Etiology and Risk Factors for Meningitis during an Outbreak in Batié Health District, Burkina Faso, January-March 2016

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ABSTRACT

Introduction: On 16 March 2016, Batié Health District notified the Burkina Faso Ministry of Health Surveillance unit of 12 suspected cases of meningitis. During the same period, Batié´s neighboring districts in Côte d'Ivoire and Ghana were experiencing a meningitis epidemic. We investigated to establish the etiology and risk factors for the disease and to recommend prevention and control measures. **Methods:** We conducted unmatched case control study. A case was any person living in Batié with fever (temp. ≥ 38.5°C) and any of the following: neck stiffness, neurological disorder, bulging fontanelle, convulsion during January to April 2016 with cerebrospinal fluid (CSF) positive to PCR. Controls were non sick household members, neighbors or friends to the cases. We analyzed the investigation and laboratory records. We included all confirmed cases and two neighborhood controls per case. We used a standard questionnaire to collect data. We analyzed data by Epi info 7 and calculated odds ratio (ORs),adjusted odds ratios (AOR) and 95% confidence interval. We proceeded to univariate, bivariate, multivariate and logistic regression analysis. **Results:** We interviewed 93 participants including 31 meningitis cases and 62 controls. The median age of cases was 8 years old [2 months-55 years] and 6.5 years old [5 months-51 years] for controls. *Streptococcus pneumoniae* 16(51.61%), *Neisseria meningitidis W* 14(45.16%) and *Haemophilus influenzae* b 1(3.23%) were the identified germs. The independent risk factors identified were travel to meningitis affected areas (Adjusted odd ratio(AOR)=12[2.3-60],p=0.0029); >5 persons sharing bedroom (AOR=5.7[1.5-22],p=0.012) and rhinopharyngitis (AOR=26[1.8-380],p=0.017). **Conclusion:** Streptococcus pneumoniae and Neisseria meningitidis W caused the outbreak in Batié. The risk factors were overcrowding, travel to affected areas, and rhinopharyngitis. We recommended reactive vaccination against Neisseria meningitidis W, limited travel to affected areas and ventilation of rooms.

KEYWORDS: Meningitis, Etiology, Risk Factors, Batié, Burkina Faso.

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RECEIVED
14/02/2020

ACCEPTED
02/03/2021

PUBLISHED
29/03/2021

LINK

https://www.afenet-journal.net//content/article/4/4/full/

CITATION
Pedwindé Hamadou Séogo et al. Etiology and Risk Factors for Meningitis during an Outbreak in Batié Health District, Burkina Faso, January-March 2016. J Interval Epidemiol Public Health. March 2021; 4(1): 4
DOI: https://doi.org/10.37432/jieph.2021.4.1.33

Introduction

Meningitis is an inflammation of the meninges. In most cases, meningitis is of viral or bacterial origin [1-3]. In 1963, Lapeyssonnie described meningitis as specifically an African epidemiological problem in the so called meningitis belt that extends from Senegal in the west to Ethiopia in the east [4,5]. In this part of Africa, climatic conditions are favorable for the outbreak of meningitis epidemics.

Similar to many countries situated in the meningitis belt, Burkina Faso has experienced recurrent large epidemics of meningitis in the last two decades[6,7] . The meningitis epidemics in the country were as follows: in 1996 (42,967 cases and 4,363 deaths); in 1997 (22,293 cases and 2,533 deaths); in 2001 (12,790 cases and 1,769 deaths); 2002 (12,928 cases and 1,482 deaths); 2003 (8,713 cases and 1,371 deaths), 2006 (19,134 cases and 1,674 deaths), 2007 (24,423 cases and 1,779 deaths), 2008 (10,425 cases and 1,114 deaths); 2010 (6,837 cases and 989 deaths) 2011 (3,984 cases and 649 deaths); and in2012 (7,022 cases and 739 deaths) [6,8].

Interventions to prevent and control meningitis epidemics in Burkina Faso include; enhanced case management and case based surveillance; mass vaccination campaign against Neisseria meningitidis A in 2010 as well as the introduction of 13 valent pneumococcal conjugate vaccine in Expanded Program of immunization of meningitis.

On 16 March 2016, Batié health district notified the Ministry of Health Surveillance (MOH) unit of 12 suspected cases of meningitis. Also, from January to March 2016the neighboring districts of Batié in Côte d'Ivoire and Ghana were experiencing ameningitis epidemic. The objectives of our investigation were to establish the cause and risk factors for the outbreak and to recommend prevention and control measures.

Methods

Study setting

Batié health district is located in the South West region of Burkina Faso. It covers five communes (Batié, Legmoin, Midebdo, Kpuéré, Boussoukoula). It has 12 health facilities, 248 villages and 94,691 inhabitants in 2016. The district of Batié is one of the five health Districts (Batié, Dano, Diébougou, Gaoua, Kampti) of the south west region. It is limited to the north by the Districts of Gaoua and Kampti, to the south west by the Republic of Côte d'Ivoire (Bouna District) and to the south east by the Republic of Ghana (Wa, Jiropa and Nadowli Districts). This part of the country has very porous borders characterized by free population movement across borders .

Study design: We conducted an unmatched case control study from March 23rdto 2ndApril 2016.

Study population: The study population was the entire population of the health district of Batié from January to April 2016.

Selection of cases and controls: A case was any person living in Batié with fever (temp $\geq$ 38.5°C) and any of the following: neck stiffness, neurological disorder, bulging fontanelle, convulsion during January to April 2016 with cerebrospinal fluid (CSF) positive on PCR. Based on this case definition, cases were identified by health workers in facilities during medical consultations. The cases were recruited in the health facilities from the consultation registers and in the laboratories. We reviewed case based investigation and laboratory forms. The cerebrospinal fluids were collected at the Health facilities level and we assessed the macroscopic appearance of the liquid before its transfer to the district laboratory for: (i) a direct examination in the fresh state to assess the presence of leucocytes and red blood cells,(ii) an examination after Gram stain to highlight the morphological characteristics of the bacterium and (iii) a latex examination for soluble antigens of the main germs responsible for meningitis.

We sent after the cerebrospinal fluid samples, collected in the dry or cryotube tubes and seeded on Trans Isolate (TI) to the reference laboratory from Sanou Souro University Hospital Center for confirmation. We used PCR as the gold standard for confirmation of cases. Controls were neighbors without meningitis. We included all confirmed cases and two neighborhood controls per case. Controls were non sick household members, neighbors or friends to the cases. We administered a semi-structured questionnaire to collect information on risk factors associated, socio-demographic data and clinical symptoms.

Controls were randomly selected as follows: (i) In a family of one case, if we have more than two controls, we proceeded to a simple random choice without discount. Thus we assigned numbers to all possible controls of the house and then randomly drew two numbers to be included, (ii) In a family where both controls were not available, we allocated random number to all neighbors and drew two numbers to be included.

Data collection:. We administered a semi-structured questionnaire to collect information on risk factors associated, socio-demographic data and clinical symptoms.

Measure and data analysis: We used Epi Info 7.2 software to analyze the data. We conducted univariate, bivariate, multivariate, and logistic regression analysis. We calculated odds ratio (ORs), adjusted odds ratios (AOR) and 95% confidence interval to identify risk factors associated. All factors with p ? 0.25 at bivariate analysis were included in the logistic regression model (step-by-step descending procedure), and proceeded to a gradual elimination until the final model.We took also into account the factors identified during our literature review .The variables retained as factors associated with meningitis in the final model were those with $p < 0.05$.

Ethical considerations: We obtained approval from the West African Field Epidemiology Training Program (WA FETP) leadership. We also obtained approval from the Burkina Faso Ministry of Health authorities for data collection through the note from Chief Medical Officer of Batié health district. Participation in this study was voluntary and only those participants who gave informed and voluntary oral consent were included in the study. The interviews were done in a place where maximum confidentiality was assured.

Results

Socio-Demographic Characteristics of study participants

We interviewed 93 participants including 31 meningitis confirmed cases and 62 controls. The median age of cases was 8 years old ranging from 2 months to 55 years. The median age of controls was 6.5 years range 5 months to 51 years. The majority of cases (54.76%) and controls (52.38%) were male. Male to female sex ratio was 1.38 (18/13) for cases and 1.14 (33/29) for controls. The majority of cases (74.19%) and controls (72.58%) were children. The majority of cases came from health facilities of Batié municipality (District hospital and Koriba health facility) (48.39%) (Table 1).

Streptococcus pneumoniae 16(51.61%), *Neisseria meningitidis W* 14(45.16%) and *Haemophilus influenzae* b 1(3.23%) were the identified organisms.

Bivariate analysis of factors associated with the occurrence of meningitis in Batié District

Travel to meningitis affected areas, having a rhinopharyngitis episode, sharing bedroom with 5 persons, attending a funerals were risk factors associated with the occurrence of meningitis in the Batié health district in bivariate analysis (Table 2). People with rhinopharyngitis were 10.43 times more likely to have meningitis (OR=10.43,p=0.00), p. Also, individuals who traveled to affected areas were 4.8 times more likely to have meningitis compared to those who did not travel (OR=4.85,p=0.00).

Stratified analysis of factors associated with occurrence of meningitis in the Batié district

Factors associated with the occurrence of meningitis in the Batié health district were stratified by sex and age group to assess possible confounding and an effect modification (Table 3) (Table 4). T able 3 shows that among participants who attended funerals, women were five times more likely to have meningitis than men (OR=5.03[1.23-20.48]). In addition, men were twenty times more likely to have meningitis if they had nasopharyngitis or respiratory infection than women (OR=20.36 [2.24-184.60]).

Table 4 shows that among those who had travelled to meningitis affected areas, people over 15 years, were eleven times more likely to have meningitis than those who were 15 years old or younger (OR=10.83 [1.3-85.44]).

Multivariate analysis of factors associated with the occurrence of meningitis in the Batié district

Multivariate analysis (Table 5) was performed to assess the risk factors associated with meningitis occurrence in Batié health district while controlling for other possible associated factors. The independent risk factors considered important by the chi-square test in the bi-dimensional analysis with p <0.25 were introduced into the logistic model (travel of the subject to meningi-tis affected areas, place of residence (Urban /Rural), attending funerals, the presence of a rhinopharyngitis, sharing bedroom with 5 persons or more (promiscuity), market attendance and the subject's immunization status). The independent risk factors found to be significantly associated with the occurrence of meningitis in the multivariate analysis were: travel towards meningitis affected areas (AOR = 11.85, 95%CI: [2.33-60.32], p = 0.003), sharing bedroom with more than 5 persons (AOR = 5.72, 95%CI: [1.46-22.42], p = 0.012) and presence of rhinopharyngitis (AOR = 25.94, 95%CI: [1.77-379.99], p = 0.017)).

Discussion

In our study, pneumococcus (51.61%) was the organism identified in most cases in Batié District outbreak. In addition, no case of meningococcal meningitis A was recorded during this outbreak in Batié.

The meningitis vaccination campaign with MenAfriVac in 2010 in Burkina Faso which protects up to 10 years could explain our results [9,10]. Also, during the same period, an increase in cases of pneumococcal meningitis were observed in the neighboring districts of Côte d'Ivoire and Ghana. Although Burkina Faso has introduced PCV 13 since 2013, this vaccine would not protect children over one year of age due to the lack of booster vaccination.[14]

In our study, overcrowding was a risk factor associated with the occurrence of meningitis in Batié district. Indeed in the villages of Batié, 30-40 people can live in the same household. This overcrowded environment facilitates the transmission and spread of the disease. Indeed, the bacterial transmission of meningitis occurs from person to person by droplets of respiratory or pharyngeal secretions. Close and prolonged contact (kissing, sneezing, and close coughing), or promiscuity with an infected person (dormitory life, sharing cutlery or glasses), promotes the spread of the disease [5].

Our results corroborate with Burman (1985) in Sweden [15] Urwin in England (United Kingdom) who found that air pollution, overcrowding and tobacco were preventable risk factors for meningitis. Overcrowding has also been isolated in several African studies [6,15-19] . However, Hodgson (1997) in Ghana did not find an association between overcrowding and meningitis [20].

Travel to areas affected by the meningitis epidemic was also one of the risk factors identify in our study. Travel is an opportunity to meet an infected person or asymptomatic carriers. Also during these trips, the prolonged contact favors the transmission by the droplets (carrier). It should also be noted that Batié health district is a crossroads area between Burkina Faso with Côte d'Ivoire and Ghana. During the same period, the health districts of Jiripa, Nadowli and Wa in Ghana and the health district of Bouna in Cote d´Ivoire were in meningitis epidemics. Also the free movement of people across borders could have contributed to the spread of the epidemic. Wilder-Smith noted that travel and international migration facilitate the rapid inter-continental spread of meningococcal disease. This is the basis of current vaccination recommendations (vaccination of all Hajj pilgrims, all travelers to areas where there are epidemics, travelers to sub-Saharan meningitis belt and certain medical conditions [21].

Rhinopharyngitis causes the fragility of the nasal mucosa, therefore a gateway for germs of meningitis in the human body. Indeed between January and April corresponds to the dry season in Burkina Faso. During this period, there are many cases of respiratory tract infections resulting in fragility of the nasal and pharyngeal mucosa. This situation leads to an easy transmission of germs in the body and the spread of the disease[22-26].

Limitations of the study

Our results cannot be generalized to the entire population of the South West region, nor to Burkina Faso, because we only worked in one district out of the 70 in Burkina Faso. There could also be a selection bias (cases recruited from health facilities and controls recruited from household members, neighbors or friends) and a recall bias (type of study). Also the number of confirmed cases for our study (31 cases in total), could explain the fact that our confidence intervals are wide.

Our study nevertheless provided information on the risk factors associated with meningitis which will be useful for the control of this pathology in Batié´s district. It also provided information for the formulation of hypotheses for other more detailed studies on meningitis in Burkina Faso.

Conclusion

Pneumococcus (*Streptococcus pneumoniae*) and meningococcal W135 (*Neisseria meningitides*) W135 were the main etiological agents identified. Travel towards affected areas, overcrowding, and rhinopharyngitis were the main risk factors for meningitis in the Batié health district.

We recommended: (i) to the Batié´s population, a limitation of travels to meningitis affected areas, an aeration of bedrooms (by creating/widening windows and leaving them open during the day), (ii) to the ministry of health, a vaccination against Neisseria meningitidis W of the population of Batié and to initiate an in-depth study pneumococcal meningitis in Burkina Faso after introduction of 13-valent pneumococcal conjugate vaccine.

What is known about this topic

- Children are most affected by meningitis during epidemics
- Pneumococcus is the main germ responsible for meningitis in this border area of Burkina
- The organization of vaccination campaign against *Neisseria Meningitidis A* in 2010 reduced the emergence of the serotype A

What this study adds

- Pathogens identify: Pneumococcus (Streptococcus pneumoniae) and meningococcal W (Neisseria meningitides W)
- Risk factors for meningitis in the Batié health district: Travel towards affected areas, overcrowding, and rhinopharyngitis

Competing interests

The authors declare that they have no competing interests.

Ethics

We obtained approval from the Ministry of Health authorities of Burkina Faso and the staff of the West African Field Epidemiology Training Program (WA FETP). Participation in the study was voluntary and only participants who gave informed consent were included in the study. Confidentiality was assured and maintained throughout the study.

Consent to publish

Consent to publish was sought from all relevant authorities as well as from the authors and was granted.

Availability of data and materials

The dataset for this study can be availed upon request. The dataset is an epi info and Excel dataset.

Authors' contributions

SPH, SB, AS and YD developed the protocol, collected and analyzed the data, interpreted the data and wrote the manuscripts. BWB, SY, SA, TAA, SH contributed to the analysis of the data, interpretation and reviewing several drafts and made a substantial contribution to the writing of the manuscripts. YI, MI, MA and SM contributed to the interpretation of the data and the revision of the manuscripts. All authors read and approved the final manuscript.

Acknowledgements

Our sincere thanks:

- West African Field Epidemiology Training Program
- African Field Epidemiology Network
- West African Health Organization (WAHO)
- CDC-Atlanta
- Université Ouaga I, Pr Joseph Ki Zerbo, Burkina Faso
- Ministry of Health, Burkina Faso

Many thanks also go to all participants for their consent to allow me to interview them.

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Table 1: Sociodemographic characteristics of meningitis cases and controls in Batié Health District, Burkina Faso, January-April 2016					
Characteristics		**Cas**	**(%)**	**Controls**	**(%)**
Age	0- 4 years	12	38.71	22	35.48
	5-14 years	11	35.48	25	40.32
	15-24 years	3	9.68	5	8.06
	25 years and over	5	16.13	10	16.13
Sex	Male	18	58.06	33	53.23
	Female	13	41.94	29	46.77
Education level	Any	20	64.52	52	83.87
	Primary/Secondary	11	35.48	10	16.13
Profession (occupation)	Any	23	74.19	45	72.58
	Farmer	4	12.90	9	14.52
	Housewife	4	12.90	8	12.90
Origin (Municipality of residence)	Municipality of Batié	15	48.39	31	50.00
	Others Municipalities	16	51.61	31	50.00
Education level of the father	Any	21	67.74	47	75.81
	Primary/Secondary	10	32.26	15	24.19
Education level of the mother	Any	22	70.97	52	83.87
	Primary/Secondary	9	29.03	10	16.13
Profession of the father	Farmer	24	77.42	58	93.55
	Salaried	5	16.13	4	6.45
Profession of mother	Housewife	25	80.65	52	83.87
	Trader	6	19.35	10	16.13

Table 2: Results of Bivariate analysis of meningitis risk factors in Batié District, Burkina Faso, January-April, 2016

Variables	**Cases**		**controls**		**OR no adjusted**	**95% CI**	**p-value**
	n	**%**	**n**	**%**			
Had Rhino-pharyngitis	8	25.8	2	3.2	10.43	2.06-52.85	**0.00**
Travel to meningitis affected areas	14	45.2	9	14.5	4.85	1.74-13.18	**0.00**
Sharing bedroom with > 5 persons	15	48.4	22	35.5	3.30	1.34-8.14	**0.00**
Attended funerals	15	48.4	17	27.4	2.48	1.01-6.09	**0.02**
Residence in rural area	4	12.9	10	16.1	1,29	0,37-4,52	**0.19**
Unvaccinated against meningitis	23	74.2	41	66.1	1.47	0.57-3.86	**0.20**
Attended at market	17	54.8	30	48.4	1.29	0.54-3.07	**0.21**
Male sex	18	58.1	33	53.2	1.27	0.51-2.90	0.33
Less than 15 years old	23	74.2	47	75.8	0.92	0.34-2.47	0.43
Tobacco consumption	1	3.2	2	3.2	1.01	0.08-11.47	0.48
Attented health facility	9	29.0	14	22.6	1.37	0.5-3.65	0.27
Alcohol consumption	7	22.6	12	19.4	1.21	0.42-3.48	0.34

Table 3: Factors associated with the occurrence of meningitis in the Batié health district stratified by sex in the health district of Batié, Burkina Faso, January-March 2016						
Contributing factors	**Sex**	**Cases**	**controls**	**Crude OR [95% CI]**	**Stratum-specific OR [95% CI]**	**Adjusted OR(Mantel-Haenszel) [95% CI]**
Attendance at funerals	Male			2.48 [1.01-6.10]	1.46 [0.44-4.88]	NA
	Yes	7	10			
	No	11	23			
	Female				5.03 [1.23-20.48]	
	Yes	8	7			
	No	5	22			
Sharing bedroom with ≥ 5 persons	Male			3.30 [1.35-8.14]	3.14 [0.95-10.35]	3.36 [1.35-8.32]
	Yes	11	11			
	No	7	22			
	Female				3.68 [0.91-14.87]	
	Yes	9	11			
	No	4	18			
Travel to meningitis affected areas	Male			4.85 [1.78-13.18]	4.48 [1.18-16.94]	4.83 [1.77-13.15]
	Yes	8	5			
	No	10	28			
	Female				5.35 [1.17-24.43]	
	Yes	6	4			
	No	7	25			
Presence of Rhino-pharyngitis	Male			10.08 [2.03-50.02]	20.36 [2.24-184.60]	NA
	Yes	7	1			
	No	11	32			
	Female				2.33 [0.13-40.46]	
	Yes	1	1			
	No	12	28			

Table 4: Factors associated with the occurrence of meningitis in the Batié health district stratified by age group in the Batié health district in Burkina Faso, January-March 2016

Contributing factors	Age group	Cases	Controls	Crude OR [95% CI]	Stratum-specific OR [95% CI]	Adjusted OR(Mantel-Haenszel) [95% CI]
Attendance at funerals	< 15 Years			2.45 [1.01-6.1]	3.67 [1.01-13.27]	NA
	Yes	7	5			
	No	16	42			
	≥ 15 Years				NA	
	Yes	8	12			
	No	0	3			
Sharing bedroom with ≥ 5 persons	< 15 Years			3.30 [1.34-8.14]	3.67 [1.29-10.43]	NA
	Yes	14	14			
	No	9	33			
	≥ 15 Years				2.62 [0.39-17.46]	
	Yes	6	8			
	No	2	7			
Travel to meningitis affected areas	< 15 Years			4.85 [1.78-13.18]	3.67 [1.15-11.72]	NA
	Yes	9	7			
	No	14	40			
	≥ 15 Years				10.83 [1.3-85.44]	
	Yes	5	2			
	No	3	13			
Presence of Rhino-pharyngitis	< 15 Years			10.43 [2.05-52.85]	9.68 [1.01-92.53]	NA
	Yes	4	1			
	No	19	46			
	≥ 15 Years				14 [1.19-163 .37]	
	Yes	4	14			
	No	18	1			

Table 5: Results of multivariate analysis of meningitis risk factors in Batié District. Burkina Faso. January-April. 2016				
Risk Factors	**Crude OR**	**OR adjusted**	**95% CI**	**p-value**
Had rhino-pharyngitis	10.43	25.94	1.77-379.99	**0.0174**
Traveled to meningitis affected areas	4.85	11.85	2.33-60.32	**0.0029**
Shared bedroom with ≥ 5 persons (promiscuity)	3.30	5.72	1.46-22.41	**0.0123**
Resident in rural area	1.29	3.2	0.37-27.69	0.2892
Unvaccinated against meningitis	1.47	2.77	0.60-12.74	0.1908
Attended funeral	2.48	1.53	0.35-6.77	0.5704
Attended market	1.29	0.55	0.14-2.16	0.3934