



Short Communication

Meningitis epidemics shift in sub-Saharan belt

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ABSTRACT

Meningococcal meningitis (MCM) poses a serious threat to public health in Africa. Epidemics appear irregularly every 5–12 years, especially in the regions across sub-Saharan ‘meningitis belt’. This study investigated the long-term spatiotemporal dynamics of MCM. It appears that dominant epidemic outbreaks in the meningitis belt spread from west to east over the study period 2006–2016.

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Introduction

Meningococcal meningitis (MCM) poses a serious threat to public health in Africa. It is particularly hazardous for African children (WHO, 2017), for whom the case-fatality rate (CFR) is high. During the 2017 meningitis epidemic in northern Nigeria, 14 473 cases (including 1158 deaths) were reported, of which over 50% involved children under the age of 16 years (Nigeria Centre for Disease Control, 2017). In general, the CFR for poorly treated cases can be up to 50% (WHO, 2017; CDC, 2017). The bacterium responsible, *Neisseria meningitidis*, is transmitted among humans aerielly (WHO, 2017; CDC, 2017) and the disease is highly contagious.

The long-term dynamics of different strains of MCM is characterized by markedly irregular periodicity (5–12 years), with attack rate reaching 1000 cases per 100 000 population (CDC, 2017; Roberts, 2008). The spatiotemporal dynamics of MCM cases in the sub-Saharan ‘meningitis belt’, which spans across Africa from Senegal to Ethiopia (first identified by Lapeyssonnie (1963)), has been investigated previously for the period 1980–1999 (Molesworth et al., 2002; Ramakrishnan et al., 2009; Lingani et al., 2015).

This short communication reports a geographical shift in pattern of the MCM epidemics in the sub-Saharan meningitis belt, based on publicly available data for the years 2006–2016.

Methods

Annually reported numbers of meningitis cases and deaths, along with the number of epidemic districts, were obtained from the World Health Organization (WHO) Global Health Observatory data repository (see <http://apps.who.int/gho/data/node.main.178?lang=en> and Lingani et al. (2015)). Weekly reported meningitis cases and deaths for the WHO Africa Region were obtained from the WHO Weekly Reports (Bulletins Hebdomadaires) (see <http://www.who.int/csr/disease/meningococcal/epidemiological/en/>).

The meningitis epidemiology data reported from January 2006 to December 2016 were studied to explore the spatial pattern of meningitis epidemics in the sub-Saharan meningitis belt (see Figures 1 and 2). Eleven regions were included from west to east: Mali, Côte d'Ivoire, Burkina Faso, Ghana–Togo–Benin region, Niger, Nigeria, Cameroon, Chad, Central African Republic (CAR), Sudan and South Sudan region, and Ethiopia (Figure 1a). These 11 regions encompass 90% of meningitis cases in the sub-Saharan meningitis belt. Reports published by the WHO on the number of ‘epidemic districts’ in each region that had crossed the meningitis epidemic threshold were analysed. The threshold is defined as a weekly attack rate of 10 reported cases per 100 000 population (according to the WHO; see <http://www.who.int/immunization/diseases/meningitis/en/>) and is a key index used to identify seasonal outbreaks.

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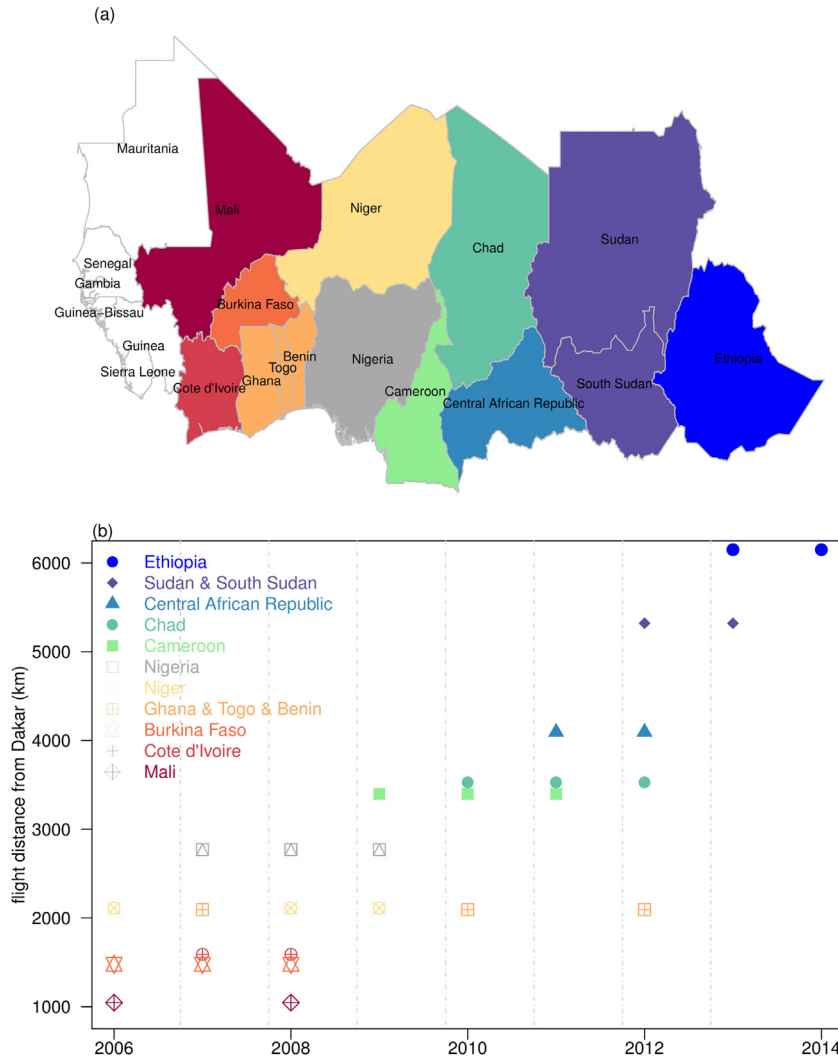


Figure 1. (a) Location of the regions along the sub-Saharan meningitis belt, and (b) the relationship between the dominant epidemic years and the westward distance (the regions in the legend from bottom to top are listed in order of their location from west to east geographically).

Results and discussion

The numbers of cases of MCM in the 11 regions of the sub-Saharan meningitis belt over the study period 2006–2016 are plotted in Figure 2. The time-series indicated that the MCM epidemics were highly irregular, often not annual in period, or annual over several consecutive years followed by fade-outs. Nevertheless, epidemics were apparent in each of the regions over the study period. Due to the difficulty finding any pattern in this disorder, it was found to be more helpful to study changes in the annual number of MCM “epidemic districts” in each of the 11 regions. For each region, the three (or two) calendar years with the largest numbers of epidemic districts were selected. Thus each region could be associated with three (or two) dominant epidemic years. The longitudinal flight distance (in kilometres) between the capitals of each region and the capital of Senegal – Dakar (the most westward point) – was recorded and referred to as the ‘westward distance’ (the Ghana–Togo–Benin region was represented by the capital of Togo and the Sudan and South Sudan region was represented by the capital of Sudan). The relationship between the dominant epidemic years and the westward distance is shown in Figure 1b: an obvious positive correlation is seen.

On a larger scale, the meningitis outbreaks appeared to be transmitted gradually eastwards, moving from country to country in an almost falling domino-like pattern, indicating the important influence of spatial dynamics. From 2006 to 2008, major outbreaks occurred in the western regions, that is, Mali, Côte d’Ivoire, and Burkina Faso (Figure 2a–c). The intense depletion of susceptible individuals in the regions, possibly to below threshold levels, resulted in die-out over the next years as the disease spread eastwards. Niger and Nigeria both experienced a dominant epidemic year in 2009 (Figure 2e, f), and this was followed by epidemic outbreaks in Cameroon and Chad, which initiated in 2010 and peaked in 2011 (Figure 2g, h). The pattern ends with outbreaks in Sudan in 2013 (Figure 2j) and Ethiopia in 2014 (Figure 2k), although the populations in both countries had been vaccinated since 2010 (WHO, 2015). It is likely that both of the latter outbreaks would have been of greater intensity if vaccination had not been introduced. Similar trends were reported for the MCM epidemics during the period 1980–1999 (Molesworth et al., 2002). This shift in timing of dominant epidemic years from west to east along the sub-Saharan meningitis belt has not been reported previously. However strong spatial dynamics are characteristic of MCM transmission and the disease is known to spread from district to district within

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