A 20-year retrospective analysis of epidemic meningitis surveillance data in Burkina Faso, Mali, and Niger

Mamoudou H. Djingarey[1], Sassan Noazin[2], Marie Pierre Préziosi[3], Clément Lingani[1], Sylvestre Tiendrebéogo[4], Kandioura Touré[5], Kairo Kiari Kaka[6], William Perea[2], Eric Bertherat[2], Denis Kandolo[1], Marc LaForce[3], Simonetta Viviani[3], Kader Kondé[1]

[1] WHO/MDSC/Ouagadougou [2] WHO/CDS/HQ [3] Meningitis Vaccine Project [4] Ministry of Health Burkina Faso [5] Ministry of Health Mali [6] Ministry of Health Niger

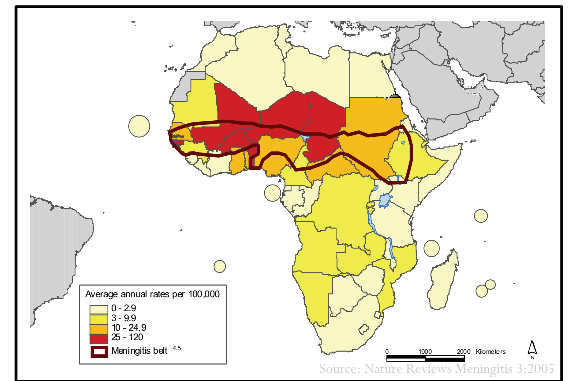
Background

- Epidemic meningitis continues to be a major public health problem in the African meningitis belt.
- Long-term surveillance data is crucial for understanding the dynamics of the disease and improving the control strategies.
- Burkina Faso, Mali, and Niger have extensive meningitis surveillance data—past 20 years.
- A detailed analysis of these data is presented.

Objective

- Describe epidemic meningitis at the national and district level for the following periods:
  - 1997–2005 in Burkina Faso
  - 1992–2005 in Mali
  - 1986–2005 in Niger.
- Explore database using various statistical methods to increase understanding of epidemic meningitis dynamics (factorial analysis, cluster analysis, temporal series, Bayesian networks).
- Make the database widely available for mathematical modeling and improved forecast of meningitis epidemics.

Figure 1: Burkina Faso, Mali, Niger : 3 hyper-endemic countries of the African meningitis belt



Methods

- Data were collected from ministries of health and codified at the WHO Multi-Disease Surveillance Centre (MDSC) in Ouagadougou.
- Databases were cleaned, updated, and standardized with particular attention paid to completing missing data and district populations.
- Alert and epidemic thresholds were determined using WHO methodology (*WHO/WER*, 75, 306–309).

Table 1: Average meningitis annual attack rates and case fatality rates for Burkina Faso, Mali, and Niger for the study period

Country	Study Period	Average pop (millions)	Cases	Average AR/ 100,000	Deaths (thousand)	CFR (%)
Burkina Faso	1997-2005	11,9	81,443	76.0	11,7	14.4
Mali	1994-2005	10,0	26,616	22.2	2,7	10.2
Niger	1986-2005	9,5	182,244	95.9	14,8	8.2

Table 2: Average district level ARs per 100 000 in epidemic vs. non-epidemic years

Country	Average district level ARs* (range) Epi years	Non epi years
Burkina Faso	158 (54-353)	48 (18-115)
Mali	50 (1-141)	11 (0-29)
Niger	211 (10-834)	44 (2-118)

Burkina Faso
Epidemic Years : 1997, 2001, 2002, 2006, 2007 Non-Epidemic Years : 1998, 1999, 2000, 2003, 2004, 2005
Mali
Epidemic Years : 1994 to1997 Non-Epidemic Years : 1998 to 2007
Niger
Epidemic Years : 1986, 1993 to 1996, 2000 Non-Epidemic Years:1987 to 1992, 1997 to 1999, 2001 to 2005

Figure 2: Meningitis epidemic weekly trends over the years in Burkina Faso (1997–2008), Mali (1992–2008), and Niger (1986–2008)

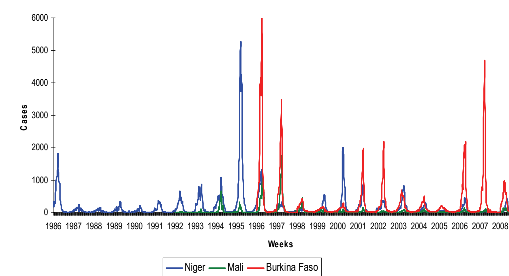
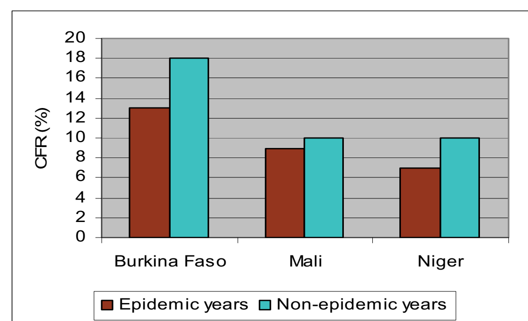


Figure 3: Average annual CFRs by country in epidemic vs. non epidemic years



Data analysis

The original databases were all converted to Excel format using Stat-trafer software. Factorial analysis was used for detection of irregularities and inconsistencies in the database. For the cluster analysis six variables were retained: mean annual incidences, variance, highest weekly incidence, week presenting highest incidence, skewness, and Kurtosis index. Statistical analysis was done using Excel, SPSS, Stata, and R. Geographical representation of data was done using Health Mapper. Cluster analysis was carried out using two different methods: hierarchical ascending and centroid. The two methods showed a consistent clustering pattern when applied to a given country. Examples below are only given for Burkina Faso. Districts clustered geographically follow three different epidemic patterns

- Group 1: stepped curve and high ARs
- Group 2: wide curve, flat peak, and lower ARs
- Group 3: later start (2 weeks later than G1&2) and slower progression to peak

Results

- Average annual incidence rates per 100 inhabitants and case fatality rates (%) for the study period were respectively: Burkina Faso: 76 (14.4%); Mali: 22.2 (10.2%); and Niger: 95.9 (8.2%)
- Average attack rates at district level during epidemic years were higher in Niger (211 per 100 000) than in Burkina Faso (158 per 100 000) and Mali (50 per 100 000)
- Case-fatality ratios are higher in non-epidemic years when compared to epidemic years.
- Disease incidence peaks at week 13 in Burkina Faso and week 14 in Mali and Niger
- Epidemics last an average of 5 weeks in Mali, 7 weeks in Burkina Faso, and 10 weeks in Niger.
- A fairly consistent seasonal pattern of meningitis was observed across 3 countries and years in terms of start, peak week, and end of the epidemic season
- Analysis of secular trends show that meningitis epidemics occur in waves that last in general 3–4 years at the country level
- Inter-epidemic periods between those waves varied from 3 years in Burkina Faso to 3–5 years in Niger
- No major epidemic waves have been observed in Mali since 1997

Figure 4: Meningitis annual average attack rates by health district: Burkina Faso (1997–2008), Mali (1992–

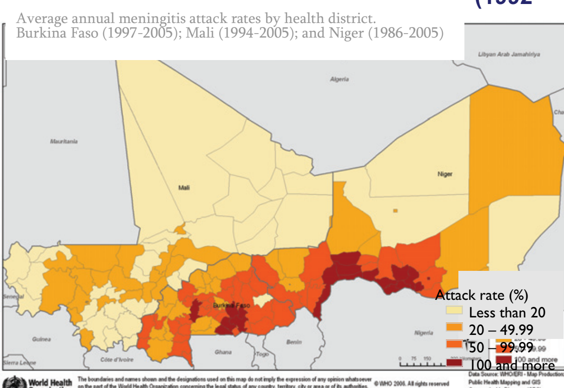


Figure 5: Meningitis epidemic dynamics at district level in Burkina Faso, Mali and Niger

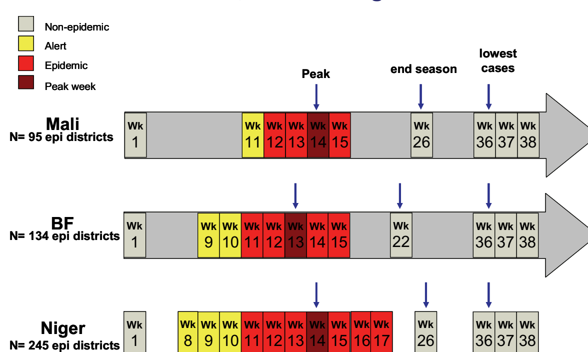
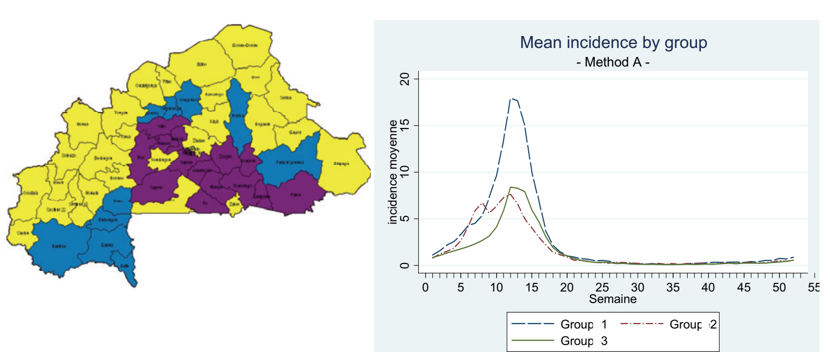


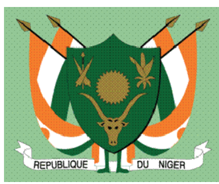
Figure 6: Cluster analysis by the hierarchical ascending method: Example from Burkina Faso, 1997–2005



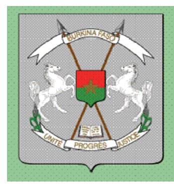
Conclusions

- These data provide a comprehensive overview of the trends and magnitude of epidemic meningitis in three highly endemic African meningitis belt countries.
- Despite its limitations, data generated from the surveillance system in the three countries were the basis to undertake prevention and control measures (i.e. response strategies for meningitis epidemics in the belt).
- Final results of cluster analysis will provide useful information for research on epidemic risk factors and environmental determinants.
- In addition, historical meningitis surveillance data may be used to further evaluate the impact of the new meningococcal A conjugate vaccine.

République du Mali



République du Niger



République du Burkina Faso