International Journal of Infectious Diseases 43 (2016) 62–67

Contents lists available at ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

Pattern of the meningococcal meningitis outbreak in Northern Nigeria, 2009

Bassey Enya Bassey *, Rui Gama Vaz, Alex Ntale Gasasira, Fiona Braka, Goitom Weldegriebriel, Williams Komakech, Maleghemi Sylvester Toritseju, Akinola Ayoola Fatiregun, Angela Okocha-Ejeko

World Health Organization (WHO) Nigeria Country Office, UN House, Plot 617/618, Diplomatic Drive, Central Business District, PMB 2861, Garki, Abuja, Nigeria

ARTICLE INFO

Article history:
Received 27 September 2015
Received in revised form 20 December 2015
Accepted 21 December 2015

Corresponding Editor: Eskild Petersen, Aarhus, Denmark.

Keywords:
Meningococcal meningitis
Outbreak
Northern Nigeria

SUMMARY

Objectives: Despite the availability of vaccines, children are the people most often affected by epidemic meningococcal meningitis. The pattern of the epidemic meningococcal meningitis outbreak in Northern Nigeria in 2009 and the *Neisseria meningitidis* strains responsible for this epidemic are described here.
Methods: A retrospective cross-sectional study was conducted in 16 states, involving 48 local government areas (LGAs), 91 health facilities, and 96 communities. Data collection involved in-depth interviews with key informants from the federal to the community level, a review of records, and a solution-oriented national workshop with participants from all states of the Federation. Cerebrospinal fluid (CSF) samples were collected from some of the suspected cases at the start of the outbreak and were tested using the rapid Pastorex latex agglutination kit.
Results: Kastina (11153, 20.4%), Jigawa (8643, 15.8%), Bauchi (8463, 15.5%), Kano (6811, 12.4%), and Gombe (6110, 11.2%) were the states with the highest prevalence of meningitis. The states of Nasarawa (11.0%), Adamawa (8.0%), and Borno (7.6%) recorded the highest percentage of deaths, while the Shongom (Gombe State 12.5%), Illela (Sokoto State 9.8%), and Ikara (Kaduna State 9.1%) LGAs recorded the most deaths amongst cases seen.
Conclusions: The testing of CSF samples during meningitis outbreaks is recommended in order to monitor the occurrence of the multiple meningitis serotypes during these outbreaks and to direct serotype-specific vaccination response activities.

1. Introduction

Epidemic meningococcal meningitis remains a major public health challenge in Sub-Saharan Africa, despite the availability of safe and cost-effective vaccines. Each year, approximately 200 000 people, mainly children, are affected by this epidemic.[1] Meningococcal meningitis is one of the deadliest diseases that has been plaguing West Africa for decades. The region that is affected the most is known as the meningitis belt; the fourteen countries that encompass the belt are Benin, Burkina Faso, Cameroon, the Central African Republic, Chad, Côte d'Ivoire, the Democratic Republic of the Congo, Ethiopia, Ghana, Mali, Niger, Nigeria, Togo, and Senegal.[2]

Although there are several strains of meningitis, the one that is most prevalent is meningococcal meningitis.[3] In Northern Nigeria, most meningitis outbreaks have been caused by *Neisseria meningitidis* serogroup A.[4]

Bacterial meningitis can be treated with antibiotics.[5] The climate, poverty, and poor living conditions experienced by the majority of West Africa's residents contribute to the severity and frequency of meningococcal meningitis.[6] Epidemics have also been associated with environmental predictors. The worst outbreak occurred in 1996–97, affecting over 250 000 people and resulting in 25 000 deaths across the meningitis belt. In 2012, countries in the belt reported over 11 647 cases including 960 deaths, resulting in a case fatality rate of 8.2%.[7] Overall case fatality rates (CFR) of 6.8% in 2013 and 10.5% in 2014 have been reported in Northern Nigeria.[8]

This article describes the pattern of the meningococcal meningitis outbreak in Northern Nigeria in 2009 and identifies the strains of *N. meningitidis* responsible for this epidemic.

* Corresponding author.
E-mail address: bassey69@yahoo.com (B.E. Bassey).

http://dx.doi.org/10.1016/j.ijid.2015.12.016

2. Methods

This outbreak was recorded between the first and twentieth epidemiological week of 2009. A suspected case of acute meningitis was defined in the presence of a fever (>38.5 °C rectal or 38.0 °C axillary) and a stiff neck (in children >1 year of age) or bulging fontanelle (in children <1 year of age), with or without convulsions.[9] A confirmed case of acute meningitis was defined as a suspected case as defined above, with either positive cerebrospinal fluid (CSF) antigen detection for bacteria, or a positive CSF culture for bacterial organisms and/or positive blood culture with the identification of *N. meningitidis*.[9]

2.1. Data collection

A retrospective cross-sectional study was conducted in 16 states, involving 48 local government areas (LGAs), 91 health facilities, and 96 communities. The 16 states were included if at least one LGA in the state had crossed the alert or epidemic threshold between weeks 1 and 20 in 2009. In each of the selected states, three LGAs were selected, two of which had to have been in the epidemic phase continuously for the highest number of weeks, and the third LGA had to have been in the alert or non-epidemic phase between weeks 1 and 20. If a selected state had not had up to two LGAs in the epidemic phase for at least 2 weeks, then one LGA in the alert or epidemic phase, one LGA of the state capital, and one rural LGA were to be included in the evaluation.

In the 16 northern states of Nigeria, the meningitis outbreak investigation was conducted by the Federal Ministry of Health in conjunction with World Health Organization (WHO) surveillance officers in all affected states.

Data collection involved in-depth interviews with key informants from the federal to the community level, a review of the records, and a solution-oriented national workshop with participants from all states of the Federation. A total of 64 trained interviewers (four per state) were involved in data collection. Four consultants and three WHO staff members supervised the data collection exercise. At the federal level, key officers of the Federal Ministry of Health, National Primary Health Care Development Agency, and international partners were interviewed. At the state level, the Director of Disease Control, a state epidemiologist, a state immunization officer, a state cold chain officer, and a health educator were interviewed. At the health facility level, the head of the facility, a clinician involved in the management of cases, and the focal laboratory person were interviewed. Heads of the various communities were interviewed at the community level.

CSF samples were collected from some suspected cases at the start of the outbreak and were tested using the rapid Pastorex latex agglutination kit. Pastorex test kits were kept in controlled, refrigerated storage, between 2 and 8 °C. Cold chain procedures were maintained while transporting test kits to the field, using GioStyle boxes with ice packs. The field team conducted quality control tests on the kits with each usage, and returned the kits to refrigerated storage at the end of each day.

3. Results

3.1. Meningitis cases and deaths in 16 northern states of Nigeria in 2009

Table 1 shows meningitis cases and deaths seen in 16 northern states of Nigeria in 2009. A total of 54 766 cases and 2449 deaths from meningitis were recorded in the 16 states. The states with the highest prevalence of meningitis included Kastina (11 153, 20.4%), Jigawa (8643, 15.8%), Bauchi (8463, 15.5%), Kano (6811, 12.4%), and Gombe (6110, 11.2%). The highest mortality rate for meningitis was registered in the state of Gombe (13.1 per 100 000), followed by Kastina (8.5 per 100 000).

3.2. The risk of developing meningitis

The risk of developing meningitis tended to be highest in Gombe State (236.2 per 100 000 population), followed by Jigawa State (182.4 per 100 000 population). However, low attack rates from meningitis were found in the other states located mostly in the north-central part of Nigeria, including Nasarawa (2.8 per 100 000 population), Niger (4.8 per 100 000 population), Plateau (5.6 per 100 000 population), and Taraba (7.8 per 100 000 population) (Figure 1).

Figure 2 shows the meningitis CFR in 16 northern states of Nigeria in 2009. A higher proportion of deaths among cases of cerebrospinal meningitis was found in the states of Nasarawa (11.0%), Adamawa (8.0%), and Borno (7.6%). However, a low CFR from meningitis was recorded in Plateau (2.0%) and Taraba (3.0%) states.

3.3. Meningitis cases and deaths in the 24 most affected LGAs in the northern states of Nigeria, 2009

Table 2 shows the meningitis cases and deaths seen in the 24 most affected LGAs in the northern part of Nigeria. Among the affected states, Gombe had the highest number of LGAs affected by

Table 1
Meningitis cases and deaths in 16 northern states of Nigeria, 2009

State	Population	Cases	Percentage (%) of cases	Deaths	Mortality rate per 100 000
Kastina	6 329 706	11 153	20.4	539	8.5
Jigawa	4 738 059	8643	15.8	307	6.5
Bauchi	5 169 866	8463	15.5	307	5.9
Kano	10 343 660	6811	12.4	251	2.4
Gombe	2 587 160	6110	11.2	338	13.1
Zamfara	3 582 912	4656	8.5	192	5.4
Kaduna	6 629 096	2230	4.1	92	1.4
Yobe	2 573 989	2032	3.7	108	4.2
Borno	4 589 174	1694	3.1	130	2.8
Adamawa	3 451 796	936	1.7	75	2.2
Sokoto	4 039 811	888	1.6	55	1.4
Kebbi	3 549 254	493	0.9	23	0.6
Niger	4 367 029	210	0.4	13	0.3
Taraba	2 484 694	195	0.4	5	0.2
Plateau	3 443 202	194	0.4	4	0.1
Nasarawa	2 036 051	58	0.1	10	0.5
Total	69 915 459	54 766		2449	3.5

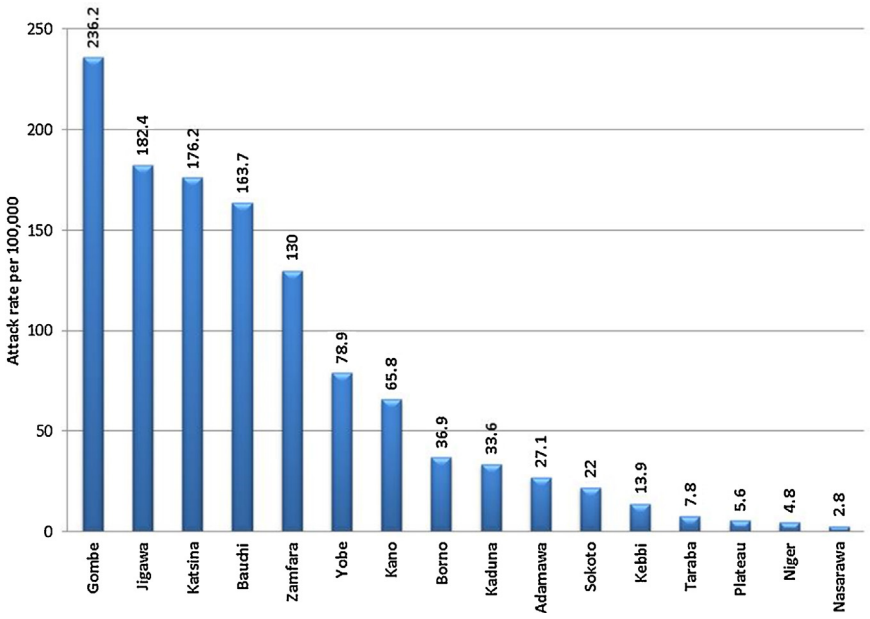

Figure 1. Meningitis attack rate in 16 northern states of Nigeria in 2009.

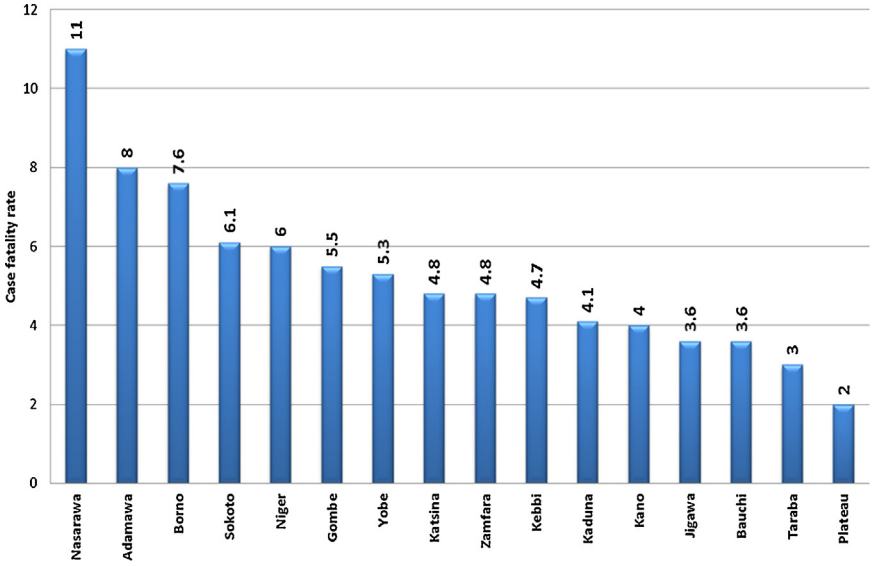

Figure 2. Case fatality rate of meningitis in 16 northern states of Nigeria, 2009.

meningitis, with a high prevalence rate of 27.5% meningitis cases found in the three affected LGAs of the state (Yamaltu Deba, Funakaye, and Shongom). However, some LGAs had only a few cases of meningitis reported, with less than 1% of cases seen in Langtang North in Plateau State (0.4%), Tureta in Sokoto State (0.5%), and Bunza in Kebbi State (0.6%). Also, Yamaltu Deba LGA of Gombe State, with a high number of cases, recorded the highest mortality rate of 21.5%, followed by Bayo LGA of Borno State (7.9%).

As shown in Figure 3, the population in Danja LGA of Kastina State was found to have had the highest risk of developing meningitis, with 728 cases of meningitis reported per 100 000 population in 2009. However, the risk of developing meningitis was lower in Bunza LGA of Kebbi State (attack rate 41.3 per 100 000 population) and Langtang North LGA of Plateau State (attack rate 23.6 per 100 000 population) compared to the other LGAs.

The CFR of meningitis in the 24 most affected LGAs in the northern part of Nigeria in 2009 is shown in Figure 4. The LGA with the highest proportion of deaths among cases seen was Shongom LGA of Gombe State (12.5%), followed by Illela LGA of Sokoto State (9.8%) and Ikara LGA of Kaduna State (9.1%). However, Langtang North LGA of Plateau State recorded no deaths among cases seen in 2009.

Table 3 illustrates the strains of *N. meningitidis* responsible for the outbreak in 2009. Out of the 2227 CSF samples tested, 16.8% were positive for serotype A, while 0.9% were positive for serotype W135.

4. Discussion

This article describes an outbreak of meningococcal meningitis due mainly to serotype A in 16 northern states of Nigeria. In this study, 54 766 cases and 2449 deaths were recorded during the outbreak in 16 northern states of Nigeria. The number of cases recorded in this study is five times higher than the 11 647 recorded in a similar study in 2012; the number of deaths recorded is two

Table 2
Meningitis cases and deaths in the 24 most affected LGAs in Northern Nigeria, 2009

State	LGA (District)	Population	Cases	Percentage (%) of cases	Deaths	Mortality rate per 100 000
Adamawa	Guyuk	193 705	150	1.6	7	3.6
Adamawa	Shelleng	162 418	230	2.5	21	12.9
Bauchi	Damban	166 845	576	6.3	19	11.4
Bauchi	Jama'are	130 321	696	7.6	7	5.4
Borno	Bayo	87 311	344	3.8	30	34.4
Borno	Kwaya Kusar	62 461	172	1.9	13	20.8
Gombe	Funakaye	259 484	987	10.8	27	10.4
Gombe	Shongom	166 536	88	1.0	11	6.6
Gombe	Yamaltu Deba	280 544	1429	15.7	82	29.2
Jigawa	Kiyawa	188 397	431	4.7	4	2.1
Jigawa	Malam-Maduri	175 867	375	4.1	15	8.5
Kaduna	Ikara	211 908	182	2.0	17	8.0
Kaduna	Makarfi	159 821	141	1.5	3	1.9
Kano	Bagwai	179 507	370	4.1	10	5.6
Kano	Dambatta	229 244	503	5.5	13	5.7
Kastina	Danja	137 359	1000	11.0	22	16.0
Kastina	Kankia	165 476	513	5.6	37	22.4
Kebbi	Bunza	133 111	55	0.6	4	3.0
Plateau	Langtang North	152 345	36	0.4	0	0.0
Sokoto	Illela	164 443	122	1.3	12	7.3
Sokoto	Tureta	74 710	41	0.5	3	4.0
Yobe	Damaturu	97 583	192	2.1	7	7.2
Yobe	Nguru	167 008	250	2.7	13	7.8
Zamfara	Maru	320 829	227	2.5	5	1.6
Total		4 067 234	9110	100	382	9.4

LGA, local government area.

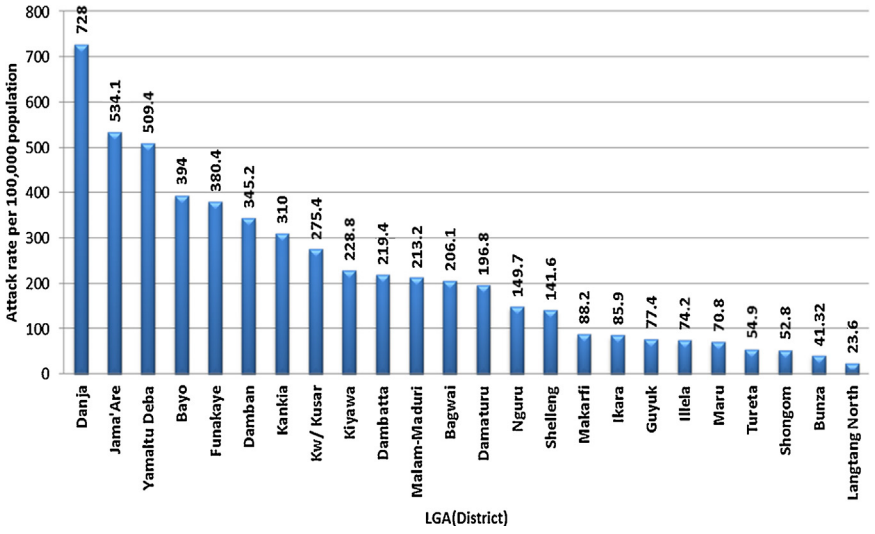

Figure 3. Meningitis attack rate in the 24 most affected LGAs of the northern states of Nigeria in 2009.

times higher than the 960 seen in a similar outbreak in 10 countries in the meningitis belt in 2012.[5] In another study, a much lower number of cases and deaths were recorded in Burkina Faso.[18] Health workers in Togo also reported lower numbers of cases.[10,11]

Overall, this outbreak in Nigeria resulted in a CFR of 4.5. This is two-fold lower than the CFR of 8.2 reported in 10 countries within the meningitis belt during an outbreak that occurred between February and May 2012.[5] This is also lower than the CFR of 10.2 reported in Togo.[7] Although the period of the outbreak was similar, the CFRs differ significantly probably because the data under review have come from different countries. Early and effective management of the cases may also be responsible for the variation seen in the CFR recorded in these countries.

The present study revealed a cumulative attack rate of 78.3 per 100 000 population; this is far lower than the 517 and 581 per 100 000 reported in Burkina Faso and Togo, respectively.[7,11] There are several potential reasons that could account for the variation in attack rates, the primary reason most likely being household crowding and active and passive smoking, which are associated with an increased risk.[12] Persons with an antecedent viral infection are also at increased risk.[9] Early studies in the USA demonstrated that black race and persons of low socioeconomic status were at higher risk of meningococcal disease than other persons; however, race and low socioeconomic status are likely markers for differences in factors such as smoking and household crowding rather than risk factors.[13] During outbreaks, bar or nightclub patronage and alcohol use have also been associated with a higher risk of disease.

A high number of cases were observed in the nine states of Kastina, Jigawa, Bauchi, Kano, Gombe, Zamfara, Kaduna, Yobe, and Borno. These states reported 11 153, 8643, 8463, 6811, 6110, 4656, 2230, 2032, and 1694 cases, respectively. The cumulative number of deaths seen in these nine states ($n = 2364$) is higher than the 960 deaths recorded in a similar outbreak from 42 districts across

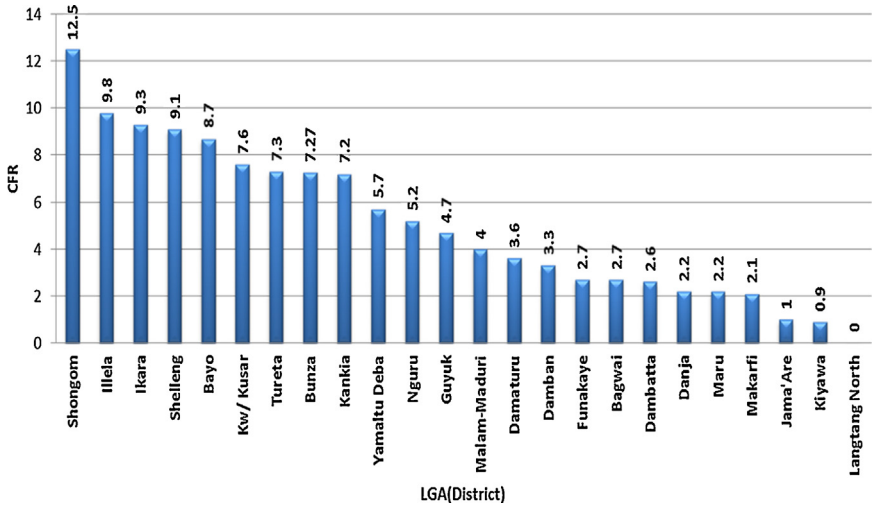

Figure 4. Case fatality rate of meningitis in the 24 most affected LGAs in the northern states of Nigeria, 2009.

Table 3
CSF samples received and processed in the state laboratories

State	CSF samples	Serology		
		NmA	NmC	NmW135
Kastina	448	56	-	1
Kano	391	-	-	-
Kaduna	338	40	-	-
Kebbi	183	-	-	-
Bauchi	174	41	-	1
Yobe	126	-	-	-
Jigawa	113	84	-	-
Borno	93	61	-	-
Gombe	92	34	-	1
Adamawa	86	30	-	17
Zamfara	55	-	-	-
Nasarawa	43	-	-	-
Sokoto	32	26	-	-
Taraba	22	-	-	-
Niger	19	-	-	-
Plateau	12	3	-	-
Total	2227	375	-	20

CSF, cerebrospinal fluid.

10 countries in the African meningitis belt in 2009.[5] This could be due to the slow response to the outbreak by the ministries of health of the various states and to late case detection and investigation, as well as inadequate case management with the recommended antibiotics.

The resulting attack rate was very high in 12 of the 16 affected states, ranging from 13.9 to 236.2 per 100 000 population. However lower attack rates ranging from 2.8 to 7.8 per 100 000 population were observed in the four states of Nasarawa, Niger, Plateau, and Taraba. These four states with low attack rates are located south of the nine states with the highest attack rates. The high attack rates seen in these nine states may be attributed to extreme heat accompanied by low humidity, which is a well-documented predisposing factor in meningitis outbreaks.[14] In these states, the CFR ranged from 2% to 11%, with Plateau State recording the lowest CFR of 2% and Nasarawa recording the highest CFR of 11%. The low CFR may be attributed to a prompt response and effective case management.

The impact of the outbreak on the 24 most affected LGAs was also evaluated. Yamaltu Deba (Gombe) was the most epidemic LGA, recording 1429 cases; Danja (Kastina), Funakaye (Gombe), and Damban (Bauchi) also recorded high numbers of cases: 1000, 987, and 576, respectively. Here the CFR ranged from 0% in Langtang North to 12.5% in Shongom, while the attack rate ranged from 23.6 per 100 000 in Langtang North to 728 per 100 000 in Danja.

This suggests that certain factors or conditions within a given population (not necessarily the size of the population) can lead to an increase or decrease in the number of cases reported and hence an increase or decrease in the number of deaths recorded. Among these factors is a lack of proper awareness of the case definition of meningococcal meningitis. The terrain in the north makes it relatively difficult to access some communities; these communities would have been successfully reached if the terrain were different. Poor living and environmental conditions also contribute to the spread of the bacteria.[10] Crowded households are likely to record more cases than those that are not crowded, because the bacteria spread through the exchange of respiratory secretions.[9]

Because of a lack of proper awareness, the implications and symptoms of the infection are not always known; therefore cases may not report to the health facilities for treatment in a timely manner.[15] In addition, the health centers may not be close enough for easy access by members of the communities.

However, the introduction of the meningococcal serotype A conjugate vaccine in 2011, targeting persons aged 1–29 years, as well as enhanced surveillance in Nigeria has since resulted in a significant decline in the number and intensity of outbreaks: 54 766 cases including 2449 deaths were recorded in the 16 states in 2009 and 1380 cases including 80 deaths were recorded in three states in 2015.[16]

N. meningitidis – the causative agent of meningococcal meningitis – has been separated by seroagglutination into nine serogroups: A, B, C, D, X, Y, Z, W135, and 29E.[17] In this study, serogroup A (16.8%) and serogroup W135 (0.9%) were responsible for the outbreak in the 16 northern states in 2009. The major bacterial strain responsible for most outbreaks in Sub-Saharan African is serogroup A (NmA). Vigorous testing of CSF samples in meningitis outbreaks is therefore recommended in order to monitor the occurrence of the multiple meningitis serotypes during these outbreaks and to direct serotype-specific vaccination response activities.

Acknowledgements

The authors would like to thank the field officers from the federal and state ministries of health for providing logistical support in the data collection and management of patients.

Conflict of interest: The authors have no conflicts of interest to disclose.

Author's contributions: BEB, AOE, and GW conducted a systematic review of the literature and retrieval of data, extraction and analysis, and wrote the first draft. AAF, MST, and KW contributed to the data extraction process and also reviewed the first draft. RGV, ANG, BF, and GW conceived and led the design of the study and drafting of the article.

References

1. Moore PS. Meningococcal meningitis in Sub-Saharan Africa: a model for the epidemic process. *Clin Infect Dis* 1992;**14**:515–25.
2. US Centers for Disease Control and Prevention. 2016 Yellow Book – CDC Health Information for International Travel. Chapter 3 – Meningococcal disease. Atlanta, GA: CDC; 2015. Available at: http://wwwnc.cdc.gov/travel/yellowbook/2016/infectious-diseases-related-to-travel/meningococcal-disease (accessed August 27, 2015).
3. Riedo FX, Plikaytis BD, Broome CV. Epidemiology and prevention of meningococcal disease. *Pediatric Infectious Disease Journal* 1995;**14**(8):643–57.
4. Kristiansen PA, Diomandé F, Ba Absatou K, Sanou I, Ouédraogo AS, Ouédraogo R, et al. Impact of the serogroup A meningococcal conjugate vaccine, MenAfriVac, on carriage and herd immunity. *Clin Infect Dis* 2013;**56**:354–63. http://dx.doi.org/10.1093/cid/cis892
5. Allan RT, Stephen BC, Anna RT. Initial therapy and prognosis of bacterial meningitis in adults. Wolter Kluwer; 2015, www.uptodate.com.
6. Molesworth AM, Cuevas LE, Connor SJ, Morse AP, Thomson MC. Environmental risk and meningitis epidemics in Africa. *Emerg Infect Dis* 2003;**9**:1287–93. http://dx.doi.org/10.3201/eid0910.030182
7. Hossain MJ, Roca A, Mackenzie GA, Jasseh M, Hossain MI, Muhammad S, et al. Serogroup W135 meningococcal disease, The Gambia, 2012. *Emerg Infect Dis* 2013;**19**:1507–10. http://dx.doi.org/10.3201/eid1909.130077
8. Funk A, Uadiale K, Kamau C, Caugant DA, Ango U, Greig J. Sequential outbreaks due to a new strain of *Neisseria meningitidis* serogroup C in Northern Nigeria, 2013-14. *PLoS Curr* 2014;6. http://dx.doi.org/10.1371/currents.outbreaks.b50-c2aaf1032b3ccade0fca0b63ee518
9. WHO Bacterial meningitis (including Haemophilus influenzae type b (Hib), Neisseria meningitidis, and Streptococcus pneumoniae). World Health Organization standards for surveillance of selected vaccine preventatble diseases 2003. WHO/V&B/03.01
10. Aplogan A, Batchassi E, Yakoua Y, Croisier A, Aleki A, Schlumberger M, et al. *An epidemic of meningococcal meningitis in the region of Savanes in Togo* 1997;**7**(6):384–90.
11. Broome CV, Rugh MA, Yada AA, Giat L, Giat H, Zeltner JM, et al. Epidemic group C meningococcal meningitis in Upper Volta, 1979. *Bull World Health Organ* 1983;**61**:325–30.
12. Brouwer MC, Tunkel AR, van de Beek D. Epidemiology, diagnosis, and antimicrobial treatment of acute bacterial meningitis. *Clin Microbiol Rev* 2010;**23**:467–92. http://dx.doi.org/10.1128/CMR. 00070-09
13. CDC. Prevention and control of meningococcal disease: Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR* 2005;**54**(RR–7):1–21.
14. Jamison DT, Feachem RG, Makgoba MW, et al., editors. second ed., *Disease and Mortality in Sub-Saharan Africa*, Washington DC: World Bank; 2006.
15. Goodman AL, Masuet-Aumatell C, Halbert J, Zuckerman JN. Awareness of meningococcal disease among travelers from the United Kingdom to the meningitis belt in Africa. *Am J Trop Med Hyg* 2014;**91**:281–6. http://dx.doi.org/10.4269/ajtmh.13-0763
16. Shrivastava SR, Shrivastava PS, Ramasamy J. Meningitis outbreak in Nigeria: public health alert. *Biol Med* 2015;7. http://dx.doi.org/10.4172/0974-8369.1000e120
17. Mado SM, Abubakar U, Onazi SO, Adeoye GO. Epidemic cerebrospinal meningitis in children at Federal Medical Centre, Gusau, Zamfara State, Nigeria. *Nigerian Journal of Paediatrics* 2013;**40**:169–71. http://dx.doi.org/10.4314/njp.v40i2
18. Nathan N, Rose AMC, Legros D, Tiendrebeogo SRM, Bachy C, Bjørløw E, et al. Meningitis serogroup W135 outbreak, Burkina Faso, 2002. Emerg Infect Dis [serial on the Internet]. 2007 Jun [date cited]. Available from http://wwwnc.cdc.gov/eid/article/13/6/06-0940, DOI: 10.3201/eid1306.060940