

Effects of Mass Vaccination against Meningococus On Childhood Morbidity and Mortality in Yobe State, Northeast Nigeria

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Abstract: Meningitis is a deadly disease that poses profound public health threats and responsible for outbreaks and death of children mainly in the meningitis belt of Africa. This study was designed to determine the effectiveness of mass vaccination against Meningitis in Yobe State, Northeast Nigeria. An ecological study design involving the collection of secondary data from Yobe State Epidemiological unit based on the Integrated Disease Surveillance Response System template was done. The outcomes measured include the morbidity and mortality from meningitis across all the local government areas in Yobe State. This involved the collection of all the meningitis cases that were reported within the period under review (2017-2018). A comparative analysis of the morbidity and mortality from meningitis before (pre) and after (post) mass vaccination against the disease was made. The mass vaccination intervention was conducted within the first week of February 2018 and the effects of this intervention was measured. A paired sample t-test was done using the Statistical Package for Social Sciences (SPSS) windows version 22 to determine the relationship between mass vaccination and morbidity and mortality from meningitis. Result revealed that a total of 480 cases were reported during the study period, 415(86.5%) in 2017 (pre mass vaccination and 65(13.5%) were reported in 2018 (post vaccination). 53 deaths out of the 480 total number of cases were recorded and the Case Fatality Rate (CFR) = 11.04% was estimated during the study. Majority 43(81.13) of the deaths occurred in 2017 while the remaining 10(18.87) were reported in 2018 when mass vaccination against meningitis was conducted. Mass vaccination resulted in a 72.9% decline in the number of cases and a 62.3% decline in the number of deaths from meningitis in Yobe State during the study period. There was a statistically significant difference in the number of cases of meningitis before (pre) and after (post) the mass vaccination. Mean 12.5, (95% CI: -5.892 to 30.892) with alpha set at 0.05, P = 0.045. However, there was no statistically significant difference in the number of deaths associated with meningitis, Mean 2.750, (95% CI: -2.097 to 7.597) with alpha set at 0.05, P = 0.646. Mass vaccination against meningitis therefore confers herd immunity to populations with a subsequent significant decline in morbidity associated with the infection. It is therefore important for mass vaccination against meningitis to be intensified in order to control, possibly eliminate and eradicate the disease in Sub-Saharan Africa with a high burden of the infection in the meningitis belt.

Keywords: *Effects, Meningitis, Meningococal Vaccine, Mass Vaccination, Immunization.*

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I. INTRODUCTION

The use of vaccines in the prevention of infectious diseases is an aged long practice in several regions of the world. Early report indicates that vaccines for small pox have been used by Africans, Chinese and Indians as far back 1000BC (Parish, 1965). Recent and scientific use of vaccines has been attributed to Edward Jenner who in 1776 succeeded in the vaccination of a British girl against small pox using matter obtained from cow postule (Moloo & Artenstein, 2008; Artenstein, 2010). This was followed by several discoveries including the first meningitis vaccine that was recommended by the WHO in 1975 and became available in the 1970s (Barrett, 2015). By 1885, rabies vaccines was discovered by Louis Pasteur in France (Artenstein, 2010) where a health law and regulation which stipulates registration of animals and mass immunization against the infection were promulgated (Dodet et al., 2013; MacDonald, et al., 2018).

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By 1974, the expanded program on immunization (EPI) was launched by the World Health Organization (WHO) through a resolution that was passed at World Health Assembly which was aimed at eradicating small pox and also targeting the six child hood killer diseases that include: Tuberculosis, Poliomyelitis, Diphtheria, Pertussis, Tetanus and Measles. By 1967 to 1977, the WHO embarked on massive vaccination campaigns which resulted to the eradication of Small pox that has claimed several lives for about two centuries. On 9th December 1979, smallpox virus was finally eradicated (Ophori et al., 2014). The successful eradication of small pox became an outstanding and a landmark breakthrough in immunology and public health with a strengthened focus on the use of vaccines in the prevention, elimination and eradication of infectious diseases across the globe. In recent times, the number of vaccines has been increased to more than the previously targeted six killer diseases to include other disease of public health concern such meningitis.

The Nigeria Centre for Disease Control (NCDC, 2019) defined meningitis as an infection of the thin layer of the connective tissue that covers the brain and the spinal cord (meninges) that could be due to bacteria, virus, parasite or fungus. Meningitis caused by bacteria is of great public health importance because it is epidemic prone, has a high morbidity and fatality rate, costly during treatment with associated neurological sequalae following delayed treatment or failure of treatment (Nigeria Centre for Disease Control, 2019).

WHO (2014) defined a suspected case of meningitis as the sudden onset of fever (>100.4°F [>38.0°C]) and at least one meningeal sign, including neck stiffness or altered consciousness in any person, or a bulging anterior fontanelle in children aged <18 month. Following the suspicion of a case, samples of cerebrospinal fluid (CSF) or blood specimens are collected from the patient and transported to a designated laboratory for confirmation by conducting culture, latex agglutination, or real-time–polymerase chain reaction (PCR) tests with the sample. A meningitis case could be probable which is defined as a suspected case with turbid, cloudy, purulent, or xanthochromic CSF with the presence of gram-negative diplococci, gram-positive diplococci, or gram-negative bacilli on microscopic examination of the CSF; or a CSF white cell count >10/mm3. A confirmed case of meningitis was defined as a suspected or probable case with N. meningitidis, Streptococcus pneumoniae, or H. influenzae isolated from CSF by culture or detected in CSF by real-time polymerase chain reaction (rt-PCR) or latex agglutination (WHO, 2011).

For surveillance, early detection and control of meningitis cases, the WHO (2014) recommended that a set of preparedness activities be implemented when the attack rate of suspected meningitis in an LGA crosses a defined "Alert" threshold, and additional response activities at a defined "Epidemic" threshold can be implemented. According to the WHO (2018), prevention and control of meningitis can be attained through vaccination of susceptible populations, early identification and treatment of affected individuals with appropriate medication. Health education and awareness creation on the disease to vulnerable populations should be done regularly. Routine immunization has been recommended for countries with moderate to high rate of the disease that are marked with frequent outbreaks and include countries in the Africa meningitis belt (WHO, 2011). In the absence of routine immunization to prevent and control the disease, mass vaccination can be done and has been shown to be effective in the prevention of the disease (Mohammed et al., 1984; Andersen et al., 1997; Woods et al., 2000; Tsai et al., 2008; Andrade et al., 2017; Stefani et al., 2016; Ajibola et al., 2018). This involves the use of Meningococcal vaccine that are any of the vaccines used to prevent infection by *Neisseria meningitides* among populations. WHO (2011) reported that the vaccines are 85 -100% effective for a minimum of 2years. The route of administration of the vaccine is either through injection into a muscle or just under the skin and has been shown to decrease the burden of meningitis and sepsis among population.

Despite the presence of vaccines against meningitis and other infectious diseases, vaccine preventable diseases continue to be a major cause of childhood morbidity and mortality across the globe especially in low- and middle-income countries in Africa. Antai (2009) noted that meningitis is an issue of public health concern globally with highest burden experienced in the meningitis belt of sub-Saharan Africa. Estimates by the World Health Organization (WHO, 2018) revealed that 400 million cases are reported annually from 26 countries within the extended meningitis belt. Though the incidence has gradually reduced in recent times due to improved immunization and response to the disease, children in some countries like Nigeria continue to experience outbreak of the disease and its sequalae. WHO (2018) noted that most patients with meningococcal infections in developed nations survive unlike in developing nations who experience a higher number of cases from the disease with associated higher mortality due to weak health systems and poor emergency response to disease outbreaks. In Nigeria, during the 2016 and 2017 outbreak that lasted for almost a year from December 2016- June 2017, a total of 14,513 cases with 1,166 deaths were recorded. Zamfara, Sokoto and Katsina accounted for almost 89% of the cases (WHO, 2017). In Northeast Nigeria, (UNICEF, 2018) noted that the burden of meningitis is high and Hassan et al. (2018) reported that between epidemiological weeks 1 and 25 in 2017, a total of 415 cases and 41 deaths (CFR: 10.0%) were recorded. This high burden of meningitis in the state necessitated several outbreak responses including outbreak investigation, mass vaccination campaign against meningitis and awareness creation on the prevention and control of the disease that was organized by Yobe State Primary Healthcare Management Board in collaboration with UNICEF, WHO, SOLINA health and other non-governmental organizations and foundations which were aimed to control and prevent the spread of the disease in the state and neighboring states.

Despite the importance of mass vaccination towards addressing disease outbreaks and epidemics across the globe, information on its effectiveness in the control and prevention of this disease is lacking in most low- and middle-income countries like Nigeria. To affirm the effectiveness of

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vaccines, the Centre for Disease Control and Prevention (CDC, 2018) opined that the use of vaccination in the reduction of morbidity and mortality from infectious diseases is a best buy in global health that is well understood and implemented by health workers, government and non-governmental organization who are poised with the prevention and control infectious diseases across the globe. Due to the scarcity of information on the effectiveness of vaccines in the control and prevention of meningitis, this study was designed to determine the effectiveness of mass vaccination against Meningitis in Yobe State, Northeast Nigeria in other to establish evidence needed for informed decision making to address the burden of meningitis.

II. RESEARCH METHOD

An ecological study design that involved the determination of the incidence and deaths from meningitis before (pre) and after (post) mass vaccination in Yobe State, Northeast Nigeria was employed. The study setting for this research is Yobe State, which is divided into 17 Local Government Areas (LGAs) with 178 wards, and its headquarters in Damaturu. The people are predominantly Kanuri, Hausa, Manga, Bade, Bolewa, Kare, and other smaller tribes. They are majorly rural dwellers, with farming, fishing and livestock rearing as their predominant occupation mostly in the rural communities. The state is rich in mineral deposits such as kaolin, gypsum, and quartz. It has an area of 47,153km^2 with an estimated population of 3,427,364 (National Population Commission, 2014). It ranks second as the worse affected states in the northeast by the activities of Boko haram for over a decade with thousands of people displaced from their homes and this has resulted to a serious humanitarian crisis that affects mostly vulnerable populations including children, pregnant women and the elderly. The insurgency has destroyed several properties including healthcare centres that has negatively impacted on the health system and resulted to a further deterioration of an already weak health system that cannot take care of the health needs of majority of its population. The state has 517 health facilities of which 504 are primary, 12 secondary and 1 tertiary facility. 320 of these facilities are providing routine immunization services to control vaccine preventable diseases but access to these services has been limited in most hard-to-reach communities as a result of the insurgency.

To ensure proper data collection and representative sampling of the target population to make a valid conclusion from the study, a purposive sampling technique that involves the collection of all the data on meningitis over the study period was done. Our team reviewed all cases of meningitis within the period of study (2017-2018). This ensured complete comparisons of the reported cases and deaths from meningitis before and after mass vaccination was carried out in the state during first week of February, 2018. The key outcome studied was number of cases and mortality from meningitis before and after mass vaccination and this included all data obtained in January – December 2017 and January – December 2018. Comparative analysis was done with previous years (2017) epidemiological data when no mass vaccination was conducted in the state and the year after (2018) when mass vaccination was carried out.

Data collection was based on the use of a proforma (checklist) which aligns with the Integrated Disease Surveillance Response (IDSR) that is linked with the Demographic Health Survey 2 (DHIS2) which is the information management system of the state and the country. This system is managed by the WHO and NCDC across the nation. To estimate the effectiveness of mass vaccination in the control and prevention of meningitis in Yobe State, our team collected pertinent data which include the socio-demographic information of patients (Local Government Area, Age and Sex), Immunization status of patients (immunized or unimmunized), outcome of the disease following treatment by health care workers (alive or death).

The instrument for this study was valid because it is based on IDSR which was created to obtain data on epidemic prone diseases such as meningitis, poliomyelitis and measles after several expert review of the tool. Data analysis was done using the Statistical Package for Social Sciences (SPSS) Windows version 22 to obtain descriptive and inferential statistics. Results were presented using frequency and percentages and appropriate graphs to highlight trend and key findings. A comparative analysis of the incidence of meningitis before (pre) and after (post) vaccination as well as an analysis of the number of deaths before (pre) and after (post) vaccination was done to ascertain the effectiveness of mass vaccination against meningitis before and after the intervention. Test for significance was done using paired sample t-test with alpha set at 0.05 level of confidence.

III. RESULTS

The results obtained from this study are presented with the tables and graphs below.

Table 1 Socio-Demographic Distribution of Meningitis in Yobe State

Variable	Frequency (f)	Percent (%)
L.G.A		

Bade	10	2.1
Bursari	3	0.6
Damaturu	47	9.8
Fika	194	40.4
Fure	111	22.7
Geidam	4	0.8
Gujba	16	3.3
Gulani	4	0.8
Jakusko	3	0.6
Karasuwa	6	1.3
Machina	1	0.2
Naugere	11	2.3
Nguru	47	9.8
Potiskum	17	3.5
Tarmua	5	1.0
Yunusari	1	0.2
Yusufari	0	0.0
Gender		
Male	264	55.0
Female	216	45.0
Age Category		
Under 5	227	47.3
5 – 18	172	35.8
19 and above	81	16.9

Table 1 shows the epidemiological distribution of meningitis in Yobe State. LGA distribution were: Bade 10(2.1%), Bursari 3(0.6%), Damaturu 47(9.8%), Fika 194(40.4%), Fune 111 (22.7%), Geidam 4(0.8%), Gujba 16(3.3%), Gulani 4(0.8%), Takusko 3(0.6%), Karasuwa 6(1.3%), Machina 1(0.2%), Naugere 11(2.3%), Nguru 47(9.8%), Potiskum 17(3.5%), Tarmua 5(1.0%), Yunusari 1(0.2%) and Yusufari 0(0.0%). Gender was males 264(55.0%) and females 216(45.0%). Age category was under 5years 227(47.3%), 5 – 18years 172(35.8%) and 19 and above 81(16.9%).

Table 2 Number of Cases of Meningitis during the Study Period

Year	Number of Cases	Percentage (%)	% Decline in Incidence
2017 (pre mass vaccination)	415	86.5	72.9
2018 (post mass vaccination)	65	13.5	
Total	480	100.0	

Table 2 Shows the number of cases of meningitis during the study period. 2017 (pre mass vaccination) was 415 while 2018 (post mass vaccination) was 65 cases and a percentage decline of 72.9%.

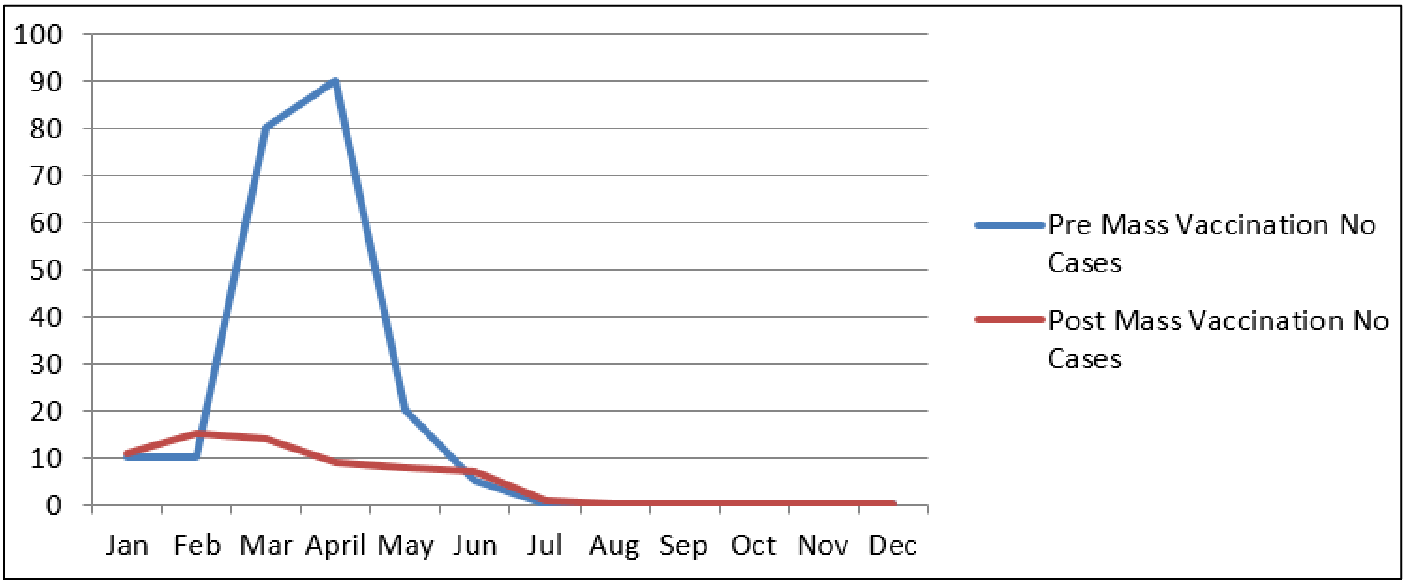

Fig 1 Monthly Variation of Number of Meningitis Cases

Figure 1 revealed that most of the cases occurred in the month of April with no cases reported from August to December.

Table 3 Incidence of Meningitis Based on Age Category and Estimated Population

Age Category	Estimated Population	Number of Cases	Incidence	Incidence/100,000
Under 5	616926	227	0.00037	37
5-18years	322172	172	0.00053	53
19 and above	2488266	81	0.00003	3
Total	3427364	480	0.00093	93

Table 3 shows the age distribution of meningitis based on estimated total population in Yobe State. These are 37, 53, 3 and a total of 93 per 100,000 Population.

Table 4 Mortality from Meningitis during the Study Period

Year	Number of Deaths	Percentage (%)	% Decline
2017 (pre mass vaccination)	43	81.1	62.3%
2018 (post mass vaccination)	10	18.9	
Total	53	100.0	

Table 3 shows mortality distribution from meningitis during the study period 43; in 2017(pre mass vaccination) and 10 in 2018 (post mass vaccination) percentage decline in mortality was 62.3%.

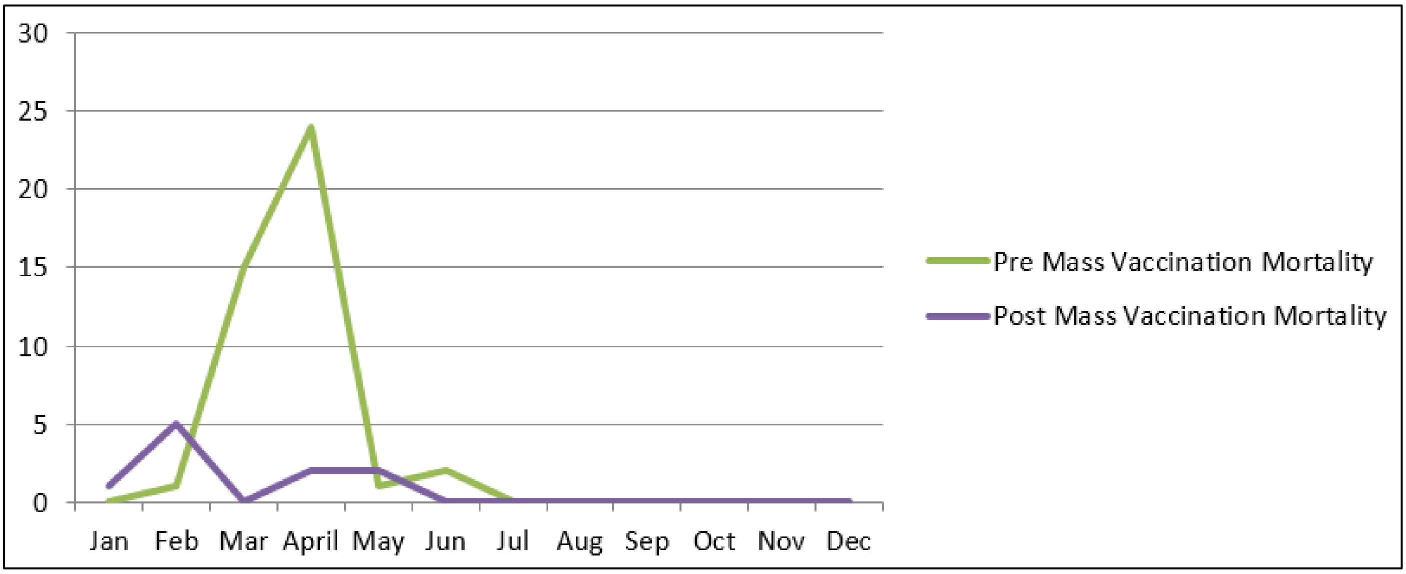

Fig 2 Monthly distribution of mortality from meningitis during the study period.

Figure 2 shows the monthly distribution of mortality from meningitis. April recorded the highest during pre-mass vaccination (2017) and February had the highest mortality for post mass vaccination. No mortality was recorded from July upwards and June upwards for pre and post vaccination from meningitis.

Table 5 Relationship of the Morbidity and Mortality of Meningitis Pre and Post Mass Vaccination in Yobe State

	Morbidity		Test of Significance	Mortality		Test of Significance
Month	Pre mass vaccination	Post Mass Vaccination		Pre mass vaccination	Post Mass Vaccination	
January	10	11	Mean = 12.5 95% CI (-5.592 to 30.892) r = 0.586 P = 0.045	0	1	Mean = 2.750 95% CI (-2.097 to 7.597) r = 0.148 P = 0.646
February	10	15		1	5	
March	80	14		15	0	
April	290	9		24	2	
May	20	8		1	2	
June	5	7		2	0	
July	0	1		0	0	
August	0	0		0	0	
September	0	0		0	0	
October	0	0		0	0	

November	0	0		0	0	
December	0	0		0	0	
Total	415	65		43	10	

Table 5 showed the relationship in the number of cases (morbidity) and number of deaths (mortality) from meningitis before (pre) and after (post) mass vaccination. More cases (415) are noted in the pre mass vaccination year while less cases (65) were recorded in the post vaccination year. There was a statistically significant relationship on the effect of mass vaccination on the incidence of meningitis. Also, most deaths (43) occurred in 2017 than 2018 (10) when mass vaccination was done but this was not statistically significant.

IV. DISCUSSION

Mass vaccination is an innovative strategy in optimizing immunization uptake through the provision of vaccines that are effective in the prevention and control of specific infectious agents. The result from our study revealed that the burden of meningitis is high in Yobe State with a total of 480 cases of meningitis with 53 deaths and a case fatality rate of 11.04% which clearly shows a high burden of meningitis that is a source for concern. This finding is higher than result by Hassan et al. (2018) who reported a case fatality rate of 10.0% in Yobe State within epidemiological week 1 - 25. The estimated case fatality rate from our finding was however slightly lower than the estimated 13.2% stated by Ajibola et al. (2018) in Kebbi State, Nigeria from their 2014 review of morbidity and mortality data from meningitis.

Our finding further revealed that almost all (94.1%) Local Government Areas (LGAs) recorded at least one case of meningitis except Yusufari, which did not record any case during the review period. The study showed that the highest burden of meningitis was in Fika which recorded almost half (40.4%) of cases, this was followed by Fune (22.4%) then Damaturu and Nguru LGAs that recorded 9.8% each. Yunusari and Machina recorded only one case (0.2%) each while Yusufari recorded none. This study clearly revealed that some LGAs have higher burden of meningitis than others and the difference in the incidence of meningitis could be attributed to a relatively low immunity among LGAs with high burden of the disease (Fika, Fune, Damaturu and Nguru) and the presence of herd immunity against meningitis among susceptible populations in the LGA that did not have (Yusufari) and those with only a case (Yunusari and Machina). This finding clearly demonstrates the role of vaccination in the prevention of diseases and the need to scale up vaccination against meningitis in the worse hit LGAs and possibly across the State where access to health care has been marred by insecurity and multi-dimensional poverty.

This study also revealed that more males (55.0%) contracted meningitis than females (45.0%). This finding was similar to a review by Theodoridou et al. (2007) who observed that the incidence of meningitis among children was higher among males than females. This could be explained by the fact that the disease spreads faster among male children who often gather together while playing unlike females children that are involved less in playful activities and therefore a reduced risk of contracting the disease.

Furthermore, almost half of those affected were under five (47.3%). This is followed by those within the age bracket of 5 – 18 years (35.8%) and the least number of cases recorded among those who are 19 years and above (Table 1). This finding is similar to report by UNICEF (2018) who also observed that the highest burden of meningitis is seen among under 5 children in the meningitis belt of Africa. The implication of this finding is that mass campaigns should focus on this age group as they experience the highest burden of the disease.

It is of great importance to note that out of a total of four hundred and eighty (480) cases of meningitis recorded during the study period four hundred and fifteen 415(86.5%) were recorded in 2017 when no mass vaccination was done while 65(13.5%) occurred in 2018 when mass vaccination against meningococcal meningitis was conducted in the state. The percentage decline in the incidence of meningitis between the two periods (2017 – pre mass vaccination intervention) and (2018 – post mass vaccination intervention) was 73.0% (Table 2). This result revealed that mass vaccination against meningitis has the capacity to reduce the incidence of meningitis by 73.0% which is a relatively high evidence to support the conduct of such health interventions that are lifesaving and needed to reduce childhood morbidity and mortality. Our finding is similar to report by Borrow et al. (2017) who reported a global decline in meningococcal disease following mass vaccination that was known to provide herd immunity among populations susceptible to the disease. Furthermore, our result revealed that there was a statistical significant relationship on the effectiveness of mass vaccination on the incidence of meningitis in Yobe State, Northeast Nigeria. This is similar to studies done Ajibola et al. (2018) in Kebbi State in Northwest Nigeria who also noted a statistical significance difference in the incidence of meningitis pre and post mass vaccination.

In addition to the variation in the number of cases before and after mass vaccination, a monthly pattern in the distribution of the disease was observed. Figure 1 showed that the meningitis epidemic often starts in the month of January with peaks in March to May with April having the highest number of cases in the year. From June, the number of cases starts to decline with a possible absence of cases from August upwards. This seasonally pattern was also noted in a Nigeria study by Abdusalem et al. (2014) who reported that meningitis peaks from February to April during the warmest and driest seasons of the year. The implication of this finding is that mass immunization against meningitis in Nigeria should commence at least three months to the onset of the warm season (preferably in December or early January when the vaccine could provide herd immunity before the peak period when susceptible un-immunized children could contract the disease.

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Meningitis can be highly fatal among vulnerable populations when immediate and effective treatments are delayed. The result from this study revealed that a total of 53 deaths were recorded during the study period. Majority (86.7%) were in 2017 (pre-mass vaccination) while the least (17.3%) occurred in 2018 when there was mass vaccination campaign. A 69.4% decline in mortality from meningitis was noted which could be attributed to the mass vaccination conducted in the state. The implication of this to public health is that mass vaccination can prevent and control the disease among susceptible populations in the meningitis belt of Africa. This finding is in alignment with UNICEF (2018) who recommended mass vaccination as a key intervention towards the reduction of childhood morbidity and mortality among susceptible children in endemic countries like Nigeria. There was also a monthly variation in the pattern of mortality recorded during the study period. More deaths occurred during the month of April with no deaths from July in the pre mass vaccination year (2017) while for the post vaccination year (2018) most of the deaths (15 cases) occurred in the month of February. On the overall, most deaths (24) occurred in the month of April, 2017 when no mass vaccination was conducted.

Generally, more deaths (81.1%) occurred in 2017 when no mass vaccination was carried out when compared to 2018 with less deaths (18.9%) when mass vaccination against meningitis was conducted. Although no statistically significant relationship was observed pre and post mass vaccination with respect to mortality, the fact that mass vaccination could prevent upto 62.2% of deaths per year from meningitis, makes this approach very commendable and calls for government and every stakeholder to support mass vaccination in the control and prevention of meningitis among susceptible populations. This finding is in conformity with study by Borrow et al. (2017) who also noted that mass vaccination is effective and can result to a decline in the mortality from meningitis.

V. CONCLUSION

The result from this study revealed that mass vaccination against meningitis greatly reduces the burden of meningitis in terms of number of cases and deaths from this vaccine preventable disease. A statistically significant relationship was observed between mass vaccination and number of meningitis cases per year but no statistically significant relation was observed between mass vaccination and mortality from the disease despite more than half reduction in the number of deaths following mass vaccination. This evidence clearly demonstrates that mass vaccination is an effective measure for the reduction of morbidity and mortality from meningitis and should therefore be encouraged and implemented in endemic regions.

RECOMMENDATION

Based on the findings obtained from this study, the following recommendation were made.

- Seasonal mass vaccination of eligible children against meningitis should be ensured in the meningitis belt of Africa.
- All campaigns should target at least last week of December to first week of January when the epidemic is about to evolve.
- Government in collaboration with partners should ensure adequate financing and provision of logistics to routinely conduct mass vaccination against the disease among susceptible populations.
- If possible, the meningitis vaccine should be included into routine immunization of children.

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