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Malaria in Mauritania: Epidemiological profile between 2009 and 2015

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Abstract

The present retrospective study was conducted to evaluate the epidemiological profile of malaria in Mauritania between 2009 and 2015. A total of 1,449,207 cases of malaria were recorded. The incidence rates of uncomplicated malaria and severe malaria were 55.2 per 1000 person-years and 3.3 per 1000 person-years, respectively. Malaria affected all age groups, but the most affected age group was 15 years and over. Malaria was reported from all regions. Hodh El Charghi and Hodh El Gharbi regions were the most affected regions. These results confirm that malaria remains a major public health problem in Mauritania.

Keywords: Malaria, epidemiology, Mauritania

1. Introduction

Malaria is a potentially fatal parasitic disease caused by parasites of the genus *Plasmodium* that are transmitted to humans by female *Anopheles* mosquito bites [1]. There are four species of parasites responsible for human malaria, including *Plasmodium falciparum* and *P. vivax*, which are the most dangerous and the most common [1].

According to the latest World Malaria Report of the World Health Organization, the numbers of cases of malaria and malaria-related deaths were estimated to be 212 million and 429,000 in 2015, respectively [2]. Nearly half of the world's population is exposed to the risk of malaria. Most malaria cases and deaths occur in sub-Saharan Africa. However, Southeast Asia, Latin America and the Middle East are also affected to a lesser extent [3].

The Islamic Republic of Mauritania is a country in Northwest Africa, located between 15 and 27° north latitude and 5 and 17° west longitude. It occupies a total area of 1,030,000 km². The country is divided into 13 administrative regions called “wilayas,” 53 provinces or departments (locally known as “moughataa”), and 218 municipalities. According to the latest census, there were 3,537,368 inhabitants in 2013, with a population density of 3.43 inhabitants per km² [4]. The climate is generally desertic, very hot and very dry. The southern part of the country, especially along the Senegal River and along the border with Mali, is characterized by a sahelian or saharo-sahelian climate. Mauritania shares borders with the following countries: Morocco (in the northwest), Algeria (in the northeast), Mali and Senegal (both in the southwest) (Figure 1). To the west, the country is limited by the Atlantic Ocean, and its coastal region extends for nearly 600 km. In the center and northern part of the country, the topography is characterized by the mountainous massifs of Assaba, Tagant and Adrar that culminate at an altitude of 400 to 500 m above sea level.

In Mauritania, malaria is a major public health problem. An average of between 250,000 and 300,000 cases are recorded each year at public health facilities of the country [5]. About 10% of the population are affected each year, which places malaria third behind acute respiratory infections and diarrheal diseases at the national level in terms of reasons for medical consultation [5]. Malaria transmission is seasonal in Mauritania [6].

Among the four species responsible for human malaria, all four have been encountered in Mauritania with a predominance of *P. falciparum*, followed by *P. vivax*, *P. malariae* and *P. ovale* [7-9]. *P. knowlesi* is considered to be the fifth human malaria species by some authors [10, 11]. It occurs mainly in Southeast Asia and is a zoonosis. The aim of this retrospective study was to study the spatial and temporal distribution of malaria cases to assess epidemiological profiles of this parasitic disease in Mauritania.

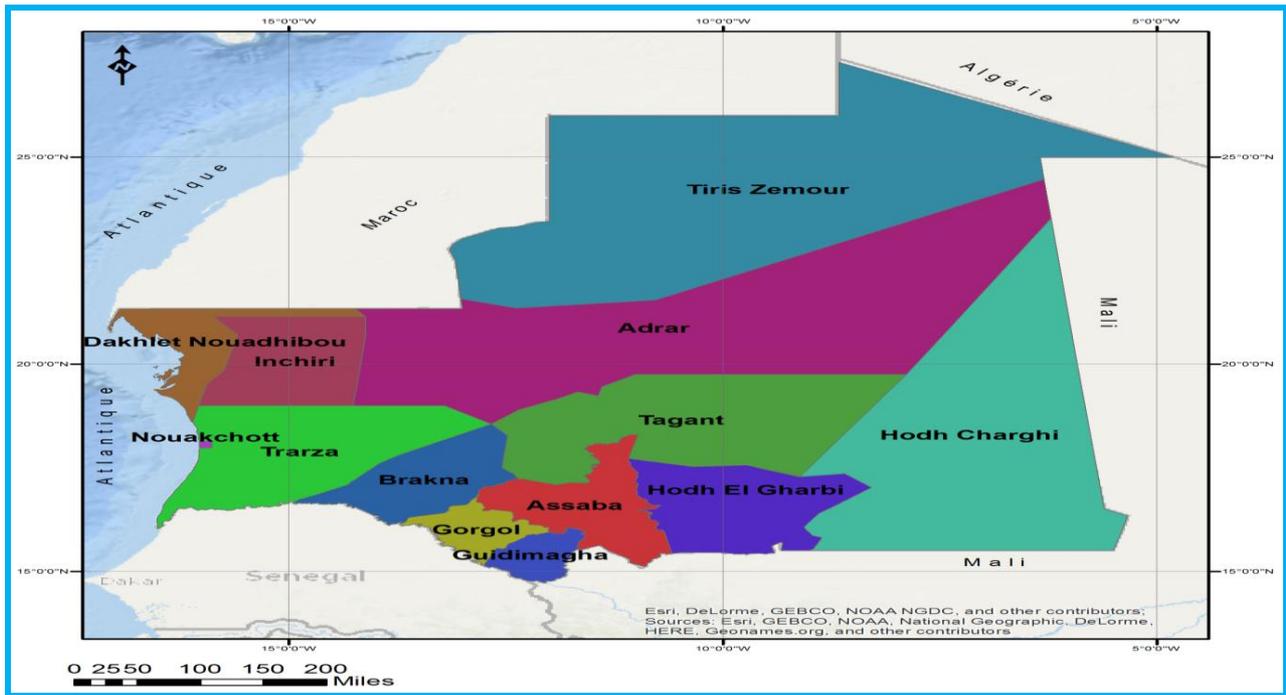


Fig 1: Map of Mauritania

2. Materials and Methods

2.1 Study area

We conducted a retrospective and descriptive study based on the analysis of the annual reports of national system of health information (NSHI) of the Mauritanian Ministry of Health on malaria cases between 2009 and 2015 at the national level and in different wilayas. Data were collected from a total of 773 public health centres, including primary health care structures and tertiary hospitals. Each region ("wilaya") has between 6 and 144 public health care centres that provided malaria reports, as follows: Adrar, 32; Assaba, 94; Brakna, 93; Dakhlet Nouadhibou, 24; Gorgol, 64; Guidimakha, 53; Hodh Charghi, 144; Hodh El Gharbi, 69; Inchiri, 6; Nouakchott, 59; Tagant, 28; Tiris Zemour, 11; and Trarza, 96. Each public health care centre provided a monthly report on the number of malaria cases.

In the majority of cases, the diagnosis of malaria was established on a presumptive clinical basis, i.e. the presence of fever, with or without suggestive symptoms such as headache, joint or muscle pain, chills, and sweats. From 2010, a few cases were diagnosed using a rapid diagnostic test (RDT) [5]. Because of the lack of qualified microscopists in the field, the diagnosis was not confirmed by microscopy.

"Uncomplicated malaria" was defined as febrile attack, preceded by prodromes evoking a flu-like episode, while "severe malaria" was defined as the presence of clinical or laboratory malfunction of a vital organ [12]. The more precise

and comprehensive criteria of severe malaria were not applied in health centres [13].

2.2 Statistical analysis

The data obtained from these reports were analysed using Microsoft Excel.

3. Results

During the period from 2009 to 2015, a total of 1,449,207 cases of malaria were registered in Mauritania. The uncomplicated form was more frequent, representing 94.3% of cases, compared to only 5.7% of cases classified as severe malaria. For uncomplicated malaria, the highest incidence was registered in the wilaya of Hodh Charghi with a proportion of 787 for 1,000 persons and an incidence rate of 112.4 for 1000 person-year (Table 1). The incidence in the wilaya of Hodh Charghi was followed by that of two wilayas, Guidimagha and Assaba, with 98 and 97.5 for 1000 person-years, respectively. The lowest number of malaria cases was recorded in the wilaya of Adrar, with an incidence rate that did not exceed 2.4 for 1000 person-years.

Concerning the severe form, the maximum incidence was registered in the wilaya of Hodh El Gharbi with 62 per 1000 person-year, which corresponded to an incidence rate of 9 per 1000 person, followed by Hodh Charghi (7 for 1000 person-years) and Guidimagha (6.2 per 1000 person-years) (Table 1).

Table 1: Incidence of uncomplicated and severe forms of malaria in Mauritania

Wilayas	Uncomplicated malaria		Severe malaria		Total	
	I (‰)	IR (‰/py)	I (‰)	IR (‰/py)	I (‰)	IR (‰/py)
Hodh Charghi	787	112.4	47	7	834	119.1
Hodh El Gharbi	523	75	62	9	585	83.6
Assaba	683	97.5	31.5	4.5	714.5	102
Gorgol	379	54.1	12	2	391	56
Brakna	447.2	64	35.7	5.1	482.9	69
Trarza	192	27.4	17	2.4	209	29.8
Adrar	81	11.6	2.1	0.3	83.1	11.9

Dakhlet Nouadhibou	17	2.4	0.7	0.1	17.7	2.5
Tagant	313.2	45	10.5	1.5	323.7	46.2
Guidimagha	685	98	43.4	6.2	728.4	104.0
Tiris Zemmour	64	9.1	5	0.7	69	9.8
Inchiri	176.4	25.2	3	0.4	179.4	25.6
Nouakchott	114.3	16.3	1.4	0.2	115.7	16.5
Total	386.2	55.17	23.1	3.3	409.3	58.5

I, incidence; IR, incidence rate; ‰py= per 1000 person-years

3.1 Distribution by age group

The results of the distribution according to age groups of malaria cases showed that the two clinical forms of malaria in Mauritania between 2009 and 2015 affected all age groups. The age group of 15 years and older constituted the group most affected by both clinical forms, with 55.7% for the uncomplicated form and 62.6% for the severe form, respectively.

The age group 5 to 14 years occupied the second place (22.1% for the uncomplicated form and 22.8% for the severe form). In the third place, we found the age group between 1 and 4 years (15.8% for the uncomplicated form and 11.4% for severe form). Finally, infants aged up to 1 year were the least affected age group (6.4% for the uncomplicated form and 3.2% for severe form) (Table 2).

Table 2: Distribution of malaria cases by clinical presentations and age groups

Wilayas	Age groups (years)								Total	
	0-1		1-4		5-14		15 and older		Uncompl	Severe
	Uncompl	Severe	Uncompl	Severe	Uncompl	Severe	Uncompl	Severe		
Hodh Charghi	1.5	1.4	3.7	3.8	6.1	6.4	13.4	12.8	24.7	24.4
Hodh El Gharbi	0.7	0.5	1.9	2.1	2.5	5.2	6.1	14.2	11.2	22.0
Assaba	1.2	0.5	2.6	1.44	3.34	2.4	9.2	8.2	16.34	12.54
Gorgol	0.6	0.05	1.6	0.4	2.05	1	5.07	3.4	9.32	4.85
Brakna	0.6	0.2	1.5	1.31	2.04	2.6	6	9.4	10.14	13.51
Trarza	0.3	0.1	0.5	0.5	0.8	1.03	2.21	4	3.81	5.63
Adrar	0.01	0.001	0.04	0.005	0.07	0.03	0.24	0.1	0.4	0.14
Dakhlet Nouadhibou	0.01	0.003	0.01	0.03	0.02	0.04	0.11	0.06	0.16	0.13
Tagant	0.1	0.02	0.2	0.12	0.4	0.2	1.2	0.7	1.9	1.04
Guidimagha	0.9	0.3	2.7	1.5	3.03	3.5	6.8	8.7	13.43	14
Tiris Zemmour	0.01	0	0.01	0.002	0.05	0.1	0.2	0.2	0.3	0.30
Inchiri	0.01	0	0.01	0	0.06	0.002	0.2	0.06	0.3	0.06
Nouakchott	0.4	0.1	1	0.18	1.6	0.3	5	0.8	8	1.4
Total	6.4	3.2	15.8	11.4	22.1	22.8	55.7	62.6	100	100

Data are expressed as%. Uncompl, uncomplicated malaria; Severe, severe malaria

3.2 Temporal distribution

Between 2009 and 2015, two clinical forms of malaria presented a fluctuating trend but with different numbers (Fig. 2). Uncomplicated malaria with an average of 195,168 cases per year showed a decreasing trend. The maximum number of uncomplicated cases was recorded in 2009 (33,991 cases), and the least in 2014 (22,401 cases).

For the severe form, the mean was 11,859 cases per year. Severe malaria also presented a fluctuating temporal evolution but with lower numbers compared to those of the uncomplicated form. The highest number of severe malaria was recorded in 2012 with 2,527 cases and the lowest number in 2015 (684 cases).

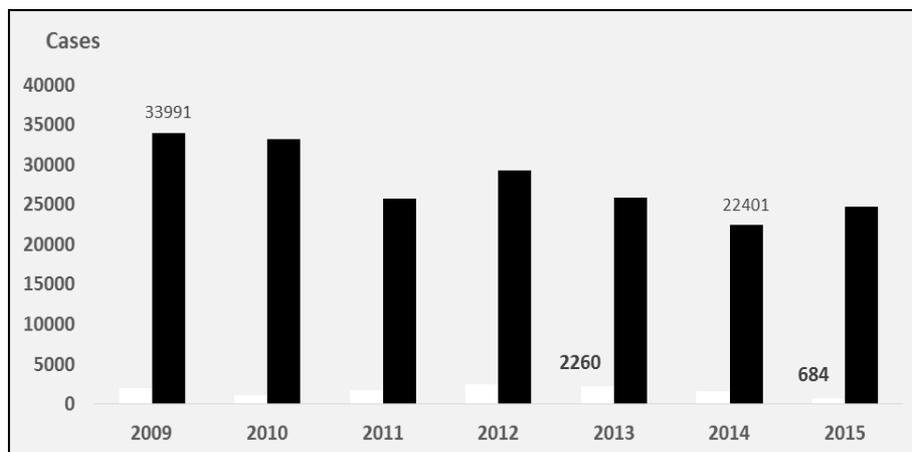


Fig 2: Annual distribution of malaria cases in Mauritania.

Fig 2 legend. The total number of reported malaria cases is presented by year. Black bars denote uncomplicated malaria. White bars denote severe malaria. The lowest and highest numbers of reported cases of uncomplicated and severe

malaria are shown in the figure.

3.3 Geographical distribution

The geographical distribution of malaria cases in Mauritania

between 2009 and 2015 was heterogeneous. The results showed that the most affected wilaya was Hodh El Charghi with an average of 50,581 cases per year, followed by wilaya of Assaba with an average of 32,864 cases per year, Guidimagha (27,422 cases per year) and Hodh El Gharbi (24,079 cases per year) (Figure 3). The average number of annual cases between 15,000 and 22,000 cases was recorded

in three wilayas, Nouakchott, Gorgol and Brakna, with 15,773, 18,644 and 21,251 cases per year, respectively. The wilayas with the mean annual number of cases between 3,000 and 8,000 were Trarza (7,975 cases per year) and Tagant (3,723 cases per year). The number of cases per year was low, i.e. less than 1,000, in four of 13 wilayas.

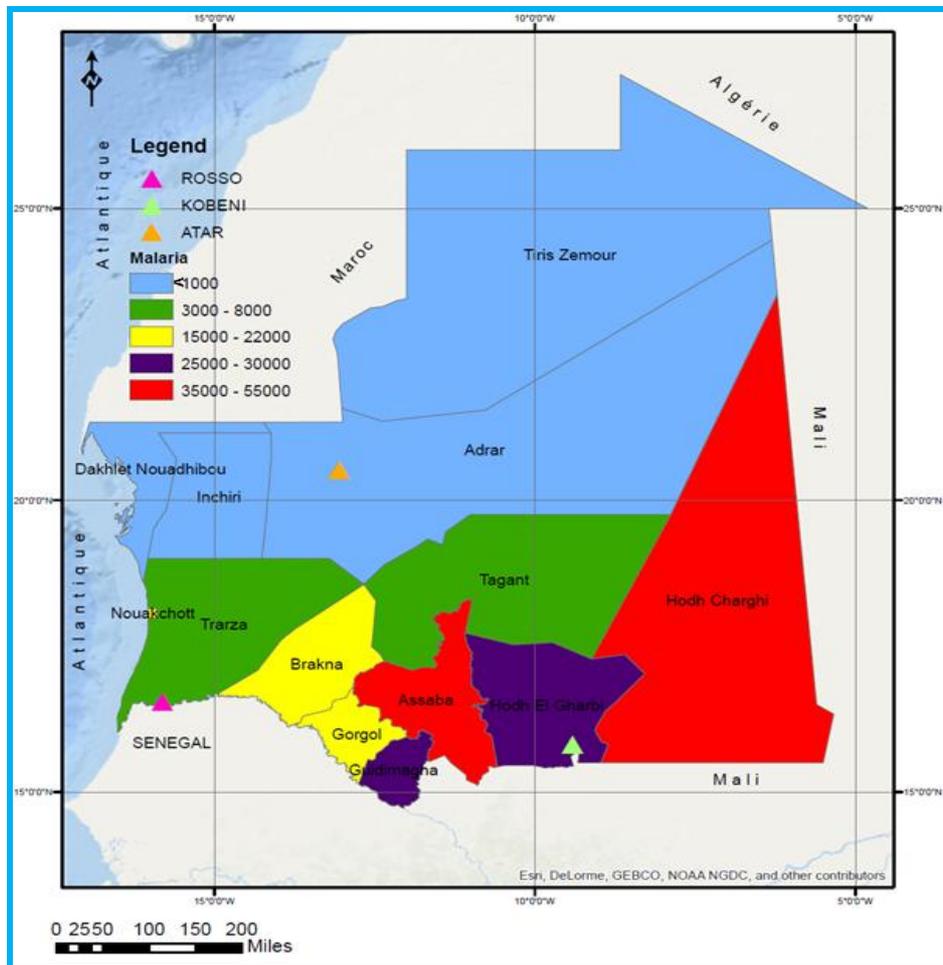


Fig 3: Distribution of malaria cases by regions (“wilayas”) in Mauritania, 2009-2015

4. Discussion

The results obtained from 2009 to 2015 showed that the geographical distribution of malaria cases in different wilayas in Mauritania is not homogeneous. There seemed to be a southeast-northwest gradient. Indeed, the farther wilaya is from that of Hodh El Gharbi in the saharo-sahelian zone, where the annual rainfall is between 150 and 350 mm, the less the wilaya was affected by malaria, as in the wilaya of Dakhlet Nouadhibou, which is located in the Saharan zone with less than 150 mm of rain per year [14]. This unequal distribution may be due to the influence of several climatic and geographic factors that influence the proliferation of *Anopheles* mosquitoes. The least affected wilayas (i.e., Tris Zemour, Adrar, Inchiri and Dakhlet Nouadhibou) are all located in the Saharan zone where malaria transmission is either very low, irregular, or absent [5].

As for the temporal distribution of malaria during the 7 years involved in our study, we found a fluctuating trend of two clinical forms of malaria but with different numbers of cases. The highest number of uncomplicated malaria cases was reported in 2009 (33,991 cases). On the other hand, the highest number of severe malaria cases was reported in 2012 with 2,527 cases. This increase in malaria cases can be

explained by changes in environmental factors and/or variations in malaria transmission patterns due to natural or anthropogenic changes [5]. For example, the malaria situation in the capital city of Nouakchott has become a major concern in the recent years due to increased rainfall and 2010 Aftout Essahili project which resulted in the arrival of a large amount of clean and potable water from the Senegal river in the water distribution network to meet the needs of urban populations for potable water.

In addition, the introduction of the RDT has significantly improved the quality of the diagnosis. Our recent studies on the systematic use of RDT to distinguish between *P. falciparum* and *P. vivax*, based on the specific *P. falciparum* antigen histidine-rich protein 2 and *P. vivax*-specific lactate dehydrogenase, confirmed by microscopy and PCR, indicated that about a quarter of febrile patients consulting spontaneously at the health centres in Nouakchott and Atar in the Saharan zone are infected with *P. vivax*, and slightly more than half of febrile patients presenting at the health centre of Kobeni in the sahelo-Saharan zone suffer from *P. falciparum* malaria (personal communication, Basco).

Given the results of our recent studies, data based on presumptive diagnosis transmitted to the NSHI overestimate

the 'true' prevalence of malaria in patients consulting a health centre or a hospital about 4 times in the Saharan zone and 2 times in the sahelo-Saharan zone. The gradual introduction of the RDT for malaria diagnosis in public health centres since 2010 might also explain the declining trend in the number of malaria cases reported between 2009 and 2015. In general, the spatio-temporal variations of malaria cases in our study were similar to the results of other studies conducted in Mauritania [6-8, 16, 17]. Similar situations have been reported by other studies in neighboring countries that showed a disparity between regions [18, 19].

Results of the distribution of malaria cases according to age groups showed that although both clinical forms of malaria occur in the country, the age group 15 years and above was most affected by both uncomplicated and severe forms of malaria. This observation could be explained by the greater mobility of this age group. Indeed, our result confirmed the findings reported by Cortes *et al.* in 2003 in southern Mauritania [7]. However, these results obtained in Mauritania differed from those obtained in sub-Saharan African countries, where children under 5 years old and pregnant women are the most vulnerable population groups to malaria due to inadequate or impaired immunity and their susceptibility to this disease [18, 20-23].

Unlike the epidemiological situation of malaria in most of the countries in sub-Saharan Africa, the period of malaria transmission is seasonal and very short in Mauritania, which prevents the development of acquired immunity. In addition, *P. vivax* malaria constitutes the majority of the malaria cases in the Saharan zone, which covers about 75% of the country's surface area. The low level of transmission, as well as interventions such as intermittent preventive treatment for pregnant women, free distribution of bed nets to pregnant women, and the use of bed nets by pregnant women and young children, may explain, at least in part, our observation that children over the age of 15 years and young adults were the most affected group of malaria in Mauritania.

5. Conclusion

The present retrospective study showed that malaria is a major public health problem in Mauritania. Malaria is characterized by a heterogeneous distribution according to geographic zones and, due to various climatic and man-made environmental changes, it may possibly become highly endemic or epidemic in some wilayas that have been slightly affected until now, as in the case of Nouakchott, the capital city of Mauritania. Regarding future perspective, other parasitological and entomological studies would be essential to improve strategies to combat malaria in Mauritania. It is also important to note that the data collected between 2009 and 2015 and reported in the present study are not exhaustive and do not reflect the exact malaria situation in Mauritania because the diagnosis of malaria was established mainly on a presumptive basis and the number of malaria cases diagnosed outside the public health system is unknown, which underestimates the 'true' malaria incidence in the country. Despite the limitation of our study based on the NSHI and essentially presumptive diagnosis that results in an overestimation of malaria incidence at the level of health centres, at least 25% to 50% of the malaria cases reported, according to the study areas, are estimated to correspond to confirmed cases. This is a first step to develop a more reliable mapping of the distribution of malaria and *Plasmodium* species in Mauritania for a better understanding of the epidemiology of malaria and for improving malaria control

interventions.

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