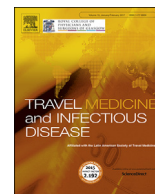




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Communicable and non-communicable disease risks at the *Grand Magal* of Touba: The largest mass gathering in Senegal

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ABSTRACT

Background: An estimated 4–5 million individuals gather each year in the holy city of Touba, Senegal during the *Grand Magal* religious pilgrimage. Pilgrims come from across Senegal and the surrounding countries, as well as from countries outside Africa. It is the largest mass gathering (MG) of the Mouride community and the largest Muslim religious MG in West Africa.

Method: A cross-sectional study was conducted on all patients who attended a public healthcare structure during the November 2015 *Grand Magal*.

Result: Data were collected on a total of 32,229 healthcare contacts. The most frequent reasons for consultation were trauma, followed by fatigue and heatstroke. Infectious diseases were also prevalent with, notably, a high rate of febrile systemic illnesses and malaria, diarrheal diseases, and respiratory tract infections. Such results are likely to be linked to overcrowding and climatic conditions, the relative lack of sanitary facilities, and limited medical resources available during the event.

Conclusion: The context of the *Grand Magal* MG is unique, given its location in a tropical developing country and its international component which may favor the globalization of locally endemic diseases. As such, it warrants investment in modern methods for public health surveillance and planning of the event.

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1. Introduction

The WHO defines mass gatherings (MGs) as “events attended by a sufficient number of people to strain the planning and response resources of a community, state or nation” [1]. Mass gatherings have been associated with high rates of morbidity and mortality from non-communicable diseases, accidents, and terrorist attacks [2]. The temporal and spatial concentration of people combined with a lack of sanitary facilities at some MGs can lead to the emergence of infectious diseases which have the potential to spread across the world when the MGs have an international

component [3]. The Hajj Muslim pilgrimage to Mecca, Saudi Arabia, is the MG at which communicable disease transmission has most closely been evaluated. Meningitis outbreaks, respiratory tract infections, and the transmission of infectious diarrhea have been extensively described [4]. Although outbreaks have not been reported frequently in or after mass gatherings outside the Hajj and Umrah pilgrimages, they have sometimes occurred at Muslim, Christian, and Hindu religious events, at sports events, and at large-scale open air festivals [5]. In this paper, we focus on a large religious MG that takes place in sub-Saharan Africa every year: the *Grand Magal* of Touba.

The Wolof language word used by the Mourides for pilgrimages is “*magal*”. The annual *Grand Magal* is the largest MG event of the Mouride Muslim community from Senegal and the largest Muslim religious MG in West Africa. It celebrates the exile of Cheikh Ahmadou Bamba Mbacké, the founder of Mouridism, a Sufi order,

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who was deported to Gabon by French colonial authorities in 1895. An estimated 4–5 million pilgrims gather each year in the holy city of Touba, for a five-day period of celebration. Touba is located about 200 km in the north-east of Dakar. According to the 2013 census, the population of Touba was 753,315. Pilgrims come from across Senegal and the surrounding countries, as well as from countries outside Africa to which Mouride Senegalese have emigrated. There is, however, no numerical figure about the proportional representation of participants according to their country of origin. The climate in the Touba area is semi-arid according to the Köppen climate classification, with a mean daily temperature of 26.8 °C and average yearly precipitation of 490 mm. The rainy season takes place from June to October. The pilgrimage begins on the 18th day of the Safara month of the Islamic lunar calendar. The lunar calendar is 10 days or 11 days shorter than the Gregorian version. Thus, the *Grand Magal* moves forward by 10 days or 11 days each year in the Gregorian calendar. A visit to the central mosque in Touba and to the mausoleum of the founder of the brotherhood is the main aim of every Mouride pilgrim. For any Mouride, simply setting foot in these holy places is enough to share in the sanctity of Cheikh Ahmadou Bamba, to receive his blessings, to acquire a spiritual force which is beneficial for the present life as well as that which is to come. Many pilgrims complete their devotions by visiting the mausolea of other important marabouts and other places in Touba associated with the holy life of the Cheikh, such as the Well of Mercy, a spring which God is said to have caused to flow in Ahmadou Bamba's honor. Its sacred water is reputed to be able to heal all sorts of illnesses and misfortune. The Mouride library, which houses the writings of the Cheikh and other Mouride theologians, and the university which the brotherhood has now opened on the edge of the town are among the other places visited by pilgrims. The pilgrimage to Touba is also an opportunity for members of the Mouride brotherhood to consult their own personal spiritual guides to whom they have sworn allegiance. Recitation of the Koran and spiritual introspection complete these religious activities [6].

During the *Grand Magal* period, in addition to the religious celebrations, intense cultural activity takes place with the free provision of food to pilgrims in the streets, conferences, seminary, debates between representatives of various Muslims communities from Senegal and beyond, the recitation of poems (qasida) by Ahmadou Bamba, and collective hymn-singing sessions at night. The *Grand Magal* represents an opportunity for family members living in different parts of Senegal or who have emigrated to Europe or to the US to come together during this period and strengthen family relationships. The commercial component of the *Grand Magal* should be stressed since most pilgrims take this opportunity to acquire a wide range of commercial goods that can be easily purchased from the large temporary market that is organized during the *Grand Magal* period [7]. During this period, pilgrims are accommodated in private housing structures (marabout houses) with a capacity that can be up to hundreds of individuals.

Compared to the Hajj pilgrimage, the *Grand Magal* has specific aspects. Although detailed demographic data are not available, the population participating to the *Grand Magal* is characterized by a larger diversity in terms of age groups since most pilgrims travel to Touba with their family, including young children, whereas the Hajj is characterized by a large proportion of elderly attendees. The *Grand Magal*, contrary to the Hajj, does not involve much physical activity and has not been associated so far with stampedes. Given its location in Senegal, the *Grand Magal* may expose participants to tropical diseases, including notably malaria. There are no specific recommendations provided by health authorities in Senegal regarding the preparation of participants and no entry restrictions.

The objective of the present survey is to describe the public

health services available during the 2015 *Grand Magal* and the profile of morbidity and mortality among patients who attended a public healthcare structure during the event.

2. Materials and methods

A survey aiming at describing the public health services implemented during the 2015 *Grand Magal* was conducted by reviewing internal reports from the “Ministère de la Santé et de l'Action Sociale”.

A cross-sectional study was conducted in the medical region of Diourbel (where the *Grand Magal* takes place), on all patients who attended a public healthcare structure during the *Grand Magal* in November 2015. Morbidity and mortality data were collected on a daily basis using a standardized instrument that provides a provisional diagnosis or primary cause of death. Because standardized case definitions or international disease classification standards are not routinely used in Senegal, provisional diagnoses were grouped into broad syndromic or body-system categories. Since data were collected anonymously, no ethic approval was required for this study.

3. Results

3.1. Public health services at the 2015 *Grand Magal*

Touba is part of the sanitary district of Diourbel (Fig. 1) that is responsible for medical preparation, surveillance and response during the event. Most of the available local public medical infrastructures are involved in this organization, including all seven hospitals and 80% of primary healthcare centers in Touba and Mbaké, as well as some private structures in Touba (Table 1). Overall, 78 medical doctors are mobilized during the *Grand Magal*, including specialists in emergency and critical care medicine, anesthesiology, general surgery, orthopedic and trauma surgery, otolaryngology, neurological surgery, obstetrics and gynecology, neurology, pediatrics, ophthalmology, dentistry and diagnostic radiology. Many of them come from Dakar to temporarily reinforce the local staff.

Medical care is provided free of charge during the *Grand Magal*. It should be stressed that there is no emergency unit in the sanitary region of Diourbel, however, during the *Grand Magal* patients can be admitted to hospital at any time. During the *Grand Magal*, medical ambulances from Dakar are pre-positioned in the area and

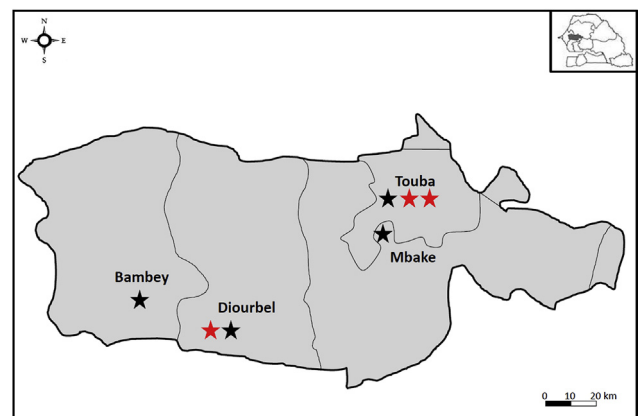


Fig. 1. Map of the Diourbel medical region showing Bambey, Diourbel, Mbake and Touba districts. Red stars: tertiary care hospitals, black stars: secondary care hospitals. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 1

Medical infrastructures involved in the *Grand Magal* by districts in the medical region of Diourbel, 2015.

	District				Total
	Bambey	Diourbel	Mbacke	Touba	
Tertiary care hospitals ^a	—	1	—	2	3
Secondary care hospitals ^b	1	1	1	1	4
Primary healthcare centers ^c	23	23	21	27	94
Dispensaries ("cases de santé") ^d	47	22	29	6	104
Advanced medical posts ^e	3	3	9	94	109
Private medical structures	3	13	2	33	51
Health squads ^f	1	2	1	1	5
Social rehabilitation centers	1	1	1	1	4

^a Bed capacity of 130 in Diourbel, 171 and 90 in Touba.

^b Bed capacity of 23 in Diourbel, 30 in Mbacke, 27 in Touba and 10 in Bambey.

^c Managed by nurses and midwives.

^d Managed by volunteer community health agents reinforced by nurses and midwives during the *Grand Magal*.

^e In charge of first aid treatment and referral to other medical structures.

^f In charge of environmental hygiene including insecticide spraying.

the Senegalese army ensures air ambulance transfer to Dakar by helicopter, when needed. Radiology facilities are available from the three tertiary care hospitals and a scanner is available at the main hospital in Diourbel. In addition to the medical care provided to pilgrims, a number of sanitation measures are conducted, including insecticide spraying of the area by air and targeted spraying of religious and housing infrastructures and waste disposal, sanitary control of food supplies and drinking water. Health education campaigns are conducted with pilgrims throughout the *Grand Magal* by specialized teams working through group conferences or individual face-to-face interviews and using local media, notably radio stations. Posters and flyers are also used for educational purposes.

3.2. Surveillance data at the December 2015 *Grand Magal*

Data were collected on a total of 32,229 healthcare contacts (Table 2). No information regarding the age and gender of the participants was available. The proportion of all ill participants who actually consulted one of the healthcare structures investigated in the present survey is unknown. The most frequent reasons for consultation were trauma, followed by fatigue and heatstroke.

Table 2

Syndromic summary surveillance data during the 2015 *Grand Magal*.

Reason for consulting	N (%)
Trauma ^a	3484 (10.81)
Fatigue	3897 (12.09)
Heatstroke	3392 (10.52)
Gastroenteritis and diarrhea	1467 (4.55)
Other gastrointestinal	3166 (9.82)
Cardiovascular	2019 (6.26)
Respiratory	1692 (5.25)
Probable malaria	1567 (4.86)
Confirmed malaria (rapid test)	941 (2.92)
Ear, nose and throat	1563 (4.85)
Dental	1538 (4.77)
Dermatologic	1434 (4.45)
Musculoskeletal	1222 (3.79)
Ophthalmic	1051 (3.26)
Gynecologic and obstetric	971 (3.01)
Urologic	397 (1.23)
Chronic diseases	360 (1.12)
Psychiatric	100 (0.31)
Others	1968 (6.11)

^a Road traffic and train accidents, violence, domestic accidents, work accidents, other accident.

Infectious diseases were also prevalent with, notably, a high rate of febrile systemic illnesses and malaria, diarrheal diseases, and respiratory tract infections. The overall hospitalization rate was 3.43% (1106 cases) with the highest rates for gynecological cases (16.17%) and confirmed malaria (14.45%). A total of 1970 patients had laboratory examinations (6.11%) and 820 patients underwent imaging (2.54%), including 63 who had an ultrasound and 15 who had a tomodensitometry scan. 58 patients underwent hemodialysis for end-stage renal disease (individuals receiving hemodialysis on a regular basis) and 74 underwent surgery (mostly for trauma, road accidents and wounds or urological, obstetrical, ophthalmological and ear-nose-throat diseases). A total of 209 patients were transferred to Dakar (0.65%), with most common reasons being trauma and accidents requiring surgery and, gynecological and gastrointestinal diseases and 10 died (0.03%), including 7 with trauma (road accidents) and the information was missing for the remaining 3 cases.

4. Discussion

Touba is marked by its socio-religious environment where the vast majority of the population shares the same religious faith and devotion to their religious *mbacké-mbacké* marabout leaders (descendants of Cheikh Ahmadou Bamba). The *dahira* is a social organization at the village or urban sector level under the responsibility of a marabout with the aim of organizing religious practices and Koranic education. The *dahira* also has a strong element of solidarity including community participation in numerous sectors such as environmental sanitation and health promotion [8]. The strong involvement of the whole community, including the members of the diaspora, in the *dahira* has facilitated the development of large infrastructure projects such as the creation of a medical hospital in the holy city of Touba [9]. This favorable context, combined with the public health authorities' efforts during the *Grand Magal*, is likely to explain the successful management of associated diseases during the event.

Because the streets are overcrowded with people and vehicles, road traffic accidents and traumas were prevalent during the 2015 *Grand Magal*. Because of the climatic conditions, heatstroke accounted for a significant proportion of diseases. Although it has not thus far happened, thankfully, the risk of a terrorist attack at the *Grand Magal* is considered a serious possibility by Senegalese authorities.

Despite intensive research, we were unable to find published evidence for outbreaks associated with the *Grand Magal*, with the exception of a cholera outbreak that occurred in Senegal in 2004–2006, with a total of 29,556 cases reported over an 18-month period. The epidemic began in Dakar, with an index case originating from Guinea which then spread to Diourbel during the *Grand Magal* in March 2005. Ultimately, 12,135 cases were notified in the Diourbel district, with most cases occurring in Touba. Cases were also reported from other regions in Senegal following the Diourbel outbreak. The attack rate in Diourbel area was 100/10⁴ individuals, three times higher than in other regions affected by the outbreak [10]. It should be noted that a previous cholera outbreak was reported during the 1973 *Grand Magal*, as quoted by Manga et al. [10]. A recent retrospective survey based on mobile phone data and inference from human mobility patterns during the 2005 cholera outbreak showed that people traveled to Touba from all over the country, and the estimated number of people present during the *Grand Magal* in Touba was nearly six times its usual population. The model accurately reproduces the fact that the important peak in cholera cases in Diourbel coincided with the *Grand Magal*, and that the disease spread throughout Senegal as pilgrims returned to their homes [11].

The crowded conditions during the *Grand Magal* (Fig. 2) and the relative lack of sanitary facilities in the city, despite the best efforts of the community [12] is likely to increase the risk of diarrheal diseases and respiratory tract infections, as suggested by the surveillance data presented in this paper and by analogy with observations from the Hajj pilgrimage [13,14], although the setting is different. Also, because the *Grand Magal* will take place during the rainy season in the coming years, the risk of malaria is also heightened, as corroborated by the results of the 2015 survey. The surveillance data presented here suffers from several limitations, including notably a lack of demographical information about the patients seen during the *Grand Magal*, and due to both the syndromic nature of the medical information recovered and a limited access to microbiological investigations. There was also a lack of information on the pathogens responsible for infectious diseases observed during the pilgrimage. Nevertheless, this survey was conducted with a large number of patients consulting at the major medical structures receiving pilgrims during the event which allowed identifying trauma, fatigue, heatstroke, and febrile systemic illnesses such as malaria, diarrheal diseases and respiratory tract infections as the most frequent reasons for consultation. From a travel-health perspective, pilgrims consulting prior to participating to the *Grand Magal* should be warned about the high frequency of motor vehicle accidents during the pilgrimage. They should be advised about the risk of heat exhaustion, counseled to avoid sun exposure at the hottest hours of the day and informed about the necessity of sufficient water intake. International pilgrims should be advised to take malaria chemo-prophylaxis, and use individual prevention against insect bites since the pilgrimage in the next years will take place during the rainy season. Vaccination against yellow fever should be recommended, and because of the frequency of diarrheal diseases, vaccination against hepatitis A and typhoid fever should be considered in non-immunized travelers. Since the influenza activity in Senegal peaks during the rainy season (July–September), vaccination against influenza should be considered in the future when the pilgrimage dates will coincide with this period. The area at highest risk for meningococcal disease in Senegal is the border with Mauritania and Mali at about 300 km from Touba, and the highest incidence is usually observed during the dry season, while the *Grand Magal* will take place during the rainy season in next years. There is no evidence from the available surveillance data on which to base a recommendation for meningococcal vaccine, and future surveillance program should address this issue specifically. Routine vaccine, including tetanus, diphtheria and poliomyelitis, should be updated when necessary. Measles, mumps and rubella vaccination should be also recommended since outbreaks have been described at other mass gatherings involving young participants [5].



Fig. 2. *Grand Magal* in Touba in 2015, Senegal.

In this context, reinforced syndromic surveillance should be implemented to better understand the role of infectious diseases at the *Grand Magal*, including notably those that are preventable by vaccination or chemoprophylaxis. Such monitoring should be conducted of both in- and out-patients consulting at the local medical infrastructures before and after the event to allow the type of infections that may affect *Grand Magal* pilgrims to be characterized and to better evaluate the surge in demand compared to baseline activity. Studies conducted in cohorts of pilgrims will provide a denominator to assess the true prevalence of the diseases [15–19]. Concurrently, microbiological surveys should be conducted to better identify the pathogens involved in *Grand Magal*-associated infectious diseases. Because the local availability of laboratory analysis is limited (only 6% of patients underwent laboratory analysis during the 2015 *Grand Magal*), sampling could be performed in selected cohorts of patients according to syndromic classification and analysis could be conducted either using a point-of-care laboratory device in Senegal [20] and/or specialized microbiological facilities outside Senegal, which have previously been successfully experimented with, in the context of the Hajj pilgrimage in Saudi Arabia [15–19]. Risk perception studies and evaluation of practices may complete the information [21–23]. The results of these surveys will serve as the basis from which to design interventional studies aiming at reducing such risks through the development of adapted collective and individual prevention measures, including use of vaccines or non-medical individual preventive measures. Furthermore, such studies may also help to rationalize investments in terms of the diagnostic and therapeutic tools used during the *Grand Magal* period.

The context of the *Grand Magal* MG is unique, given its location in a tropical developing country and its international component which may favor the globalization of locally endemic diseases. This situation is particularly challenging with regards to the relatively limited medical resources available during the event, so far. On other hand, the strong social cohesion of the Mouride community and its positive attitude toward community involvement in social and health project represent a unique opportunity to invest in modern methods for public health surveillance and event planning. International collaboration may enable the lack of microbiological facilities in the region where the *Grand Magal* takes place to be overcome.

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