Microbes and Infectious Diseases 2021; 2(4): 823-830

Microbes and Infectious Diseases

Journal homepage: https://mid.journals.ekb.eg/

Original article

Six years surveillance of *Plasmodium falciparum* Malaria among febrile patients reporting in Centre de Santé d'Okala, North West Gabon

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ARTICLE INFO

Article history:
Received 16 June 2020
Received in revised form 3 August 2020
Accepted 5 August 2020

Keywords:
Malaria
Prevalence
Febrile patients
Health center
Okala

ABSTRACT

Background: Malaria remains a threat to the health of the population of Gabon based on the high hospitalisations and deaths caused by this disease. This study aimed at determining the prevalence and associated risk factors of malaria in febrile patients visiting the Centre de Santé d'Okala (CSO). **Methods:** A six years study was conducted on febrile patients seeking for health services at the CSO from the year 2014 to 2019. Blood samples of 2388 patients were tested for antigens specific to *Plasmodium falciparum* using the Beacon® rapid diagnostic kit. **Results:** The overall prevalence of *P. falciparum* malaria was 29.857%. The year 2014 (35.553%) recorded the highest prevalence rate. Individuals from Okala (44.137%) community recorded the highest number of cases. Females (56.886%) had higher infection prevalence than their male (43.114%) counterparts. Children ≤ 10 years old (57.412%) had the highest prevalence rates than other age cohorts. **Conclusions:** The number of malaria cases reported in the CSO are currently increasing and community sensitisation on preventive measures against this disease is required in order to flatten the curve of positive cases.

Introduction

Malaria remains the most life-threatening parasitic disease in sub-Saharan Africa [1-5]. According to the World Health Organization (WHO), malaria affected nearly 228 million people worldwide in 2019 compared to 219 million in 2017 with 405,000 human losses [6]. Among the deaths caused by malaria, 67% (272,000) are children <5 years old [6]. In addition, Africa remains the continent that is most affected by malaria with 93% (213 million) cases and 94% deaths [6].

DOI: 10.21608/MID.2020.34444.1030
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According to the National Health Information System (NHIS), malaria alone accounted for 153,666 cases of consultations and 160 deaths in health facilities in the year 2017 [7]. Also, malaria is one of the main obstacles to economic development in Gabon with relatively high death rates and associated school and professional absenteeism [8]. Tertiary health facilities in some communities in Africa reported high consultation rates with malaria and typhoid [9]. Several individuals in sub-urban communities visit such health care facilities only when they are confronted with persistent fever. This observation has been made in the Centre de Santé d'Okala that offers health services to the population of Akanda and its environs. A pilot entomological survey in Akanda and its environs indicated high frequency of *Anopheles* vectors of malaria in this zone [10]. However, no data exists on the prevalence of malaria in this peri-urban area of Libreville.

To manage malaria cases in Gabon, it is important to improve on the testing capacity of the health care facilities. The rapid diagnostic tests (RDTs) may improve malaria management in areas without microscopy. For successful diagnosis to be realized, the methods used must be highly sensitive and specific, reason why several studies have been conducted to validate the sensitivity of histidine-rich protein 2 (HRP2) and Plasmodium lactate dehydrogenase (pLDH)-based RDTs. The HRP2-based RDTs have been reported to be more sensitive than pLDH [11]. The most popular RDTs presently used, identify histidine-rich protein 2 (HRP2) and /or Plasmodium lactate dehydrogenase (pLDH) and this type has been recommended by the Gabonese Ministry of Health on the basis of its accuracy and ease of use in its medical centers. The use of RDTs faces the problem of low specificity when compared to gold standard techniques such as microscopy [12].

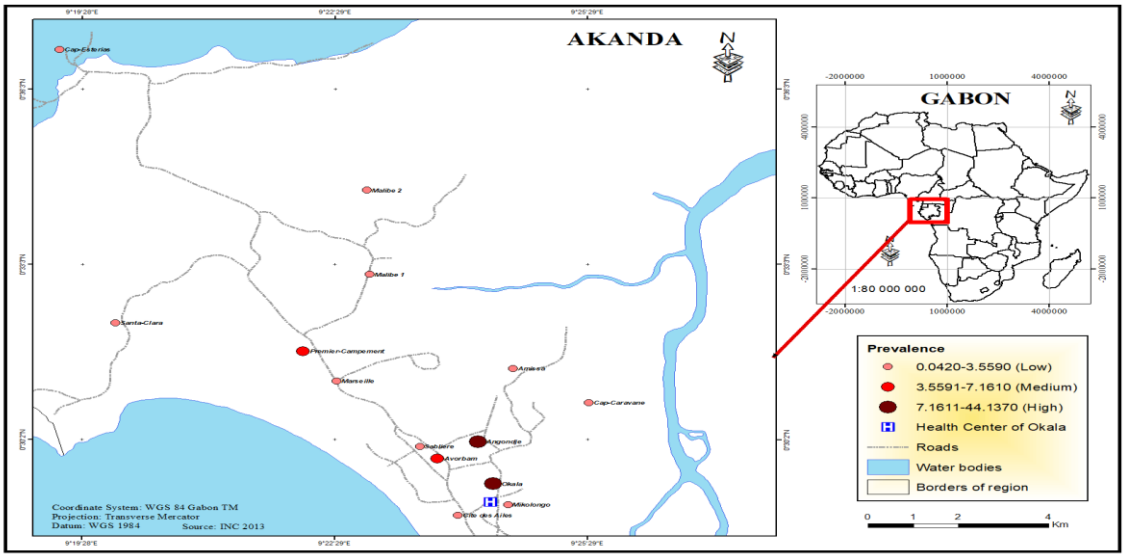
However, the use of microscopy at times is cumbersome, requires trained personnel, and logistics which is difficult in field conditions, so most health facilities in resource limited communities like that of Okala prefer RDTs. The use of RDTs have been used in scientific investigations at hospital and community levels in Gabon [13]. Most of the studies on malaria were conducted on children and pregnant women and were cross sectional [13-15]. The present 6 years survey seeks to determine the prevalence of malaria and its associated risk factors in febrile patients visiting the CSO.

Material and Methods

Study area

A hospital-based survey on malaria was conducted from 2014 to 2019 at the Centre de Santé d'Okala with following geographical coordinates: 0^0 28' 56.729''N and 9^0 24' 20.249''E **(Figure 1)**. This is a tertiary public health care facility located at the peri-urban zone of Libreville (capital of Gabon). It offers health services to the whole of Akanda and its environs. This area has been reported to harbor several breeding sites of *Anopheles* vectors of malaria [10].

Figure 1. Location of Centre de Santé d Okala and distribution of prevalence with community.



Study population

Our study population consisted of febrile individuals (presenting axillary temperature >37.5 ºC and or >24hrs fever) [13] of all ages from different communities of the peri-urban area of Libreville. An oral consent of the patients was demanded before their enrollment in the study. Two thousand three hundred and eighty-eight (2388) individuals were included in the study.

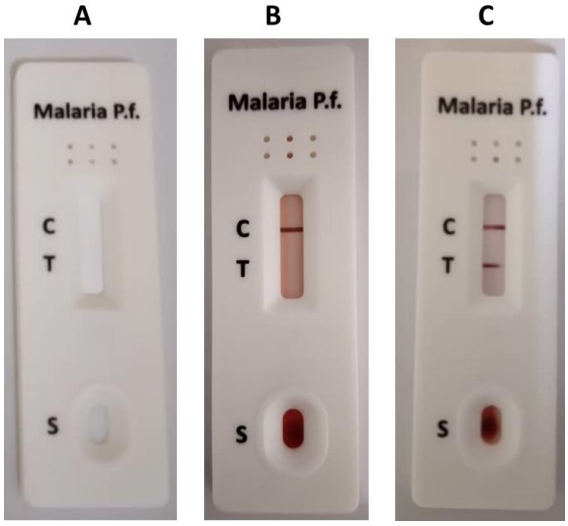
Ethical statement

The study protocol was performed according to the Helsinki declaration and approved by Chief Medical Officer of Okala. Informed oral consent was obtained from patients.

Sample collection and analysis

Finger pricking was the approach used to collect the drop of blood of patients for the test. The malaria PF/PAN antigen test (BEACON® diagnostics PVT. LTD, 424, INDIA) RDT kit was used **(Figure 2).** This test uses a pair of anti-pan plasmodium lactate dehydrogenase (pLDH) and anti-histidine rich protein-II (Pf HRP-II) specific to *Plasmodium falciparum*. This enables simultaneous and differential detection of all malaria species and *P. falciparum* infection in an individual. The test was conducted following manufacturer's instructions and positive and negative results were read as in **figure (2)**.

Figure 2. Beacon ® rapid diagnostic kit showing test results: A: kit before test; B: negative; C: positive; S: sample; T: test; C: control.



Data analysis

Statistical analysis was conducted using the JASP 0.13.0.0 statistical package. The test positive proportion of individuals with sex, age, year, and community was compared using the Chi² test. All tests were kept at $p<0.05$ significant level. The prevalence was determined using the following formula:

$$\text{Prevalence} = \frac{\text{Number of positive cases}}{\text{Number sampled}} \text{x}100$$

Results

The overall prevalence of malaria caused by *P. falciparum* in individuals visiting the Centre de Santé d'Okala is 29.857%.

The age cohort for children (≤10 years old) (57.412%) recorded the highest test positive proportion of *P. falciparum* malaria cases, followed by those from 21 to 30 years, but lowest prevalence rates were recorded in individuals with ages from 31 to 40 years. There was no statistically significant difference ($X^2 = 20.000$; df= 16; $p = 0.220$) in age and infection prevalence **(Table 1)**.

Table 1. *Plasmodium falciparum* malaria prevalence with age

Parameters	**Number positive (%)**	**Number negative (%)**	**Total number (%)**
Age cohort	$X^2 = 20.000$; df= 16; $p = 0.220$		
≤10	356 (14.907)	1015 (42.504)	1371 (57.412)
11 to 20	163 (6.825)	205 (8.584)	368 (15.410)
21 to 30	102 (4.271)	207 (8.668)	309 (12.939)
31 to 40	44 (1.842)	113 (4.731)	157 (6.574)
≥41	48 (2.010)	135 (5.653)	183 (7.663)
Total	**713 (29.857)**	**1675 (70.142)**	**2388 (100)**

Based on sex, females (56.886%) represented higher test positive proportion of cases than males (43.114%). However, there was no statistically significant difference ($X^2 = 0.172$; df=1; $p = 0.678$) in cases recorded with sex **(Table 2)**.

Highest test positive proportion of *P. falciparum* malaria cases were recorded in the year 2014 while lowest cases occurred in the year 2017. There was a statistically significant difference (X^2=39.292; df=5; $p<0.001$) in *P. falciparum* malaria cases with prospection years **(Table 3)**.

Table 2. *Plasmodium falciparum* malaria prevalence with sex

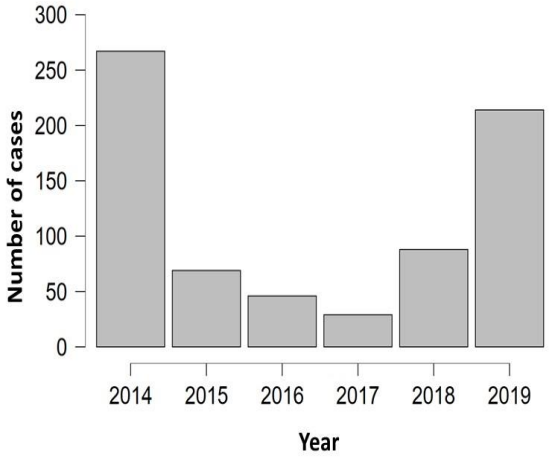
Parameters	Number negative (%)	Number positive (%)	Total number (%)
Sex	$X^2 = 0.172$; df=1; $p = 0.678$		
Female	957 (40.100)	400 (16.785)	1358 (56.886)
Male	718 (30.054)	312 (13.060)	1030 (43.114)
Total	**1675 (70.155)**	**713 (29.845)**	**2388 (100)**

Table 3. *Plasmodium falciparum* malaria prevalence with year

Parameters	Number negative (%)	Number positive (%)	Total number (%)
Year	X^2=39.292; df=5; $p<0.001$		
2014	582 (24.372)	267 (11.181)	849 (35.553)
2015	322 (13.484)	69 (2.889)	391(16.374)
2016	130 (5.444)	46 (1.926)	176 (7.370)
2017	69 (2.889)	29 (1.214)	98 (4.104)
2018	171 (7.161)	88 (3.685)	259 (10.846)
2019	401 (16.792)	214 (8.961)	615 (25.754)
Total	**1675 (70.142)**	**713 (29.858)**	**2388 (100)**

The peak positive *P. falciparum* malaria cases was recorded in the year 2014 (35.553%) and the curve flattened from 2015 to 2018 and started to rise in 2019 **(Figure 3)**.

Figure 3. Trend in the number of malaria cases in febrile patients and prospection year.



The highest test positive proportion of *P. falciparum* malaria individuals was recorded in Okala (44.137%), but lowest infection rate occurred

in Mikolongo (0.042%). However, there was a statistically significant difference (X^2 = 51.723; df=13; *p<0.001*) in malaria prevalence with community **(Table 4)**

Table 4. *Plasmodium falciparum* malaria prevalence with community

Parameters	Number negative (%)	Number positive (%)	Total number (%)
Community	X^2 = 51.723; df=13; *p<0.001*		
Première Campement	92 (3.853)	59 (2.471)	151 (6.323)
Amissa	43 (1.801)	19 (0.796)	62(2.596)
Angondjé centre	523 (21.901)	199 (8.333)	722 (30.235)
Avor-Mbam centre	124 (5.193)	47 (1.968)	171 (7.161)
Cap-Caravane	6 (0.251)	6 (0.251)	12 (0.503)
Cap Estérias	52 (2.178)	33 (1.382)	85 (3.559)
Cité des ailes	26 (1.089)	9 (0.377)	35 (1.466)
Malibé 1	8 (0.335)	14 (0.586)	22 (0.921)
Malibé 2	12 (0.503)	14 (0.586)	26 (1.089)
Marseille	4(0.168)	2 (0.084)	6 (0.251)
Mikolongo	1 (0.042)	0 (0.000)	1 (0.042)
Okala	766 (32.077)	288 (12.060)	1054 (44.137)
Sablière	9 (0.377)	8 (0.335)	17 (0.712)
Santa-Clara	9 (0.377)	15 (0.628)	24 (1.005)
Total	**1675.000 (70.142)**	**713.000 (29.858)**	**2388.000 (100.000)**

Discussion

Malaria in sub-Saharan Africa is frequently caused by *P. falciparum* [2,3,9,16,17]. We sampled 2388 patients visiting the CSO from 2014 to 2019 and 29.857% of them tested positive for *P. falciparum.* The present prevalence was higher than that reported by other authors [13,14,18], but inferior to 37% reported by **Manego et al.** [15] in Gabon. The differences in malaria infection prevalence in the different studies in Gabon could be due to the discrepancies in the study designs, duration, diagnostic methods and the endemicity of sampled regions.

In malaria endemic settings, protective immunity is always correlated with age [19,20]. This concept is in line with the observations of this study where highest prevalence was recorded in children ≤ 10 years old than with the other age intervals. This supports the fact that children are still at risk of malaria despite the decreasing malaria burden in the zone [18,21,22]. Studies conducted elsewhere reported associations between malaria infection and the use of insecticide treated bed nets. This indicated that elderly individuals were conscious of the use of mosquito bed nets, indoors insecticide spraying as well as practicing other protective measures to avoid mosquito bites than children in the study area. This observation has already been made by other authors

[3,19]. However, recruiting only suspected clinically symptomatic patients, possibly affected the results of this study. Furthermore, comprehensive surveys are required to identify the drivers of malaria infection in the study area that were not addressed in this study.

Based on sex, females recorded higher cases than males with no statistically significant difference. This finding is similar to that reported in other studies from Gabon and elsewhere [9,17,19,23,24]. The higher prevalence with females was partly because higher fraction of the sampled females was coming for antenatal clinics. The study of **Jäckle et al.** [25] in rural communities of Gabon established that pregnant women represented higher risk of malaria infection.

The peak of malaria cases was recorded in 2014 and the curve flattened from 2015 to 2018 but spiked again in 2019. This yearly malaria dynamics curve indicates that the measures put in place to curb the spread of malaria by the Ministry of health of Gabon such as provision of mosquito nets through its national malaria program helped to reduce malaria burden. Furthermore, the malaria program distributed free mosquito nets between 2006 and 2008 to pregnant women and those with children <5years old in Akanda. Also, in 2015 some communities were chosen based on the availability of mosquito nets and Akanda was among. It is worth mentioning that biolarvicides (Griselesf® and Bactivec®) were applied in mosquito breeding sites in Akanda from 2016 to 2018. However, it seems that such control measures were relaxed in 2019, reason why an upsurge in the number of malaria cases occurred during this year. This observation has been made in Sudan by **Eshag et al**. [19] and **Mawili-Mboumba et al.** [3] in Gabon.

The highest test positive proportion of malaria cases was recorded at Okala than with other communities could be explained by the higher economic status of this population and their easy accessibility of the CSO compared to others that are located very far from this tertiary health care facility. A community-based randomized study would have been a better sampling approach to include a representative population of each community in the study in order to avoid bias in the interpretation of the results. However, the occurrence of highest cases of malaria at Okala could be justified by the high abundance of *Anopheles* malaria vectors in the zone [10].

Conclusion

The overall *P. falciparum* malaria prevalence in febrile patients visiting the Centre de Santé d'Okala was 29.857 %. The year 2014 recorded the highest number of cases than other prospection years. The community of Okala recorded the highest number of cases. Age and sex did not influence malaria prevalence in the area.

Acknowledgements

Authors are grateful for the technical assistance of the laboratory technicians of the Centre de Santé d'Okala for their assistance during the study.

Competing interests

The authors declare that they have no competing interests in relation to this article. All the authors read and approved the final version.

Authorship

Each author listed in the manuscript had approved the submission of this version of the manuscript and takes full responsibility for it.

Ethical approval

All participants in this study gave their oral informed consent.

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