

Original Research Article**Analysis of bacterial meningitis surveillance data, 2011-2015,
East Mamprusi District, Ghana.****Abstract**

Background: Globally meningitis mortality ranges between 2% and 30% and that of Ghana is estimated to range between 36% to 50%. The East Mamprusi district in Ghana reports cases due to its location in the meningitis belt. This study assessed the distribution of cases in the district by person, place and time from 2011-2015.

Methods: Meningitis surveillance data in the East Mamprusi district in northern Ghana from 2011- 2015 was analyzed. Case based forms, laboratory tests results and weekly line lists were reviewed. MS excel was used to analyze the data. We calculated the incidence of the disease and assessed the trend using the alert and epidemic thresholds. We determined the distribution of cases by persons. Case fatality rates and prevalence of etiological agents were estimated.

Results: The Northern Region recorded a total of 961 suspected meningitis cases from 2011-2015. Of this number, 205 were confirmed of various organisms with 77 deaths. Between 2011 and 2015, 376 suspected and confirmed meningitis cases were reported from East Mamprusi district. With males representing 57.5% (216/376). About 20% (75/376) of the cases were below one year. The median age of cases was 15 (range 1-77years). The highest number of cases 36.7% (138) were reported from Nalerigu Sub-district. Every year, meningitis incidence increased between January and May. The case fatality rate increased from 4.0% in 2012 to 13.3% in 2015. *N. meningitides*, *S. pneumonia* and *Nm W135* were the common etiological agents in the East Mamprusi District.

Most of the cases were reported among the venerable age group of 1-15 years and from the district capital. There is an observed impact of a 2012 vaccination campaign in the district. It has led to a decline of meningitis cases in the district. There has been reported outbreaks over the period and most outbreaks were reported during the dry and windy season. Case fatality rate is on the increase though incidence is declining. N. meningitides is the prevalent etiological agent isolated.

Key words: Meningitis, Surveillance, Analysis, data, Mamprusi east district

1.0 Introduction

Meningitis is an inflammation of the meninges. The meninges are the three membranes that cover the brain and spinal cord. Meningitis can occur when fluid surrounding the meninges becomes infected (1). Viral and bacterial meningitis are contagious. They can be transmitted by coughing, sneezing, or close contact (1).

Bacterial meningitis remains a source of substantial morbidity and mortality in childhood (2). Meningitis is a life threatening central nervous system infection that is prevalent worldwide (3). Pneumococcal meningitis continues to be associated with high rates of mortality and long-term neurological sequelae. The most common route of infection starts by nasopharyngeal colonization by *Streptococcus pneumonia* (4).

The causative organism varies with age, immune function, immunization status, and geographic region, and empiric therapy for meningitis is based on these factors (5). The disease epidemiology is changing rapidly due to immunization practices and changing bacterial resistance patterns (5). As a part of the United Nations Millennium Development Goal 4, the WHO has introduced a new vaccine policy to improve vaccine availability in resource poor countries (5).

Categorisation of countries by risk of meningococcal disease.

HIGH:

Countries with >10 cases/100,000 population)

51 and/or > =1 epidemic over the last 20years.

52 MODERATE:

53 Countries with 2–10 cases/100,000population per year.

54 LOW:

55 Countries with <2 case/100,000 population per year.

56 Classification based on country-specific epidemiological data with pre-defined cutoffs of
57 high, moderate, and low endemicity categories as used by the WHO's Strategic
58 Advisory Group of Experts on Immunizations (SAGE) in its recently updated
59 recommendations on the use of meningococcal vaccines (6).

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61 ***Meningococcal Vaccines: WHO position paper, November 2011. Weekly***
62 ***Epidemiological Record. 2011. pp. 521–540.***

63 Meningococcal disease is found worldwide, with the highest incidence of disease found
64 in the 'meningitis belt' of sub-Saharan Africa. In this region, major epidemics occur
65 every 5 to 12 years with attack rates reaching 1,000 cases per 100,000 population.
66 Other regions of the world experience lower overall rates of disease and occasional
67 outbreaks, with annual attack rates of around 0.3 to 3 per 100,000 population (7).

68 Ghana experienced widespread CSM epidemics with high morbidity and mortality in
69 1984/85 and 1996/97 (8). During the 1996/97 epidemic, about 19,000 people were
70 affected with 1,200 deaths in almost all districts of the three northern regions of the
71 country. Ghana has since experienced minor focal outbreaks each year during the dry
72 season in the three regions which lie within the Meningitis belt of Africa (8). Between
73 2011 and 2015, the Northern Region recorded a total of 961 suspected meningitis
74 cases. Out of this number, 205 were confirmed of various organisms and out of that, 77
75 deaths were recorded. During December 9, 2015-February 16, 2016, a total of 432
76 suspected meningitis cases were reported to health authorities in the three northern
77 regions. The Ghana Ministry of Health, with assistance from CDC and other partners,
78 tested cerebrospinal fluid (CSF) specimens from 286 patients (9).

Accurate estimation of global, regional, and national burden meningitis in children is problematic for some reasons. The incidence of meningitis in populations can be adequately estimated generally only by longitudinal studies in the community. Such studies are not common in developing countries, where the burden of meningitis is higher, partly because such studies require a greater commitment of researchers and investors over a longer period (10).

Meningitis is one of the epidemic prone diseases in Ghana and it is being reported weekly, including zero reporting. Surveillance of this condition like other priority diseases such as measles and acute flaccid paralysis (AFP) is mainly passive. However, periphery services that generate, collate and transmit the data to higher levels do not conduct rigorous data analysis and hence sometimes overtaken by seasonal focal outbreaks. The analysis of a five-year meningitis data will help determine the magnitude, trend and distribution of cases to make recommendations for effective surveillance and control.

2.0 Methods

2.1 Study type

This study was a secondary data analysis of meningitis surveillance data in East Mamprusi district (EMD) between 2011 and 2015. All reported and recorded cases of meningitis over the five year period was analyzed.

2.2 Study area

The East Mamprusi District (EMD) is one of the oldest districts in the Northern Region of Ghana with a land mass of 3,037Km². It lies within the imaginary boundaries of the meningitis belt of sub-Sahara Africa that extends from Senegal in West Africa to Ethiopia in East Africa and experiences annual dry and dusty northeastern trade wind from November to March. Hence, it is one of the meningitis epidemic prone districts in Ghana. Projected population of the district was 139,606 in 2015 and majority of the people are subsistence farmers. The district is divided into five (5) health sub-districts

namely Gambaga, Gbintri, Langbensi, Nalerigu and Sakogu. A sub-district has at least a health centre as the first periphery referral point and a number of Community-Based Health Planning and Services (CHPS) compounds manned by health personnel. Baptist Medical Centre (BMC) in Nalerigu – a mission health facility is the major health facility that serves the district and beyond including southern districts of the Republic of Togo.

2.3 Data collection

We reviewed reported IDSR case based forms, laboratory test results of CSF and weekly line lists of meningitis incidence in East Mamprusi District. A Microsoft Excel softcopy template for meningitis data was adopted from the East Mamprusi District Health Administration and modified for data abstraction. Demographic data captured included age, sex and residence (proxy: sub-district). Other variables collected included time of onset, etiological agents (from laboratory test results of CSF specimens), and treatment outcome and immunization status of cases. We interviewed the District Disease Control Officer on meningitis surveillance and on any record of outbreak between 2011 and 2015. The data was obtained from disease surveillance and health information departments of the East Mamprusi Health Directorate.

2.4 Data analysis

We initially sorted the data set by date of onset and aggregated case incidence by epidemiological weeks. The data was entered into Microsoft Excel 2010 for the analysis. We further summed the incidence by month and year to observe monthly and annual trends respectively. We determined the weekly incidence of meningitis and compared with the alert and epidemic thresholds. These thresholds are indicators for monitoring the weekly incidence of meningitis disease to identify possible outbreaks. In addition, we determined the annual incidence. Proportion of cases by age was calculated. Annual prevalence of etiological agents was determined for the study period. We also calculated annual case fatality rates. The results were presented in tables and graphs.

133 3.0 RESULTS

134 3.1 Socio-demographic distribution of cases

135 Between 2011 and 2015, three hundred and seventy six (376) suspected and confirmed
 136 meningitis cases were reported from EMD, with males representing 57.5% (216/376)
 137 (Table 1). About 20% (75/376) of the cases were below one year. The median age of
 138 cases at one year and older was 15 (min 1 and max 77). The commonest affected age
 139 group across the study period was 1 to 15 years (Figure 1). The incidence of
 140 meningitides in this age group increased from 2011 to 2013 and decreased in the
 141 subsequent two years. Averagely, meningitis incidence was low in the age group of 60
 142 years and older (Figure 1).

143 Nalerigu Sub-district recorded the highest incidence rates of meningitis for the period.
 144 The fall in rates was systematic in Gambaga and Gbintri Sub-districts from 2011 to 2014
 145 (Figure 2).The incidence rate of meningitis remained virtual same from 2011 to 2015 in
 146 the other sub-districts (Figure 2).

147 **Table 1: Socio-demographic characteristics of meningitis cases, East**
 148 **Mamprusi District, Ghana, 2011 – 2015.**

Characteristic	Frequency	Proportion (%)
Gender		
Male	216	57.5
Female	160	42.5
Total	376	100%
Age/yrs		
< 1	75	20
1 – 15	157	41

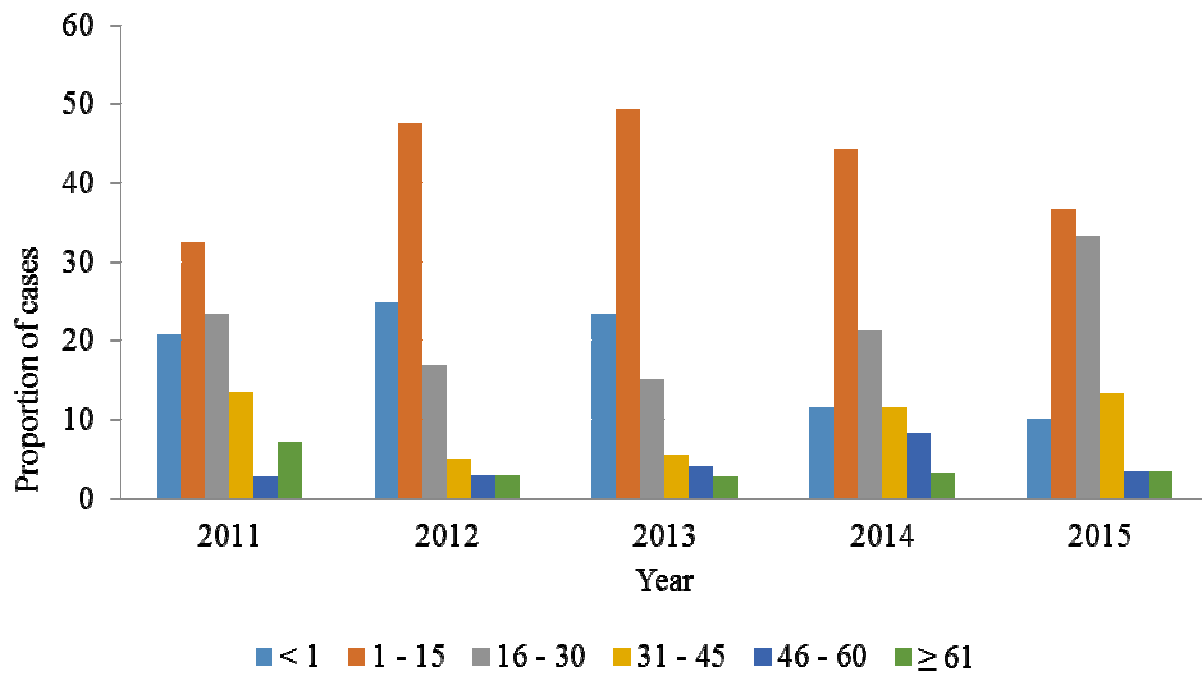
16 – 30	77	21
31 – 45	35	9
46 – 60	14	4
≥ 61	18	5
Total	376	100%
Sub-district		
Nalerigu	138	36.7
Gambaga	68	18.1
Sakogu	62	16.5
Langbensi	60	16.0
Gbintri	48	12.8
Total	376	100%
Year		
2011	111	29.5
2012	101	26.9
2013	73	19.4
2014	61	16.2
2015	30	8.0
Total	376	100%

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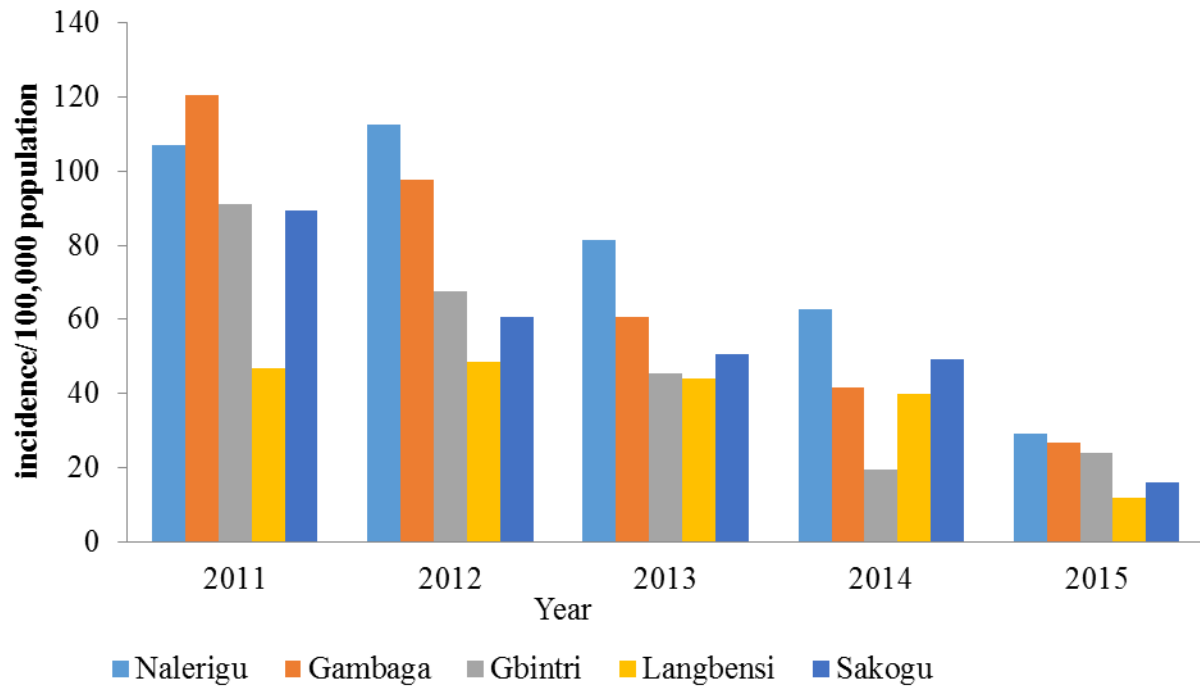
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Socio-demographic data of meningitis cases, east Mamprusi district, 2011-2015.

151 Figure 1: Annual distribution of meningitis cases by age, East Mamprusi district, Ghana,
152 2011-2015.



163 Figure 2: Annual incidence rate of meningitis by sub-districts, East Mamprusi district,
164 Ghana, 2011-2015.



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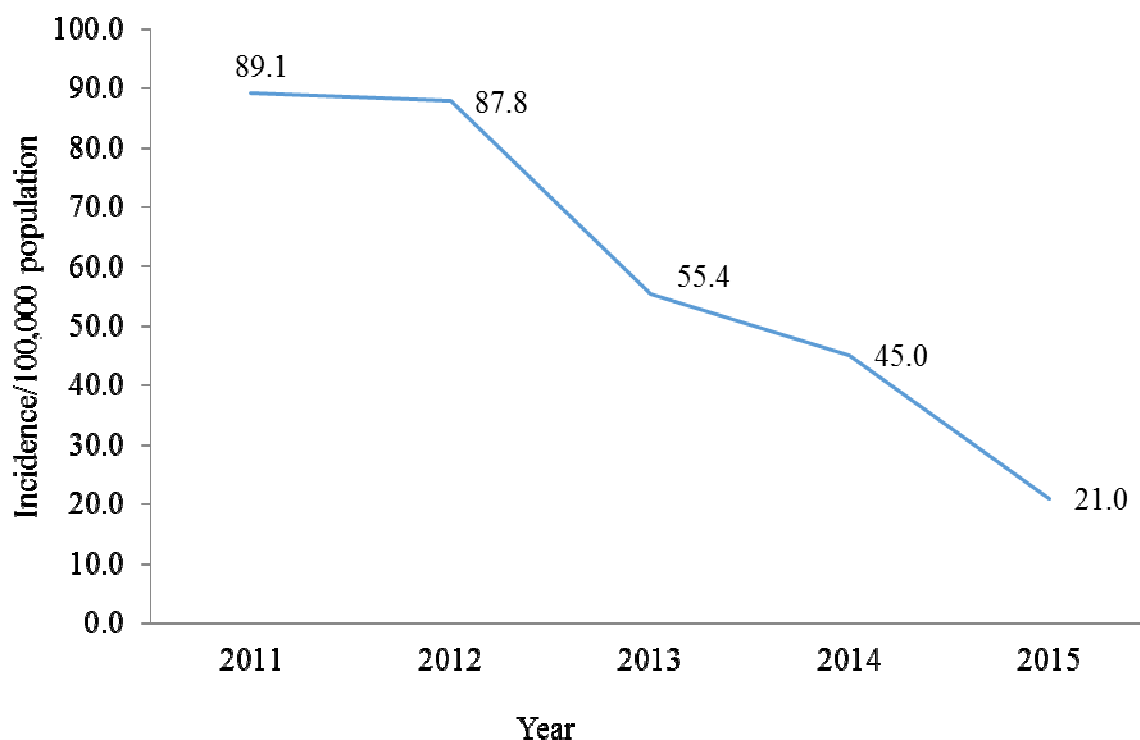
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3.2 Annual trend of meningitis cases

A decrease in incidence was observed within the surveillance data period. Between 2011 and 2012, meningitis incidence decreased marginally from 89.1/100,000 population to 87.8/100,000 population in the East Mamprusi District. The annual incidence rate decreased sharply from 87.8/100,000 population in 2012 to 55.4/100,000 population in 2013. A continued downward incidence rates was observed in the subsequent two years but not comparable to the 2013 record (Figure 3).

Figure 3: Trend of annual incidence of meningitis, East Mamprusi District, Ghana, 2011-2015



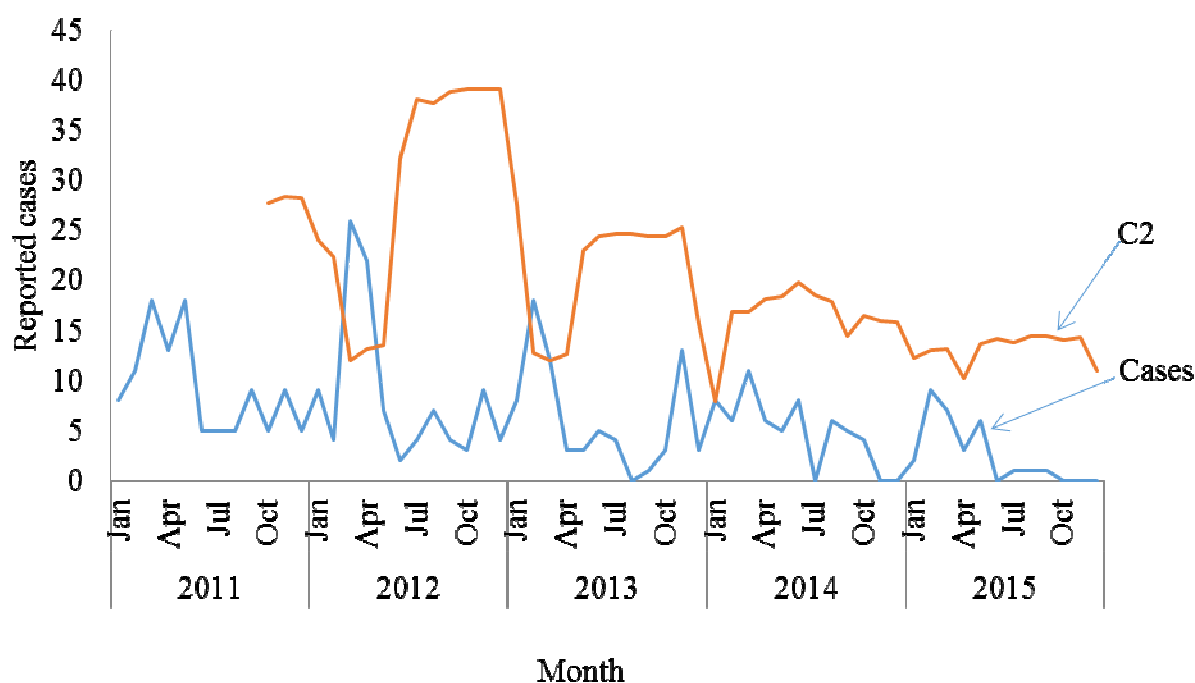
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189 3.3 Monthly trend of cases

190 Every year, meningitis incidence increased between January and May (Figure 4). In
 191 2012 and 2013, meningitis cases were more than expected from March to May and
 192 February to March respectively. In addition, for these two years, cases increased after
 193 October.

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195 Figure 4: Monthly meningitis incidence, East Mamprusi district, Ghana, 2011-2015.



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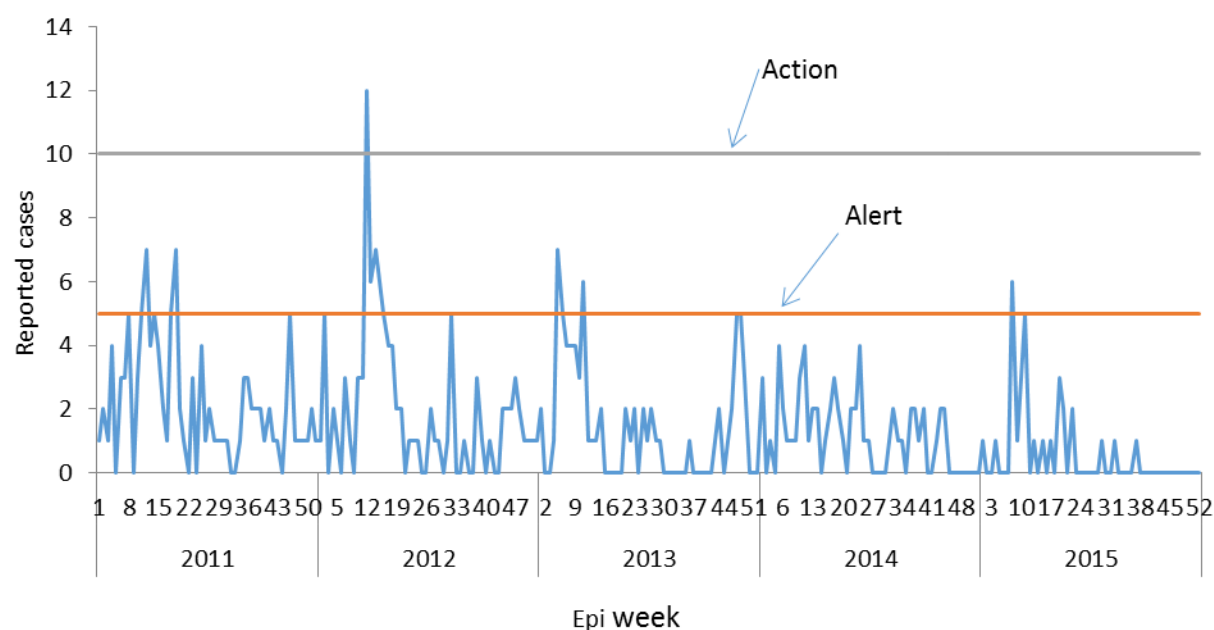
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3.4 Trend of cases by weeks

In 2012, meningitis incidence (12 cases) exceeded the epidemic threshold in week 12. The weekly meningitis cases reached or exceeded the alert threshold at least twice annually with the exception of 2014. Averagely, cases increased between weeks 5 and 20 every year (Figure 5).

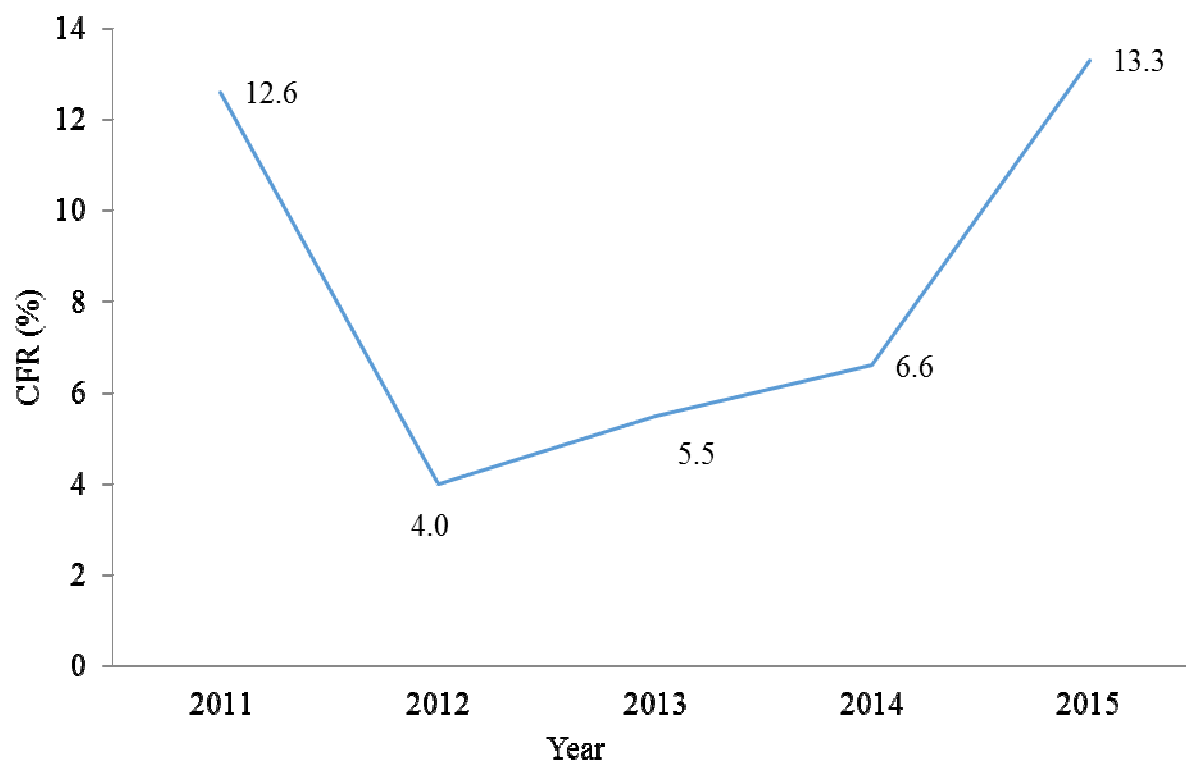
Figure 5: Weekly reported suspected and confirmed meningitis incidence, East Mamprusi district, Ghana, 2011-2015.



3.5 Trend of case fatality rate (CFR)

Figure 6 shows the annual CFR of meningitis cases in the East Mamprusi District. The highest CFR (13.3%) was recorded in 2015. In 2011, the CFR was 12.6% and decreased steeply to 4.0% the following year. CFR rose gradually in the subsequent two years after 2012, but a sharp increase occurred between 2014 and 2015 (6.6% and 13.3% respectively).

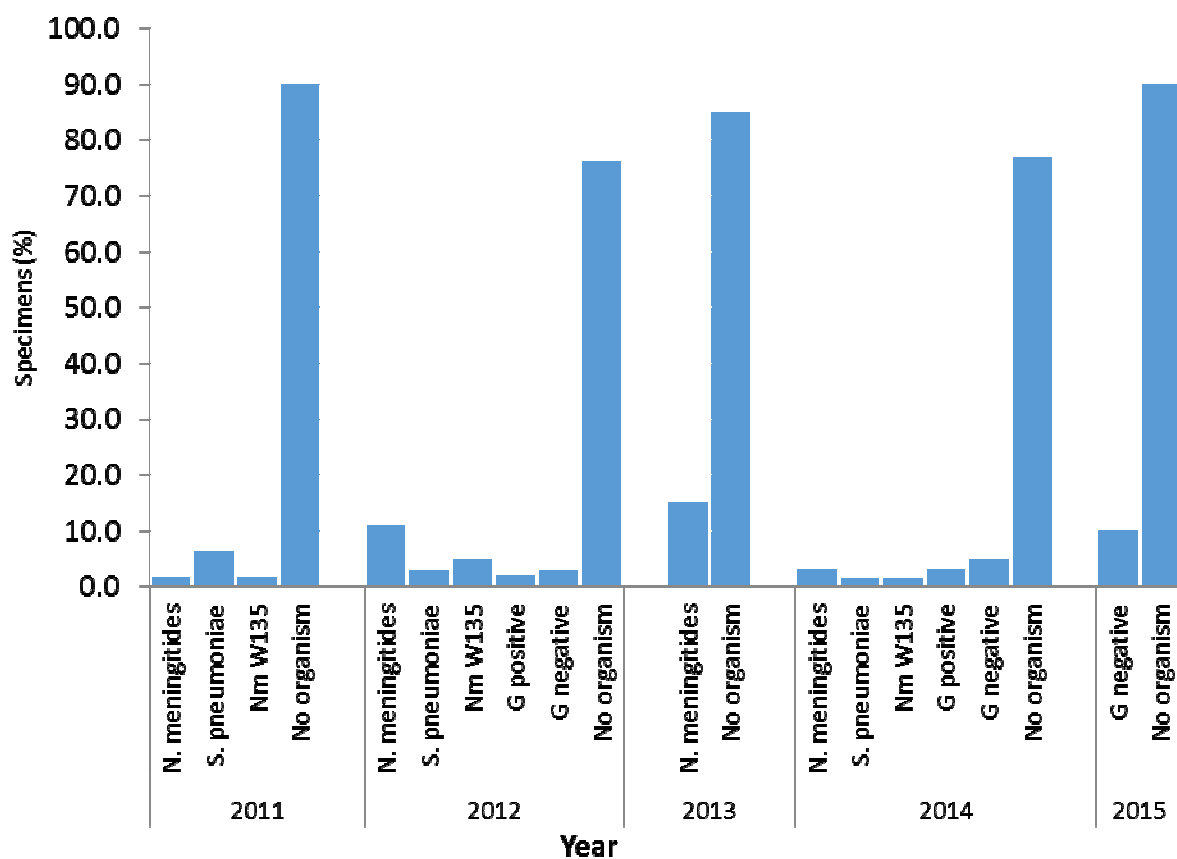
Figure 6: Annual CFR of meningitis cases, East Mamprusi district, Ghana, 2011-2015.



3.6 Distrubution of etiological agents of meningitis

As shown in the figure 7, organisms were not reported in most of the annual CSF specimens. *N. meningitides*, *S. pneumonia* and *Nm W135* were the common etiological agents in the East Mamprusi District. Streptococcal pneumonia was the commonest agent isolated in 2011. Neisseria meningitides was the prevalent microbial agent in the district between 2012 and 2014.

Figure 7: Annual distribution of pathogens (latex, culture, PCR) in CSF specimens, EMD, Ghana, 2011-2015.



241 **4.0 Discussion**

242 The age group 1-15 years were most affected because they are a venerable age group
 243 due to their low immunity. A study in Burkina-Faso showed that annual national
 244 incidence of meningococcal meningitis was highest among infants aged <1 years(11).
 245 Pneumococcal bacteria are also spread by close contact with an infected person and by
 246 coughing, sneezing etc. However, in most cases they only cause mild infection, such as
 247 a middle ear infection (otitis media). Those with a poor immune system may develop a
 248 more severe infection such as meningitis (12).

249 Nalerigu sub-district is the capital and has a higher population. The relatively higher
 250 population density may be a factor for the higher incidence compared to the other sub-
 251 districts.

252 The continuous decline of cases can be attributable to improved vaccination coverage
 253 and control measures. In 2012, MenAfriVac conjugate vaccine was introduced in the
 254 district and children between 1 and 29 years vaccinated. In Calgary Canada, a study on
 255 the impact of vaccination showed that invasive pneumococcal disease in children
 256 decreased from an average of 17 cases/100,000/year in 2000/2001 to 4
 257 cases/100,000/year in 2015 after the vaccination program (13).

258 The monthly trend of cases shows peaks from February to May, possibly due to the
 259 weather conditions during this period when the infection can thrive and spread. In 2012
 260 and 2013, there were outbreaks between "March and June" and February 2013
 261 respectively. The system was able to detect the 2012 outbreak but failed in 2013. This
 262 could be due to the reduction in annual incidence or inadequate peripheral data
 263 analysis.

264 Though the incidence of cases has declined over the period, the case fatality rate is on
 265 the increase possibly due to poor case management and or late case reporting. Periodic
 266 stock out of materials (rapid kits and reagents) in first-line laboratories responsible for

267 confirmation of causal agents might have resulted to delay in appropriate treatment and
268 poor outcome.

269 *N. meningitides* was the prevalent etiological agent isolated from CSF specimens within
270 the period (2011 – 2015). Other agents included *S. pneumonia* and *Nm. W135*. The
271 poor understanding of meningitis causal agents' epidemiology in Ghana resulted to
272 unexpected seasonal focal outbreaks in recent years. Also, CSF specimens were not
273 totally typed for other strains of Neisseria due to inadequate logistics.

274 **5.0 Conclusion**

275 Most of the cases were reported among the venerable age group of 1-15 years and
276 from the district capital. There is an observed impact of a 2012 vaccination campaign in
277 the district. It has led to a decline of meningitis cases in the district. There has been
278 reported outbreaks over the period and most outbreaks were reported during the dry
279 and windy season. Case fatality rate is on the increase though incidence is declining. *N.*
280 *meningitides* is the prevalent etiological agent isolated.

281 **6.0 Competing interest**

282 The authors declare no competing interest.

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