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Bacterial Meningitis: A Review in the Upper East Region of Ghana 2010-2014

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Authors' contributions

This work was carried out in collaboration between all authors. Author JKLO did the study design and wrote the protocol. Authors JKAW, EA, JKO, JO, JKLO and BA did the statistical analysis and literature searches while analyses of study were by authors DKA and OSO. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Meningitis is an acute inflammation of the protective membranes covering the brain and the spinal cord. It can cause severe brain damage and is fatal in 50% of cases if untreated. The Upper East Region (UER) of Ghana recorded 70 case-patients in 2014 with a case fatality of 10%. Furthermore, there have been series of out outbreaks of bacterial meningitis in the region. The study reviewed meningitis surveillance data to assess the progress towards interruption

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of meningitis transmission and identified opportunities for surveillance improvement in the UER.
Methods: This involved records review and secondary data analysis of all reported meningitis cases in the Region from 2010 to 2014. Data quality was assessed: described by person, place, time, causative agents involved and identified opportunities for system improvement.
Results: Of 1142 suspected cases of meningitis recorded at the health facilities and communities in the UER, 352(30.8%) were confirmed cases of various forms of Bacterial meningitis. Majority of the cases (50.7%) were males. The age group 0-9 years was mostly 491(43.0%) affected. There were 146 deaths, giving a case fatality rate of 13.0%. The identified etiological agents were *Neisseria meningitides* (Nm W135) 50.3%, *Streptococcus pneumonia (*41.7%), *Neisseria meningitides* (Nm A) 1.7%, *Neisseria meningitides* (Nm Y 5%), *Haemophilus Influenzae* Type B1.5%. Majority of the case-patients were observed in 2010 (34.7%) and 2012 (44.2%) between February and April (%). The Kassena Nankana Municipal recorded the highest number of cases 234(20.5%) and the Bulsa South District recorded no case of bacterial meningitis cases. 69 (6%) of case-patients had no lumber puncture done. Time spent before presentation of case-patients to the health facilities had no significant association with the outcome of the infection (p= 0.319).
Conclusions: There has been a consistent outbreak of Bacterial meningitis in the Upper East Region that involved many cases-patients with some mortality. More bacterial meningitis cases were recorded in children compared to adults. Lumber puncture was not performed in all case-patients. Many case-patients were recorded in the first quarter of the year with the majority in the Kassena Nankana District. There is an urgent need to review the management of meningitis, coupled with enhanced strategies in prevention of occurrences of the disease in the Upper East Region of Ghana.

Keywords: Bacterial meningitis; outbreak; Upper East Region; Ghana.

1. INTRODUCTION

Meningitis is an acute inflammation of the protective membranes covering the brain and spinal cord, known collectively as the meninges [1]. The inflammation may be caused by infection with viruses, bacteria, or fungi, and less commonly by certain drugs, subarachnoid haemorrhage, cancer and other conditions [2]. *Neisseria meningitidis, Haemophilus influenza type b* (Hib), and *Streptococcus pneumoniae* constitute the majority of all cases of bacterial meningitis, and 90% of Bacterial meningitis in children. Among the 13 subtypes or serogroups of *N. meningitidis* identified, six are recognized to be the main causes of epidemics. The pathogenicity, immunogenicity, and epidemic capabilities differ according to the serogroup. Thus the identification of the serogroup responsible for an outbreak is crucial for its containment [3].

Bacterial meningitis infection can cause severe brain damage and is fatal in 50% of cases if untreated. Although meningitis is a notifiable disease in many countries, the exact incidence rate is unknown although there had been a decline in the number of cases [4]. In 2013 meningitis resulted in 303,000 deaths compared to 464,000 in 1990 globally [5].

The bacteria are transmitted from person-to-person through droplets of respiratory or throat secretions from carriers. *N. meningitidis* can be found growing in the nose and throat of about 10% of healthy people and this enables the bacteria to be spread through exposure to infected respiratory secretions. Though the immune system of these “carriers” keeps the bugs in check, this can sometimes fail and *N. Meningitidis* enters the bloodstream and travels to the brain, where it infects the meninges and causes inflammation. The classic triad of diagnostic signs consists of nuchal rigidity, sudden high fever, and altered mental status. However, all the three features are present in only 44–46% of bacterial meningitis cases [6,7]. Initial diagnosis of Bacterial meningitis can be made by clinical examination followed by a lumbar puncture showing a purulent spinal fluid.

A range of antibiotics can treat the infection, including penicillin, ampicillin, chloramphenicol and ceftriaxone. Under epidemic conditions in Africa in areas with limited health infrastructure and resources, ceftriaxone is the drug of choice. Meningococcus vaccines exist against groups A, B, C, W135 and Y [8]. Until recently in Africa, the approach for prevention and control of meningococcal epidemics was based on early detection of the disease and emergency reactive mass vaccination of the at-risk population with

bivalent A/C or trivalent A/C/W135 polysaccharide vaccines, though the introduction of MenAfriVac (meningococcus group A conjugate vaccine) has demonstrated effectiveness in young people and has been described as a model for product development partnerships in resource-limited settings [9].

Until recently, outbreaks due to meningitis were not common. A major outbreak was recorded first in Geneva in 1805; this was followed by other outbreaks in Europe and in the America [10,11]. The rate of Bacterial meningitis in the Western countries is about 3 people per 100,000 annually with viral meningitis being more common, at 10.9 per 100,000, and occurring more often in the summer. The rate of Bacterial meningitis in Brazil, however, is higher, 45.8 per 100,000 annually [7].

Africa recorded its first outbreak of meningitis in 1840, since then, major outbreaks occurred in Nigeria and Ghana in 1905–1908 [10]. Sub-Saharan Africa has been plagued by large epidemics of Bacterial meningitis for over a century, [12], leading to it being labeled the "meningitis belt". Epidemics typically occur in the dry season (December to June). The largest epidemic ever recorded in history swept across the entire region in 1996–1997, causing over 250,000 cases and 25,000 deaths [13].

Between 26 January and 5 March 2015, 652 suspected cases of meningococcal disease, including 50 deaths were reported in 10 local government areas of 2 states, Kebbi and Sokoto in Nigeria. Laboratory tests have confirmed the predominance of *Neisseria meningitides* serogroup C in the affected areas [14].

During the 2014 epidemic season, 19 countries in the meningitis belt reported a total of 14 317 suspected meningitis cases including 1304 deaths (case-fatality: 9.1%). In 2013, outbreaks of meningitis were reported in Guinea and South Sudan; 404 suspected cases (38 deaths) and 196 suspected cases (13 deaths) were notified. Additionally, outbreaks of meningitis were reported in Benin (1 district), Burkina Faso (1 district), and Nigeria (3 districts). These outbreaks were of short duration and the predominance of the Nm bacteria was not confirmed [14].

Ghana as well as the Upper East Region (UER) continues to record outbreaks of bacterial meningitis. The UER has a seasonal hyperendemicity and epidemic occurrence of meningitis. In 2014 as many as 470 suspected cases were notified throughout the country out of which 104 cases were confirmed with 67 deaths. The UER of Ghana similarly, recorded series of outbreaks: 70 suspected cases were recorded with 7 deaths in 2014. We therefore reviewed and analysed the 2010 to 2014 meningitis surveillance data in the Upper East Region. This was to enable us assess the progress towards interruption of bacterial meningitis transmission in the region based on the magnitude of cases, the distribution by person, place, time, causative agents involved, and identified opportunities for system improvement.

2. METHODS

2.1 Study Area

The Upper East Region is located in the north-eastern corner of the country and between longitude 0° and 1° West and latitudes10° 30″N and 11°N. The population of the region is estimated to be 1,097,692 with a growth rate of 1.2%, and population density of 111-people/square km (2010 Census). It has two international boundaries; namely Burkina Faso to the north and the Republic of Togo to the East. The people of these three countries share so much in common: language, socio-cultural and belief systems. There is intense cross border movement of people, goods and services. The challenges of disease surveillance and control in particular and health service delivery in general arising out of this geo-physical and social cultural associations cannot be over-emphasised. Rainfall pattern is short and scanty (800-900mm per annum) and long dry season with dry Harmattan winds and hot periods – 43°C. The Upper East Region is divided into thirteen (13) administrative districts and 91 health sub-districts with 338 health facilities. Some 60% of the population has adequate access to health facilities (within one hour travel). The region lies within the meningitis belt in Sub Saharan Africa, a region that is highly endemic of the disease. This endemic region stretches from Ethiopia to Senegal (Fig. 1). There have been frequent outbreaks of meningitis during the dry seasons, December–May and in every 8-12 years, large outbreaks normally occur. The last mass vaccination against bacterial meningitis was in 2011 where there was a massive outbreak in the region.

The updated recommended meningitis epidemic control strategy consists of: (i) early detection of

cases and outbreaks through enhanced surveillance, and the use of revised operational alert and epidemic thresholds; (ii) case management with a 5–7 day course of the appropriate antibiotic; (iii) reactive immunization of populations in affected districts with serogroup-specific vaccines; (iv) mass preventive vaccination with the(Men A conjugate Vaccine) MACV; (v) introduction of MACV into national routine childhood immunization programmes.

All the public health facilities have focal persons on disease surveillance. The diseases under public health observation include meningitis. These focal persons report weekly to the district-level, which in turn reports monthly to the regional-level on meningitis and other diseases of public health importance. When a case of meningitis is identified by a clinician at the health facility or by a community-based surveillance volunteer, the sub-district or district level surveillance focal person is notified, who then conducts a detailed investigation of the case and follows up to the nearby communities. The investigation entails completing a case investigation form and lumber puncture (usually done by trained physicians) for cerebrospinal fluid (CSF). The specimen is then sent to the District or Regional Hospital Laboratory for laboratory diagnosis. The results of CSF analysis are communicated back to the District Hospitals and the District Health Directorates through the District Surveillance Officer. Detailed information on the Meningitis is then entered into a district database on disease surveillance.

2.2 Study Design

This was a five-year retrospective review of secondary data on all reported Meningitis cases, undertaken in March to April 2015. We reviewed Meningitis surveillance electronic data-set in Microsoft Excel and case-based investigation forms from 2010 to 2014 at the Upper East Regional Disease Control Unit of the Ghana Health Service. Key data elements extracted were age, sex, district, date of birth, date of onset of symptoms, date reported at the health facility, outcome of ailment, the type of bacterial meningitis and the serotype of *N. meningitidis*. Data on the case based forms were reviewed for missing data points, validated, and used to update the electronic database for all the meningitis cases reported. The MS Excel data base was imported into STATA version 11 and statistically analyzed. Univariable analysis of key socio demographic, case-investigation and

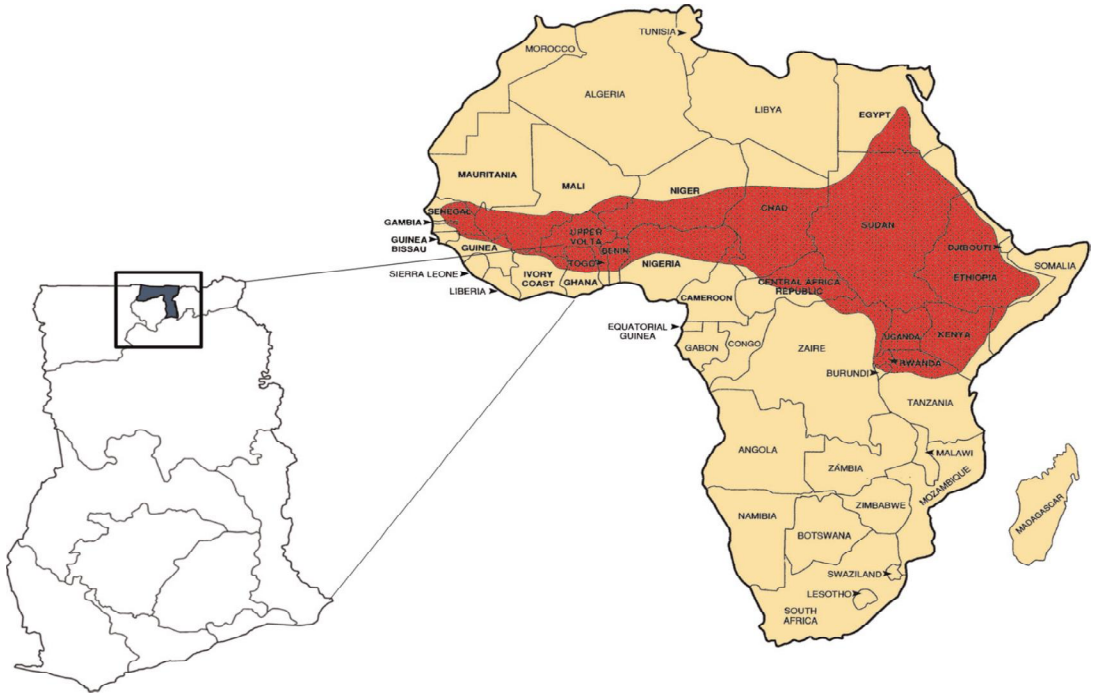

Fig. 1. Map of Africa and Ghana, indicating the meningitis "belt"

administrative data by person, place and time were expressed as frequency-distributions and percentages. In a bivariable analysis, using X^2 test and $p<0.05$, the association between gender, delay on presentation of case-patients at the health facilities and outcome of the Bacterial meningitis infection was explored.

3. RESULTS

Between 2010 and 2014, 1142 suspected cases of meningitis were recorded at the health facilities and communities in the UER. More males 579(50.7%) than females were recorded under the period of review. Of these, 352(30.8%) were confirmed cases of various forms of bacterial meningitis. The number of laboratory confirmed meningitis cases in 2010, 2011, 2012, 2013 and 2014 were 126(32%), 15(60%), 179(35%), 13(9.4%) and 19(27%) respectively. About six percent of the cases had no lumber puncture done. The identified etiological agents of meningitis were Neisseria meningitides (Nm W135) (177; 50.3%), Streptococcus pneumonia (147; 41.7%), Neisseria meningitides (Nm A) (6; 1.7%), Neisseria meningitides (Nm Y) 17(5%), Haemophilus Influenza Type B 5(1.5%). A total of 146 deaths were recorded given an overall case fatality rate (CFR) of 13.0%, with the highest 14.0 % (x/y) in men.

The age-specific case fatalities in <1, 1-4, 5-15 and >15 years old were 8.5%, 2.5%, 12.0%, and 18.0% respectively. Similarly, the case fatality rates of the laboratory confirmed cases were: Neisseria meningitides (Nm W135) 21(12%), Streptococcus pneumonia 49(33.3%), Neisseria meningitides (Nm A) 2(33.3%), Neisseria meningitides (Nm Y) 0(0%) and Haemophilus Influenza Type B1 (20%).

Between 2010 and 2014, there were two outbreaks of meningitis and 396(35%) and 512(44%) patients respectively were involved (Fig. 2). The affected age group ranged from 1 to 88 years with a median age of 13.0, mean of 19.0 and a standard deviation of ±20.0 years. The age group 0-9 years was mostly 491(43.0%) affected. A similar trend was observed among the confirmed cases. The least 7 (0.6%) affected age group was 80 years and above (Fig. 3). The mean number of days of stay at the health facilities was 2.3(SD 3.2).

Distribution of meningitis cases is shown in Fig. 4. Majority of the case-patients were recorded between January to April while no case was recorded in the month of September in the five-year period.

Of the total number of cases, the Navrongo (WAR Memorial) Hospital recorded most 332(29%) within the period whilst Zebilla hospital recorded the least 34(3%) (Fig. 5). About 61(5.3%) cases were recorded in the private health facilities and in the communities during active case search in the course of the outbreaks.

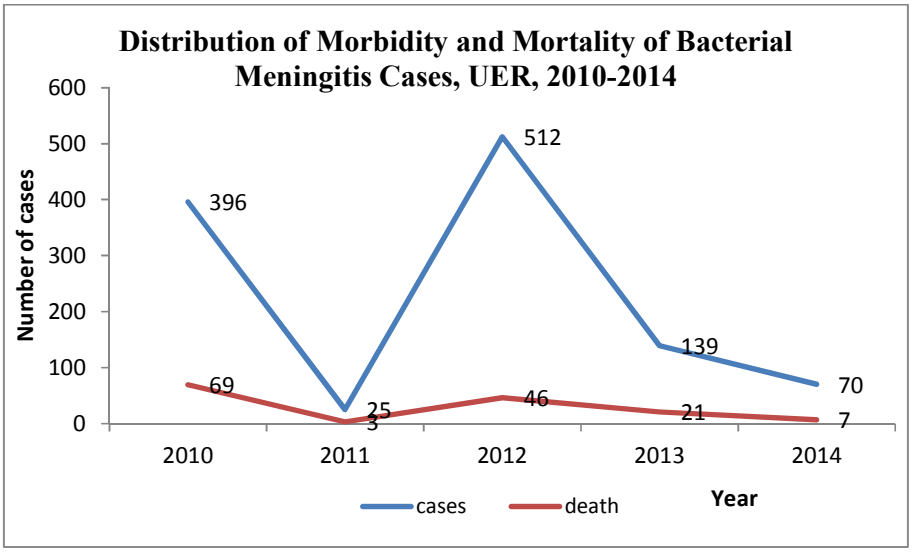

Fig. 2. Distribution of morbidity and mortality of bacterial meningitis cases, UER, 2010-2014

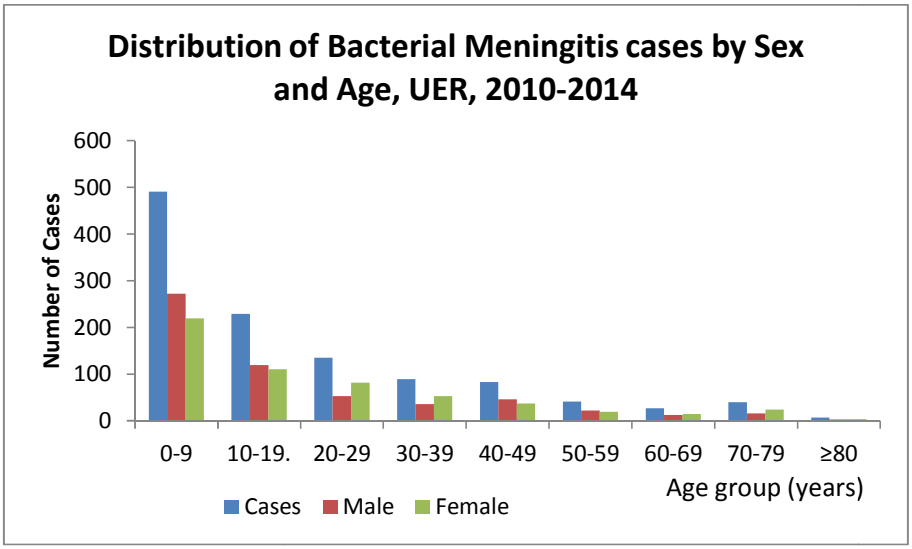

Fig. 3. Distribution of bacterial meningitis cases by sex and age, UER, 2010-2014

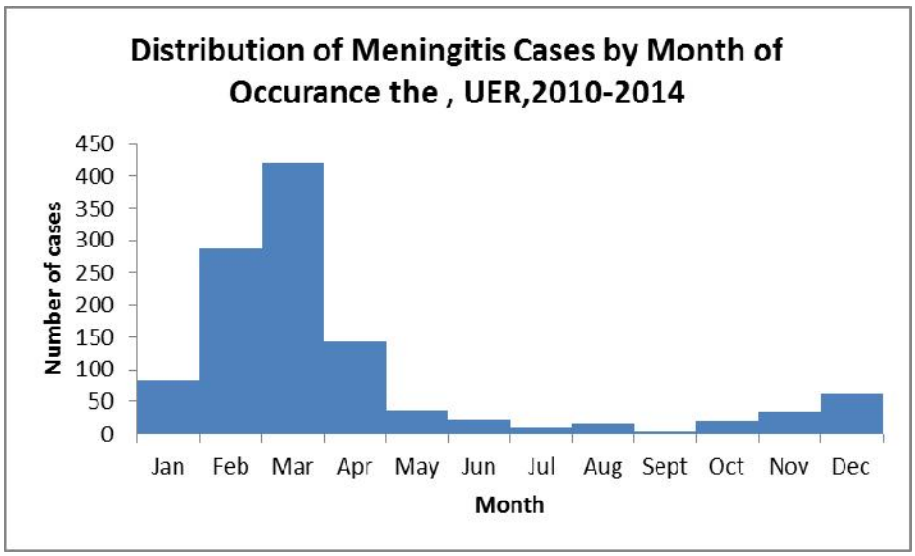

Fig. 4. Distribution of meningitis cases by month of occurrence the, UER, 2010-2014

Serotypes NmW135 and *Streptococcus pneumoniae* were commonly recorded among children less than 9 years old 128(39.5%) and older children 67(20.7%). However, *Haemophilus influenzaetype b* (Hib) was more common 3(60%) among children less than 5 years old (Fig. 6). Majority of the Bacterial meningitis cases were recorded in the Kassena Nankana Municipal 234(20.5%). Bulsa south district recorded no case for the entire period under review.

Most 43 (12.2%) of the NmW135 causes of the Bacterial meningitis cases were recorded in Kassena Nankana Municipal and *Streptococcus pneumonia* 34(9.7%) Bulsa North District (Figs. 8 & 9). 69(6.0%) suspected cases had no lumber (LP) puncture done (LPND), however at the Bongo District Hospital all the suspected case had LP done (Fig. 5).

Gender and delay on presentation of case-patients of Bacterial meningitis in the health facility had no significant association with the outcome of the infection (p-values 0.421 and 0.319 respectively).

4. DISCUSSIONS

According to the current study, there were two major outbreaks of meningitis within the five years under review and these outbreaks were contained after mass vaccination in the region. These outbreaks did occur in the dry season. These findings confirm the known facts that, the Upper East Region falls within the 'Meningitis belt" of Africa extending from Senegal through Ethiopia and there are frequent outbreaks of meningitis in this region compared to the regions in the southern part of Ghana. The outbreak normally occurs in the dry season and also hot temperatures [10,12]. The dry and sandy harmattan is conducive for the transmission of this infection. It has been hypothesized that high temperatures coupled with low humidity may favour the conversion of benign Bacterial meningitis bacteria in the nose and throat to pathogenic bacteria by damaging the mucosa and lowering immune defense [15,16]. There is therefore the need for early forecasting of logistics coupled with targeted mass education on prevention of meningitis before these known transmission periods.

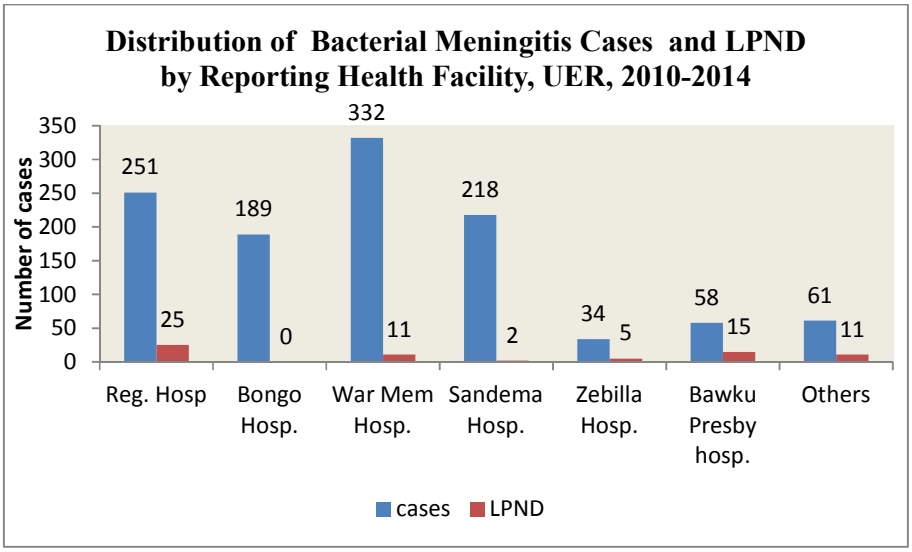

Fig. 5. Distribution of bacterial meningitis cases and LPND by reporting health facility, UER, 2010-2014

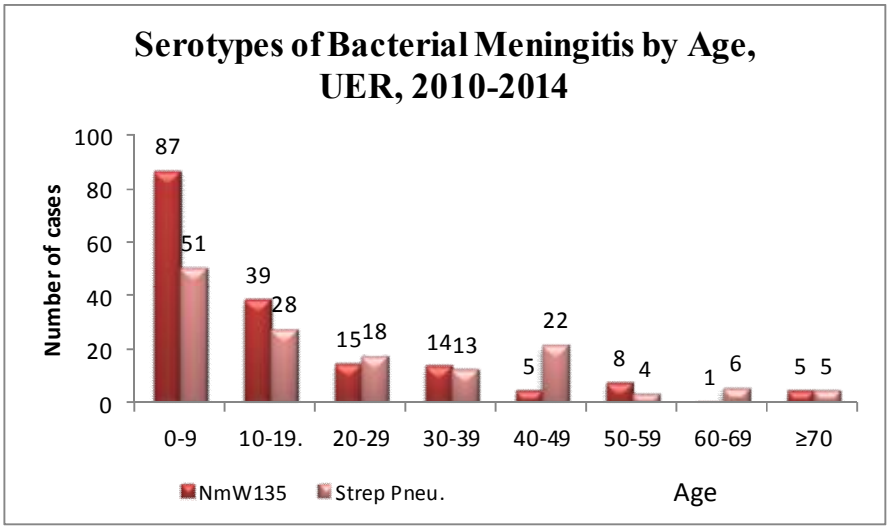

Fig. 6. Serotypes of bacterial meningitis by age, UER, 2010-2014

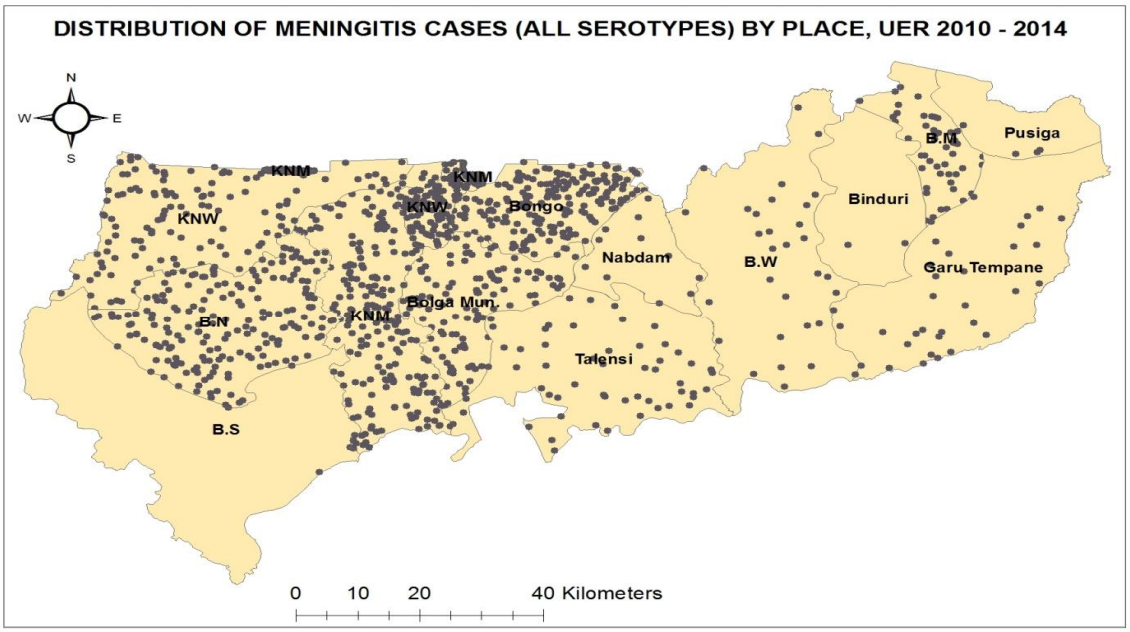

Fig. 7. Distribution of meningitis cases (All serotypes by place, Uer 2010-2014)

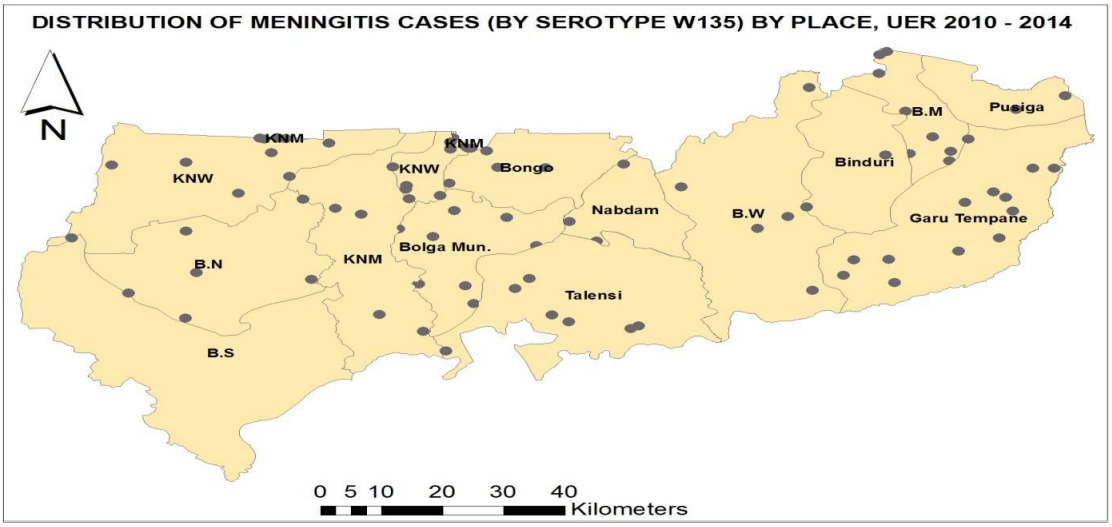

Fig. 8. Distribution of meningitis cases (By serotype W135) by place, UER 2010-2014

Bacterial meningitis caused by *Niesseriae meningitidisW135* and *Streptococcus pneumoniae* were commonly found based on the data among the young and old children compared to the adults. However, *Haemophilus influenza type b* (Hib) was mostly found among children less than 5years. These findings corroborate studies by Sáez-Llorens [1] and Tunkel [17] in Bacterial meningitis in children, which may be due to the relative immaturity in the immune system of these young ones. More proactive measures must be ensured in the management of Bacterial meningitis among children. The case fatality rate among *Streptococcus pneumoniae* cause of bacterial pneumonia is relatively high.

The study revealed a predominance of cases in males among both children and adults during the period of investigations. Although this finding was

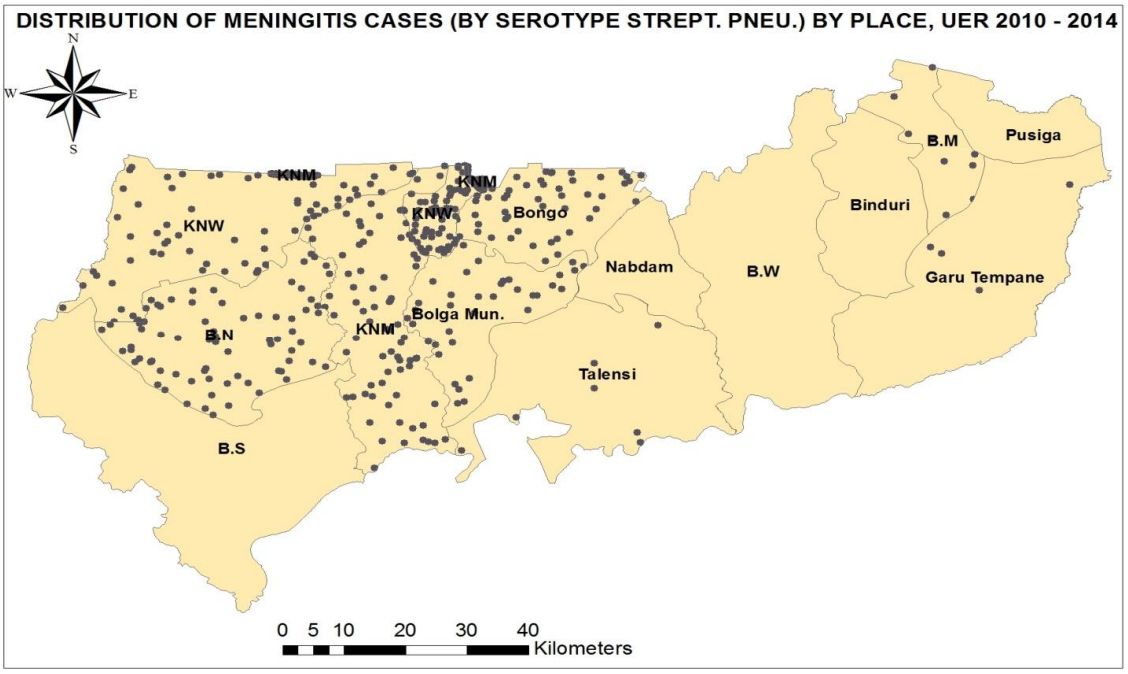

Fig. 9. Distribution of meningitis cases (By serotype strept.pneu.) by place, UER 2010-2014

not statistically significant based on our data, it has been confirmed in other publications [18,19], as a possibility for an increased risk among males, but taking in consideration the almost equal care-seeking behavior among males and females, future studies are necessary in this direction.

The age groups with the highest proportion of cases from the review data were nineteen years and below. Typical of meningitis, these ages were possibly exposed to more risk factors for transmission such as overcrowding and active and passive smoke exposure [20,21].

Bacterial meningitis is a lethal disease that requires immediate antimicrobial therapy. Lumbar puncture is a key diagnostic procedure and elevation of cell counts in cerebrospinal fluid (CSF) is an important sign of Bacterial meningitis [22,23]. The study revealed that some case-patients had no lumber puncture performed on them to facilitate the diagnosis. This could lead to misdiagnosis of the condition, and, in this way to inappropriate management of cases. Prescribers in the region need to be frequently trained and re-trained in the lumber puncture procedure.

The case fatality rates recorded in the study was relatively high (13%). This rate is higher than the 5%-10% being recorded in the industrialized countries. There are many factors which may account for this observation and notable amongst them are: access to primary health care services, the quality of reference laboratories, timely and appropriate medical care and treatment, patient predisposing conditions, and the virulence of the strains [24-26]. There is therefore the need to set up emergency treatment centres and conduct frequency in-service training on triage in the Upper East Region.

It was realised in the study that, delay on presentation of case-patients of baterial meningitis in the health facility had no significant association with the outcome of the infection based on available data. It has been documented elsewhere that, early deaths were not related to delays in presentation in Ghana and Swaziland [27,28]. This implies that Bacterial meningitis can be fatal and there should be a targeted effort on the prevention of the disease, the key among them being health education in the communities.

It was worth noted that Bulsa North District recorded most of the streptococcus pneumoniae cause of the Bacterial meningitis. Taking into consideration the fact that this serotype has been noted for causing the highest mortality in bacterial meningitis cases-patients, there is the need to further investigate this observation.

5. CONCLUSIONS AND RECOMMENDATIONS

Overall, the meningitis surveillance has remained an effective strategy in monitoring and documenting the progress towards interruption of meningitis transmission in the UER since its inception in 1997. Analysis of data from the past 5years has shown that there have been consistent outbreaks in the region involving quite a number of cases-patients with some mortality. There were more meningitis cases recorded in children compared to adults. Lumber puncture was not performed in all case-patients. There is an urgent need to review the management of meningitis, coupled with enhanced strategies in prevention of occurrences of the disease in the Upper East Region of Ghana.

ETHICAL CONSIDERATIONS

This project was conducted as part of health system process improvement and service-based learning in the Upper East Region. Official permission was obtained from the Regional Director of Health Services for the use of the data. We ensured the confidentiality of the meningitis case-patients through the use of de-identified and coded data.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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