, Sunyani Municipality, Streptococcus pneumonia.

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INTRODUCTION

Meningitis is a serious public health concern, with bacterial meningitis posing the greatest worldwide impact (World Health Organization, 2023). The disease is vaccine-preventable yet it remains a global public health concern that causes long-term disability and death (World Health Organization, 2020). Meningitis is a deadly illness caused by a variety of pathogens such as bacteria, fungus, or viruses.. Meningitis is an inflammation of the brain and the spinal cord covering, called meninges. It affects people of all ages, but children younger than one-year-old and adolescents are mainly affected (Kinfe, Sendo and Gebremedhin, 2021). The disease is caused by different pathogens, including bacteria, fungi, and viruses; however, bacterial meningitis has the most significant worldwide impact (Patel *et al.*, 2019). Bacterial Meningitis has a high mortality rate, up to 70% if left untreated, and 10–20% of survivors suffer long-term complications(Collaborators, 2018). According to a WHO report in 2019, the global burden of Meningitis is associated with high fatality, up to 50% when untreated, and high frequency, more than 10% of the severe consequence (World Health Organization, 2019). About 30,000 cases are still reported each year from sub-Saharan Africa (Patel *et al.*, 2019).

Ghana is located in the African meningitis belt, reporting high cases of Meningitis (Letsa *et al.*, 2018a). In 2016, the country recorded 2,184 confirmed cases of the meningitis with 93 deaths across 59 districts in nine regions(WHO, 2019). Large outbreaks in Ghana are due to Neisseria Meningitis, with incidence higher than 1/1,000 populations occurring in November through May in some regions in the country's northern parts. Ghana recorded 89 confirmed cases between 2010 and 2018, (Dartey *et al.*, 2020a) ('Ghana Health Service Report 2018.). The Brong Ahafo Region, recorded 969 suspected cases of Meningitis with 85 deaths (Case Fatality Rate (CFR = 9.0%)) between December 2015 and March 2016 (Letsa *et al.*, 2018a),(Dartey *et al.*, 2020). There was a propagated nature of the Meningitis epidemic due to a range of factors that cooperated favorably to accelerate the quick spread in an area that usually falls outside of Africa's meningitis belt and may be deemed to have significant populations (Letsa *et al.*, 2018a). Meningitis is among Ghana's top 11 priority diseases targeted for routine surveillance in the Integrated Disease Surveillance and Response (IDSR)

guideline resources used to operate the surveillance system (IDSR 2nd Ed Gh Revised 10.03.2017', 2017). According to WHO adapted IDSR technical guideline for Ghana, systematic data analysis of the meningitis surveillance indicators helps determine disease burden and detect any possible outbreak in the locality ('IDSR 2nd Ed Gh Revised 10.03.2017, 2017). The WHO global roadmap to defeat Meningitis by 2030 is inspiring and requires full implementation of all surveillance indicators, (WHO, 2019)

The high burden resulting from the consistent outbreak of Meningitis in different parts of Ghana has been a peculiar surveillance challenge in the healthcare system. We analyzed the surveillance data for Sunyani Municipality in the Bono Region to determine the incidence, patterns of distribution of Meningitis, and to estimate the timeliness and completeness of reporting in the Sunyani Municipality.

METHODS

Study design

We employed a descriptive cross-sectional study using secondary data from the Meningitis weekly Surveillance reports and the municipal line list between January 2015 and December 2019. The dataset for Meningitis from six sub-districts in the Sunyani Municipality was

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extracted and reviewed for the present analysis.

Study setting and population

The study was conducted at Sunyani Municipality. Sunyani Municipality is one of the capital town of the Bono Region, (Ministry of Food & Agriculture of Ghana, 2023). The municipality lies within mid-south western part of Ghana, with Heights from 750 feet (229 meters) to 1235 feet (376 meters) above sea level. The municipality has an average monthly temperature ranges from 23°C to 33°C, with the lowest temperatures occurring in August (22 °C) to September (2°C) and the highest in February, March and April with temperature between 31°C, (Ministry of Food & Agriculture of Ghana, 2023). It has an estimated population of 151, 378 inhabitants, (Sunyani Municipal District, Ghana, 2023). The Municipal Health Directorate (MHD) is in charge of overseeing the district's health care system and coordinating the efforts of all its providers. Each sub-municipality has 34 health facilities and 34 Community-Based Health Planning Services (CHPS) zones. When Sunyani Municipality was the Regional Capital of Ghana's Brong-Ahafo Region in 2016, the region had a meningitis epidemic, with the municipal hospital serving as the hub of the outbreak response (Letsa *et al.*, 2018b).

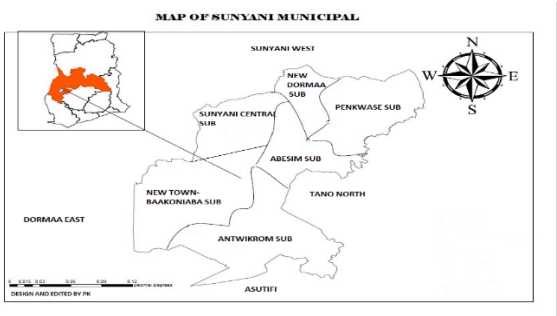

Figure 1: Map of Sunyani Municipal, Bono Region of Ghana ('Sunyani', 2023)

Data Collection

The data collected in both line list and the District Health Information Management system (DHIMS) were captured using the standard case definitions adopted in the Integrated Disease Surveillance and Response (IDSR) for Ghana ('IDSR 2nd Ed Gh Revised 10.03.2017)

Suspected Meningitis: A suspected case is anyone who has fever (>38.5°C rectal or 38.0°C axillary) with one or more of the following symptoms: neck stiffness, altered consciousness, or other meningeal signs ('IDSR 2nd Ed Gh Revised 10.03.2017)

Confirmed Meningitis: A confirmed case is any suspected case confirmed by the isolation of Neisseria Meningitis from Cerebra Spinal Fluid (CSF) or blood ('IDSR 2nd Ed Gh Revised 10.03.2017)

We retrieved soft copy of Miningitis line lists for Sunyani Municipality from the health regionsline list These contained information on all cases of meningitis to determine the median age, sex. We also extracted data on these cases from the DHIMS database. DHIMS is an aggregated database that record data of suspected cases, laboratory confirmed and deaths captured within the surveillance system on weekly basis for all prioriety diseases adopted in the IDSR. The data collected from the DHIMS was used also to determine the completeness and timeliness of reporting. Data collected from the DHIMS was used to analyze socio-demographic variables including, subdistricts, total suspected, confirmed and deaths, reporting weeks and year as well as timeliness and completeness of reporting among other variables.

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Meningitis Threshold

We used the Meningitis threshold to determine whether the cases reported met the requisite criteria to declare the municipality for outbreak of meningitis. Thresholds are presented as critical surveillance indicators for determining whether or not there was an epidemic of a particular illness in a specific population within Sunyani municipalit (Franklin *et al.*, 2021) *(Hartfield and Alizon, 2013)*. The World Health Organization's (WHO) defines alert and epidemic levels, in the current guidelines for Meningitis, particularly for nations in the Meningitis Belt. "An alert threshold of 5 cases per 100,000 inhabitants per week for areas with populations greater than 30,000, as well as an epidemic threshold of 10 lab-confirmed cases per 100,000 in one week when epidemic risk is high, or 15 cases per 100,000 in other cases1 for areas with populations greater than 30,000"(*IFRC* Meningococcal meningitis | Epidemic Control Toolkit, 2022) (Hartfield and Alizon, 2013). Ghana adopted an epidemic threshold of 10 cases per 100,000 people per week for a population of more than 30,000 people (WHO guideline', 2014). The IDSR indicates that "several cases will trigger a response when the epidemic threshold for cerebrospinal meningitis in countries of the meningitis belt is 10 cases per 100,000 population, and the alert threshold is 5 cases per 100,000" *WHO guideline, 2014)*. Both the results of suspected and confirmed cases were classified on the trend line graph against the established tresholds of 5 suspected and 10 confirmed cases per week to establish if there was any outbreak at any point in time within the five years period.

Data analysis

Data was cleaned, de-identified and analysed using Microsoft Excel 2010 for. Descriptive analysis was performed and ratios, frequencies and rates generated. We calculated the incidence per 100,000 using the estimated population for the respective years., as well as the case fatality rates. Using information from the DHIMS, we also assessed the report's timeliness and completeness to the next level. . For analysis purpose the age of each case was categorized into groups as follows: less than five years, 5-14 years, 15 and above years. Those whose age could not be determined were classed as unknown. Age groups were defined to identify the distribution of cases across different age categories. We alculated median age of the cases, along with the interquartile range (IQR) since the data was not symmetrically distributed. Timeliness and completeness at each level are critical to the quality of reporting system. We estimated completeness rate by extracting actual report from expected report and multiply the value by 100%. Similarly, timeliness of report was calculated by extracting report on time from actual report and multiply the value by a 100%. The results obtained were rated against the WHO standard of 80% to determine if completeness and timeliness of reporting were good or below standard. The summary of our findings was presented in tables and graphs. Meningitis trend over the 5 year-period was depicted using a graph while the timeliness and completeness of reporting were represented as bar charts.

RESULTS

Overall, 84 cases were suspected for meningitis, with 17 lab confirmed cases giving the overall incidence of 2/100,000 population from the Sunyani Municipality between 2015 and 2019. There were seven deaths (Case Fatality Rate 7/17(CFR)=41.2%). The highest incidence rate, 7.8/100,000 population, was recorded in 2016, while 2018 recorded the highest case fatality rate of 100% (2/2). No laboratory-confirmed meningitis death was recorded in 2019, (Table 1).

The median age of cases was 27 (Interquartile range = 7-58) years. The highest proportion of

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confirmed cases was recorded among the age agroup 15 years and dolder with 41.2%(7/17), followed by the unknown age group 41.2%(7/17%).

Only one case was suspected which was also confirmed among chidren under five years (<5). Similarly, we found 52.9%(9/17)confirmed Meningitis in females, 23.5%(4/17) in male and 23.5% (4/17) were unknown sex

Of the 17 confirmed Meningitis cases, 12/17(70.6. %) were Streptococcus pneumoniae(SP) with only 1/17 (5.9%) were confirmed for Neisseria meningitidis (NM). However, we identified 4/17 (23.5%) of the lab-confirmed cases were not classified for any of the meningitis subtypes. Only 3 out of 6 sub-districts have reported cases of Meningitis within the period under review. However, lab-confirmed cases of meningitis were clustered in two of the three subdistricts that have reported cases. Of the 17 confirmed cases, Penkwase had 52.9% (9/17) and Sunyani Central had 8/17(47.1%) were recorded in DHIMS. Meanwhile, No lab confirmed cases was reported in Abesim, Antwikrom, and New Dormaa subdistricts. There was one suspected Meningitis death reported from New Town-bakoniaba Subdistrict in 2018. (Table 2).

The trend of Meningitis and surveillance/laboratory turn-around time

We observed no confirmed outbreak during the period under consideration. However, five suspected cases of Meningitis were reported once in epi week 7, 2015 and trice in epi weeks 5, 8, and 9 respectively in 2016. Across the five years, the majority, 62/84 (73.8%) of suspected cases were reported in the early part of the years between epidemiologic week 1 to 11 (January to February) each year (Figure 2: Trend of Meningitis by week, Sunyani Municipality, 2015 – 2019Figure 2).

Timeliness and completeness of Reporting

The average laboratory turn-around time from the date of onset to the date of cases detection was two days. The date of case detection to specimen collection was one day, and between specimen collection and analysis was another one day. We did not find the date of the result released by the lab. The average timeliness and completeness of reporting for the five years period were 27.8% and 29.5%, respectively from 2015 to 2019. (21)]. Considerable improvement was only observed in 2019 with 72% timeliness and 79% completeness respectively.

For all the years observed (2015 to 2019), timeliness and. The percentage timeliness of reporting was also far below the WHO target of 80% with the exception of 2019, where 80% was met. (

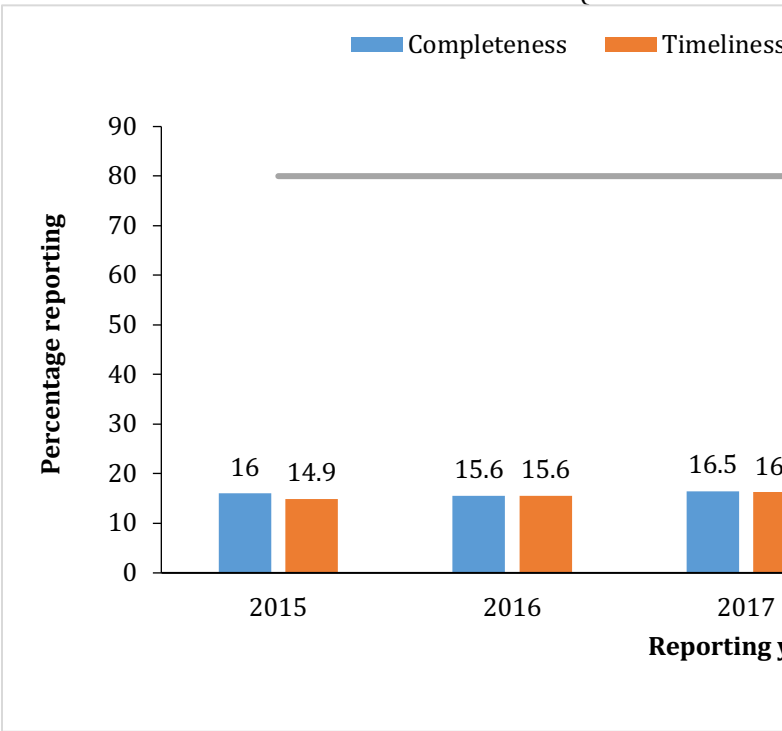

Figure 3). Also, from 2015 to 2019, none of the subdistricts achieved the WHO target of 80% timeliness and completeness of the report There were consistent late and incomplete

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reporting across the respective subdistricts facilities (Figure 4).

DISCUSSION

The analysis of meningitis cases in the Sunyani Municipality from 2015 to 2019 provides valuable insights into the incidence, case fatality, laboratory confirmation, and reporting trends. The outcomes of our analysis give a clear picture of the data collected from the DHIMS and the line list to help establish the set objectives.

The Sunyani Municipality had a low incidence of Meningitis in 2016 despite a possible outbreak in the Municipality. This rate is relatively low compared to the meningitis burden in regions along the meningitis belt. According to the United States Center for Disease Control and Prevention (US CDC) study in Sub-Saharan Africa, this is below the high incidence rate level for an area along the Meningitis belt. For a location along the Meningitis belt, a Meningitis incidence rate of 10-100 cases per 100,000 inhabitants may be considered high(‘*WHO, meningitis factsheet, 2019)*. Additionally, the case fatality rate (CFR) highlights a significant public health concern, with the highest CFR recorded in 2018. This underscores the need for improved case management strategies and timely response to meningitis cases to reduce mortality. However, Sunyani Municipality and Jaman North are among the 20 of the 27 districts that detected Meningitis in the Brong Ahafo Region in 2016, making the region with the highest recorded cases of Meningitis in nine affected regions (*Dartey et al., 2020b*). Sunyani referral hospital serves as one of the epicenters for case management. In the Jaman North District, there was an epidemic of Meningitis which accounted for 44 of the 971 confirmed cases registered in 2016, suggesting a high incidence of infection (*Dartey et al., 2020b)*. The low incidence of Meningitis at the Municipality may be due to a enhanced outbreak response and case treatment put in place to avoid further transmission and better monitoring that may have reduced their susceptibility to the disease *(Dartey 2020*). Penkwase and Sunyani Central sub-districts reported a majority (80/84) of the cases in the Municipality, suggestive of the availability of the referral hospitals in the two subdistricts. However, the silent reporting of cases from the other subdistricts (Abesim, Antwikrom, and New Dormaa) may indirectly suggest that reporting the standard case definition for meningitis case detection may not have been understood by facility staff.

Cases less than l4 years were less common compared to those aged 15 years and above. This finding contrasts with the WHO, 2020 report that cases younger than one-year-old and adolescents are mainly affected (WHO, 2020). However, the difference in the outcome may be due to the study location. Our analysis was limited to a small area, while WHO analysis covered countries in Africa, including Ghana. Additionally, the substantial number of unclassified cases underscores the possibility of deficiencies in data collection and reporting procedures, thereby compromising the accuracy and completeness of demographic information in surveillance reports. For surveillance information to be complete, it is imperative to address this issue in order to optimize public health interventions. Moreover, the large number of unclassified cases and demographic data gaps points to deficiencies in data collection and reporting processes. Efforts to improve data accuracy and demographic classification are critical for effective surveillance and public health interventions.

Streptococcus pneumonia was determined to be the predominant meningitis subtype in the Municipality. In addition, no verified cases of *Neisseria meningitides* (N.M.) were recorded. This results is consistent with the global patterns, where Streptococcus pneumoniae is a prominent contributor to bacterial

meningitis(Weiser, Ferreira and Paton, 2018). The small percentage of Neisseria meningitidis indicate that while pneumococcal meningitis is the main issue, there is a need for improved diagnostic skills to reliably identify and classify additional agents that cause the disease. The absence of confirmed cases in other subdistricts, despite suspected cases, suggests gaps in laboratory confirmation and possible underreporting. These findings aligns with the results of the outbreak report in Brong Ahafo Region in 2016 indicating the Meningitis outbreak in the region due to Streptococcus Pneumonia. This could also mean that the recommendations from previous studies suggesting mass vaccination of the affected communities may have been taken into consideration by the Ghana Health Service that has led to the decrease in Bacterial Meningitis (Neisseria meningitides) in the Municipality (Letsa *et al.*, 2018a).

Our analysis found an increase in cases reported in the first quarter of each year under review. The increase in suspected cases was observed in all five years (2015 – 2019). This observation is similar to a study done in Tanguieta, in the Atacora Region of Benin that also saw an increase in meningitis cases exceeding the alert threshold in the early part of a year (week 4 to 6) of 2016 and the outbreak investigaton conducted in Nigerbetween November 2022 and January 2023 ('Bulletin Meningite, 2018) In contrast, the Nandom district in the Upper West Region of Ghana achieved the epidemic level at week 43, while the Lawra district reached its alert threshold at week 42, indicating variation in the seasonal pattern of increased meningitis cases due to geographical locations and time (WHO., 2011). While no confirmed outbreaks were recorded during the period, clusters of suspected cases in specific epidemiological weeks warrant continued vigilance and preparedness for potential outbreaks.

Timeliness of response was observed to be effective from case detection to sample collection and analysis. The average timelines from the date of onset, date seen at facility, date of sample collection, and date sample tested are approximately one day, meaning there was an effective collaboration between the disease control unit and laboratory services in that locality. This collaboration may have contributed to their swift response to prevent the occurrence of the outbreak in the Municipality and reduce high fatality. However, timeliness and completeness of weekly reports to the next level were never attained for the reporting period and by subdistricts probably because there were no criteria set to monitor the facilities reporting. Timeliness and completeness are significant indicators in the IDSR and may hinder the Municipality's overall performance. The lack of timely reporting may indicates delays in detecting and responding to health concerns, which may result in the uncontrolled transmission of diseases and delayed treatments. (IDSR 2nd Ed Gh Revised, 2017). Consistent late and incomplete reporting from subdistrict facilities highlights systemic challenges in the surveillance system, which may delay outbreak detection and response

Moreover, we observed no form of an outbreak as no confirmed meningitis cases exceeded the alert or epidemic thresholds. This statement agrees with the WHO 2019 bulletin report for West Africa. According to the report, "from week 40 to 44 (November 2019), one district in Ghana crossed the epidemic threshold. Four other districts reached the alert threshold in 4 countries (Benin, Ghana, Nigeria, and Chad) during the same period" (Who, 2011)('IDSR) Technical Guidelines,2019', no date). Limitations

A significant proportion of the cases had missing demographic information, including age and sex, which limited a detailed epidemiological analysis It became

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unachievable due to the Covid-19 pandemic as some healthcare staff was asked to work at home when they considered their surroundings unsafe. However, while demographic data such as age, sex, and meningitis subtypes were analyzed and presented in Table 2, a substantial portion of the data remained incomplete. This was managed by excluding cases with missing values from specific analyses. For instance, cases with unreported age or sex were categorized as "unknown" to ensure that the available data could still provide meaningful insights while acknowledging its limitations.

The study relied entirely on secondary data extracted from the District Health Information Management System (DHIMS). This limited control over the quality and completeness of the dataset. Missing data in key variables restricted the scope of detailed analysis and may have introduced biases in the findings.

CONCLUSION AND IMPLICATION

The analysis found a low incidence of Meningitis among the residents, however, 2016 accounted for the high incidence rate for the five years studied. The analysis also found suspected outbreaks at the beginning of 2015 and 2016, but the response to prevent it from becoming an epidemic in the Municipality might be timely. The Municipality could not meet the WHO target of 80% timeliness and completeness of weekly reporting for the five years.

The study highlights the need for improved outbreak investigation and management in resource-limited settings like Sunyani Municipality. Strengthening training and capacity-building efforts for healthcare workers to standardize case definitions and improve data reporting is critical at the Sunyani Municipality. Improved diagnostic infrastructure is essential for accurate identification of causative agents, which could guide targeted interventions such as vaccination campaigns. Community engagement, risk communication, local capacity for data analysis, and equitable resource allocation are also essential for early detection and response. These strategies provide a comprehensive framework for mitigating outbreak impacts.

DECLARATIONS

Ethical Considerations: This exercise was conducted as part of support for routine surveillance system evaluation conducted by the Ghana Health Service. Institutional permission was obtained from the Ghana Health Service, Bono Regional Health Directorate and the Sunyani Municipal Health Directorate to use their data for the analysis.

Conflict of Interest: All authors disclose that there are no conflicts of interest whatsoever.

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Table 1

Table 1: : Incidence and case fatality of Meningitis by year, Sunyani Municipality, 2015-2019

Year	Mid-Year Population	Suspected cases	Lab confirmed cases	Deaths	Case fatality rate (%)	Incidence per 100,000 pop
2015	138,002	16	2	1	50.00	2/138,002 (1.45)
2016	141,251	38	11	3	27.30	11/141,251 (7.79)
2017	144,502	19	3	1	33.30	3/144,502 (2.08)
2018	147,826	2	1	2	100.00	1/147,826 (0.68)
2019	151,378	9	0	0	0.00	NA
Total	**722,959**	**84**	**17**	**7**	**41.2**	**17/722,959 (2.4)**

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Table 2: Distribution of Meningitis by age group, sex, meningitis subtypes, subdistrict, and year, Sunyani Municipality, 2015 – 2019

Variables	Suspected Cases	Lab confirmed cases	Deaths	Case fatality rate (%)	Proportion confirmed cases (%)
Age group	**(N =84)**	**(N = 17)**	**(N = 7)**		
<5 Years	1	1	1	1/1 (100%)	1/1 (100%)
5 -14 Years	6	4	1	1/4 (25.0%)	4/6 (66.7%)
15 years and Older	33	9	2	2/9 (22.2%)	9/33 (27.3%)
Age Unknown	44	3	3	3/3 (100%)	3/44 (6.8%)
Sex	**(N=84)**	**(N=17)**	**(N=7)**		
Male	18	4	1	1/4 (14.3%)	4/18 (22.2%)
Female	21	9	2	2/9 (22.2%)	9/21 (42.9%)
Unknown sex	45	4	4	4/4 (100%)	4/45 (8.9%)
Meningitis Subtype	**(N=84)**	**(N=17)**	**N= 7**		
Strep pneumoniae`	34	12	2	2/12 (16.7%)	12/84 (14.2%)
Neisseria meningitidis	1	1	1	1/1 (100%)	1/84 (1.2%)
Unknown Sub-type	49	4	4	4/4 (100%)	4/84 (4.8%)
Sub-districts	**(N=84)**	**(N=17)**	**(N=7)**		
Abesim	0	0	0	0/0(0.0%)	0/84 (0.0%)
Antwikrom	0	0	0	0/0(0.0%)	0/84 (0.0%)
New Dormaa	0	0	0	0/0 (0.0%)	0/84 (0.0%)
New Town-bakoniaba	4	0	1	NA	NA
Penkwase	35	9	6	6/9 (66.7%)	9/35 (25.7%)
Sunyani Central	45	8	0	0/8 (NA)	8/45 (17.8%)
Year	**(N=84)**	**(N=17/84)**	**(N=7)**		
2015	16	2	1	1/2 (50.0%)	2/16 (12.5%)
2016	38	11	3	3/11 (27.3%)	11/38 (28.9%)
2017	19	3	1	1/3 (33.3%)	3/19 (15.8%)
2018	2	1	2	(NA)	1/2 (50.0%)

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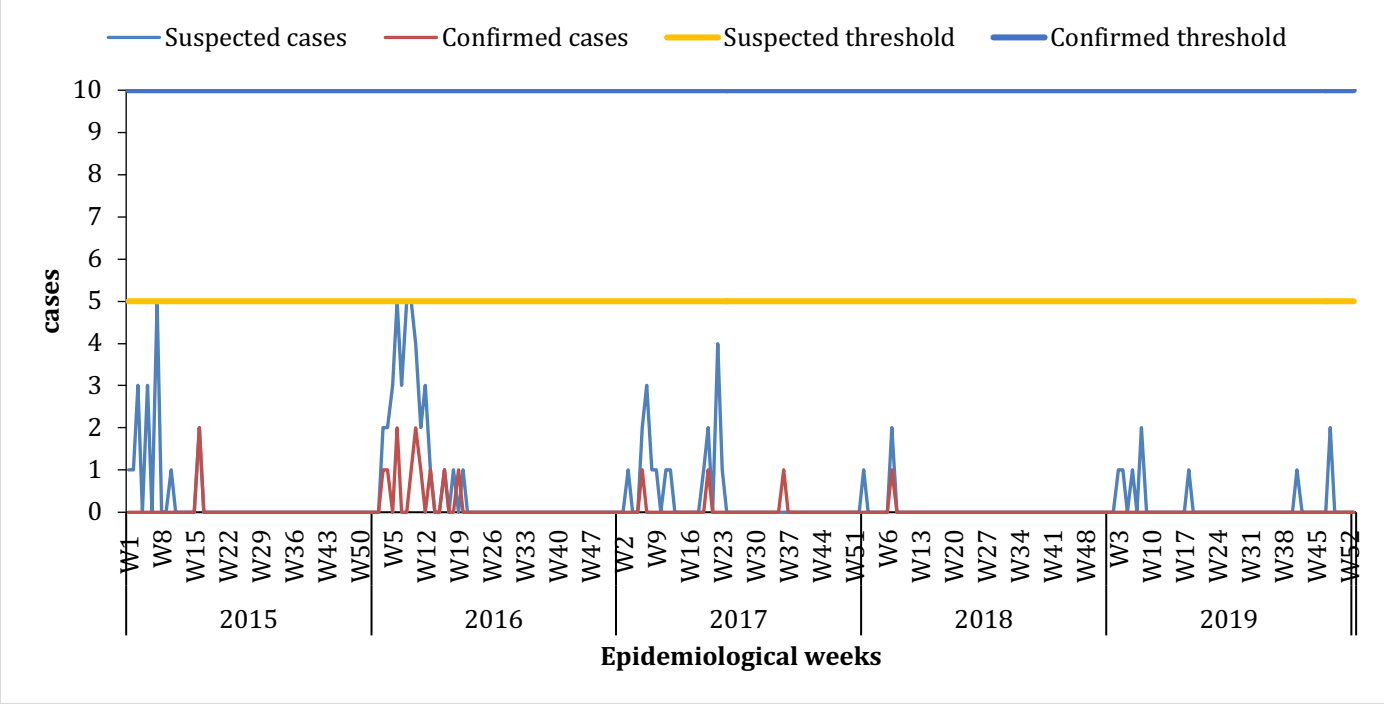

Figure 2: Trend of Meningitis by week, Sunyani Municipality, 2015 – 2019

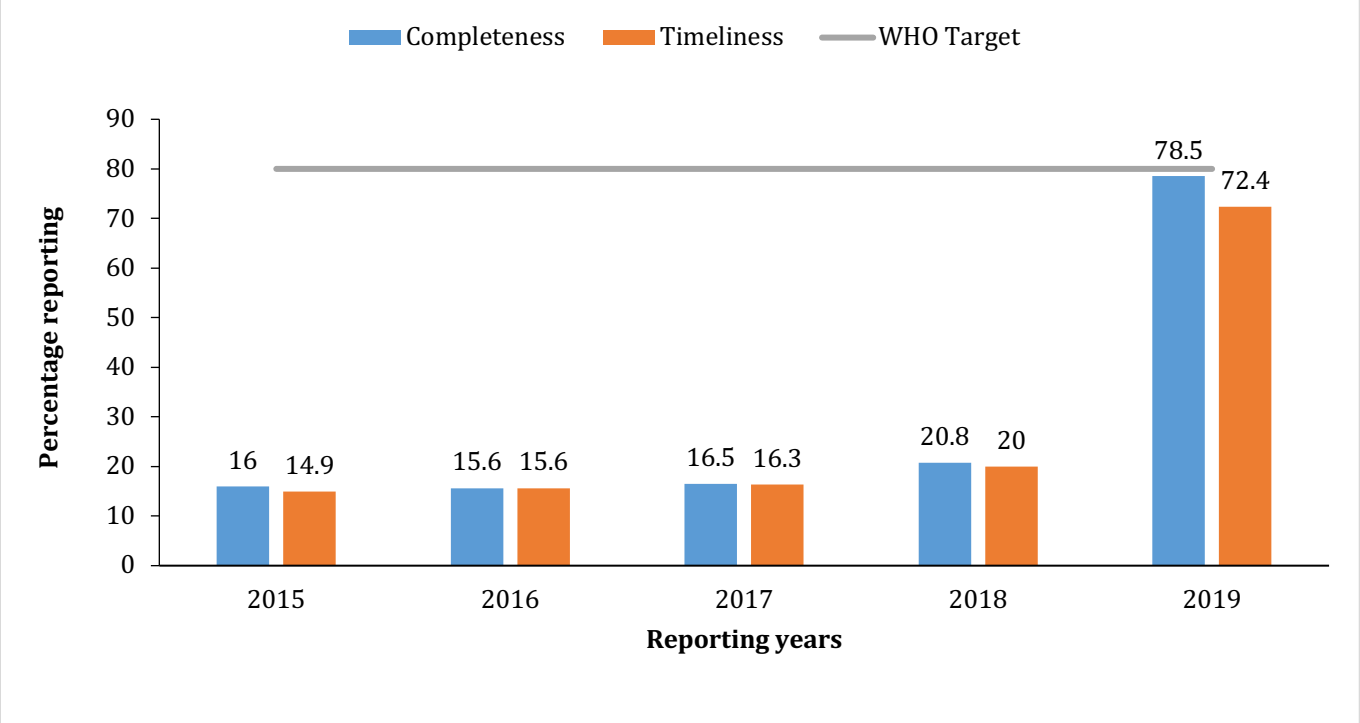

Figure 3: Completeness and Timeliness of reporting by year, Sunyani Municipality 2015 – 2019

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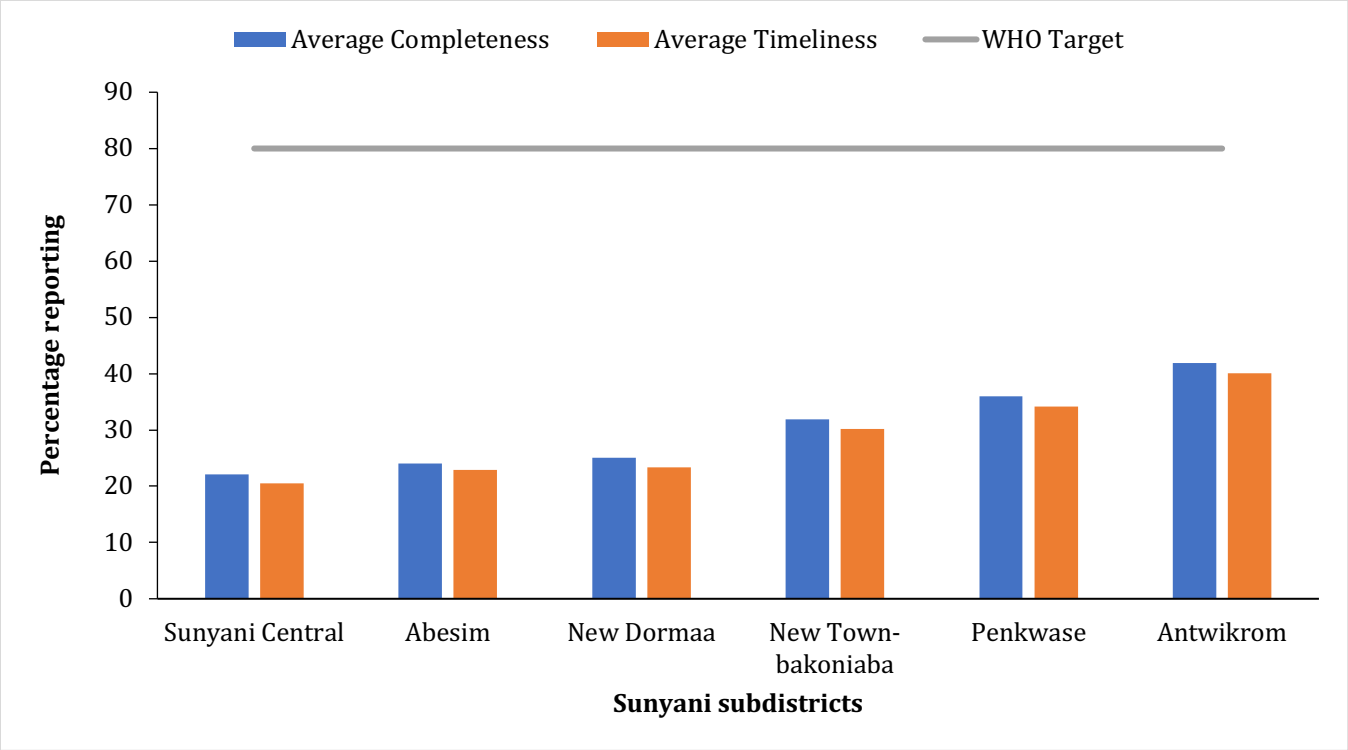

Figure 4: Completeness and Timeliness of reporting by subdistricts Sunyani Municipality, 2015 – 2019