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## **MALARIA PREVALENCE AMONG CHILDREN UNDER FIVE IN THE COMMUNE OF NTOUM, NORTHWEST GABON**

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### **ABSTRACT**

**Background:** In Gabon, the malaria burden among five children residing in the western corner of the Estuary province is unknown. The aim of this study was to determine the prevalence of malaria infection among children aged five, characterize the sociodemographic profile of these children, and present the means of mosquito control used by their parent or guardian.

**Methods:** This prospective observational study was conducted over six (6) months, from June to December 2024, at NTOUM Regional (NR) Hospital. Blood samples were collected from 274 children attending the hospital, and analyzed using two different diagnostic methods (microscopy and rapid diagnostic test (RDT)). The socio-demographic data of the children's parents or guardians and the means of malaria prevention used in their household were recorded using a structured questionnaire. Data were then analyzed using R software version 4.1.2. Statistical significance was set at  $P < 0.05$ .

Results: 189 blood samples were microscopically and immunochromatographically positive, representing an overall malaria prevalence of 69%. Very good agreement was observed between light microscopy and RDT (97.5%). Among all the independent variables considered in this study, only unemployment was significantly associated with malaria (OR=2.28; 95% CI = 1.2 – 4.35; P =0.0118). Whereas, children vomiting was less likely to be infected with malaria (OR= 0.53; 95% CI = 0.29 – 0.99; P = 0.045) The parents or guardians of the children surveyed were mostly educated to secondary or university level (94.4%) and preferred insecticide - treated nets to aerosol insecticides (71% and 21.2% respectively).

Conclusion: Malaria is a major public health problem in Gabon. It affects particularly children under five years old living in the commune of Ntoum. To break the chain of malaria transmission in this part of the country, better access to malaria preventive measures is needed.

**Keywords:** Prevalence, Malaria, Children aged 0-5, Ntoum, Gabon.

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## **INTRODUCTION**

Malaria poses a serious public health problem in many countries around the world [1]. The African continent, which is heavily affected by this erythrocytopathy, accounts for 95% of cases, with 96% of deaths, 78% of which are children [2]. The equatorial African country of Gabon is not exempt from this disease. Indeed, the equatorial climate and lush vegetation of sub-Saharan countries are conducive to the hatching and maturation of *Anopheles* mosquito larvae [3, 4]. With year-round transmission, Gabon is classified as a hyper-endemic malaria country [5]. The disease has a greater impact on children under the age of 5, due to the immaturity of their immune systems, and results in a high rate of school failure among the latter [6, 7]. Although several national malaria control strategies are in place, including free distribution of impregnated mosquito nets and indoor residual spraying, malaria remains the most prevalent parasitic disease in the country [8]. In rural areas, community studies on malaria are inadequate and non-existent for children aged between zero and five living in the commune of Ntoum. In order to address this problem, this study was carried out with a view to assessing the prevalence of malaria and the clinical profile of these children, as well as the means of controlling mosquito bites used by their guardians or parents.

## **MATERIAL AND METHODS**

### **Study setting and location.**

This study was carried out at the Ntoum hospital in the Estuary province, in the north-west corner of Gabon. With a population of 6.3%, The Estuary is Gabon's largest province. The province covers an area of 20,740 km<sup>2</sup>, or 7.7% of the country's total surface area, and enjoys an equatorial climate with two dry and two rainy seasons. The natural vegetation of this part of Gabon initially consists of equatorial, ombrophilous evergreen forest [9]. Temperatures range from 21 to 28°C year-round, while average annual rainfall reaches 1,800 mm [8]. Logging and agricultural practices favor the development of secondary forest.

### **Type, period and study population**

This was a prospective observational study conducted over six (6) months, from June 08 to December 08, 2024. The study population consisted of children aged 0 to 5 years receiving outpatient care at Ntoum Hospital.

### **Inclusion and non-inclusion criteria**

All children aged 0-5 who came to the laboratory for malaria screening and accompanied by a parent or guardian who had given informed consent to participate in the study were included. Excluded from the study were all children accompanied by their parent or guardian, whose clinical examination did not include malaria.

### **Study approval and ethical considerations**

The study was approved by the General Management of the NTOUM Regional Hospital, subject to compliance with the law on the protection of personal privacy, in accordance with the code of ethics in the Gabonese Republic. The information required for this study was collected on anonymous survey forms. Therefore, no information related to a patient will be divulged, as well as the confidentiality of their information after approval.

### **Sample size and statistical analysis**

The sample size was calculated using a single population proportion formula based on a prevalence rate of 15.8%, as reported in the Third Gabon Demographic and Health Survey (EDSG-III) published in 2022 by the Direction Générale de la Statistique (DGS). A sample size of 274 children was selected for an alpha error risk of 5% and a precision of 5%. Data were entered using Microsoft Excel 2016 and analyzed using R version 4.1.2, including measurement of rates and correlations.

### **Data and biological material collection**

When a child aged between zero and five years, accompanied by a guardian or parent, came to the laboratory department, he or she was taken by a nurse to an adjoining room for a questionnaire. The first part of the interview concerned the child (socio-demographic profile and clinical symptoms) and the second part concerned the parent or guardian (level of education, occupation, mosquito control methods used). At the end of the interview, a venipuncture on an EDTA tube was performed on the child by another nurse in the sampling room.

### **Biological protocol**

For each blood sample, an RDT (Bioline® Malaria Antigen Pf/Pan® SD) was performed by a biotechnician according to the manufacturer's recommendations. The same blood sample was then sent to another biotechnician for microscopic examination. The latter took a thick smear on a clean, degreased slide, heat-fixed the smear with a hair dryer, then stained it with a 10% solution of Giemsa. Fifteen minutes later, the slide was rinsed with tap water and dried using an hair dryer. After applying a drop of immersion oil, the slide was placed on the stage of a Zeiss binocular optical microscope and read at the x100 objective.

## RESULTS

### Sociodemographic and clinical profile of the study population

A total of 274 children aged between 0 and 60 months were enrolled in the study. Boys (139 cases, 50.73%) outnumbered girls (135 cases, 49.27%). The age range from 0 to 12 months was the most representative (110 cases, 40.15%), with an average age of 20.88 months. The study population came exclusively from the first arrondissement of Ntoum commune (92.3%). A small proportion resided in the second and third arrondissements, at 3.7% and 1% respectively. Most of the children's guardians or parents had secondary (157 cases, 57.3%) or university (99 cases, 36.1%) education, and very few had left school at primary level (6.6%). Many of the target children's parents or guardians were schoolchildren (93 cases, 34%), and 33.2% were in work, compared with 32.8% who were unemployed. Fever was the clinical symptom most frequently observed in children attending the Ntoum departmental hospital (263 cases, 30.2%), followed by asthenia (163 cases, 18.8%) and cough (157 cases, 18%). The vast majority of study children's households owned an insecticide-treated net (71.2%) and hardly used any aerosol insecticide (78.8%) (Table 1).

**Table 1: Characteristics of children aged zero to five surveyed at Ntoum departmental hospital Northwest Gabon.**

Variable	Frequency (%)
<b>Gender</b>	
Male	139 (50,7)
Female	135 (49,3)
<b>Age (months)</b>	
0 – 12	110 (40,1)
13 – 24	75 (27,4)
25 - 36	33 (12)
37 – 48	32 (11,68)
49 - 60	24 (8,76)
<b>City of residence</b>	
1 <sup>st</sup> district	253 (92,3)
2 <sup>nd</sup> district	11 (3,7)

3 <sup>rd</sup> district	3 (1)
Libreville	4 (1,4)
Kango	2 (0,7)
Andem	1 (0,3)
<b>Level of parents education</b>	
Primary	18 (6,6)
Secondary	157 (57,3)
University	99 (36,1)
<b>Occupation of parents</b>	
Student	93 (34)
Employed	91 (33,2)
Unemployed	90 (32,8)
<b>General symptoms</b>	
Coughing	157 (18)
Headache	56 (6,5)
Diarrhea	82 (9,4)
Vomiting	103 (12)
Asthenia	163 (18,8)
Fever	263 (30,2))
Chills	45 (5,1)
<b>Use of Insecticide Spray</b>	
Yes	58 (21,2)
No	216 (78,8)
<b>Use of Bed net</b>	

Yes	195 (71,2)
No	79 (28,8)

### Concordance of diagnostic tests and prevalence of malaria in the target population

The concordance rate between microscopic and RDT results was satisfactory (97.5%). Of the seven (7) cases of discordance observed, 4 samples were RDT negative but light microscope positive, and 3 samples were RDT positive but light microscope negative. The concordance of parasitological (thick drop) and immunochromatographic (RDT) examinations revealed 189 cases of *Plasmodium falciparum* positivity, representing a prevalence of 69% of children aged 0-60 months suffering from malaria (Table 2).

### Parasite density

In most cases, the parasite density read by microscopy was low (<1000 parasites/ $\mu$ l of blood) (64.1%). Moderate (1000 - 9999 p/ $\mu$ l blood) and high (>10,000 p/ $\mu$ l blood) parasitaemia levels prevailed in 17.7% and 18.2% of infected children respectively. (Table 2).

**Table 2: Biological results and parasite density**

Biology	Frequency (%)
<b>Microscopy</b>	
Positive	192 (70,1)
Négative	82 (29,9)
<b>TDR</b>	
Positive	191 (69,7)
Négative	83 (30,3)
<b>Concordance Microscopy / TDR</b>	
Microscopy + / TDR +	189 (69,0)
Microscopy + / TDR -	4 (1,5)
Microscopy - / TDR +	3 (1,0)
Microscopy - /TDR –	78 (28,5)
<b>Parasite density (p/<math>\mu</math>l)</b>	

Low (< 1000)	
Moderate (1 000 – 9 999)	123 (64,1)
High (> 10000)	35 (18,2)
	34 (17,7)

### Distribution of malaria infection

Of all the children in the study exposed to malaria, those aged 0 to 12 months were the most infected (76 cases, 38.8%), followed by those aged 13 to 24 months (53 cases, 27%) and those aged 37 to 48 months (24 cases, 12.2%). Malaria infection was most widespread in the first arrondissement of the Ntoum commune, with 173 cases (91.6%). The second and third arrondissements were less affected by malaria, with 4.2% and 0.5% of cases respectively. Neighboring towns (Libreville, Kango and Andem) were also represented, with 2.1%, 1.1% and 0.5% of cases respectively (Table 3). Fever, asthenia and cough were the clinical signs most frequently encountered in children aged zero to five suffering from malaria, with 28.3%, 18.9% and 17.1% of cases respectively (Table 3).

### Vector control

Mosquito control practices in the commune of Ntoum are unsatisfactory. Indeed, 78.5% of parents or guardians of children suffering from malaria did not use aerosol insecticides to protect themselves from mosquitoes, and 30.2% of them did not own an insecticide- treated net (Table 3).

**Table 3: Association of malaria infection with independent variables of children under five years old attending the Ntoum Departmental Hospital, Northwest Gabon.**

Variable	Frequency (%)	Malaria + (%)	Odds ratio	95% CI	P-value
<b>Gender</b>					
Male	139 (50,7)	100 (52,4)	1,23	0,74 – 2,07	0,4144
Female	135 (49,3)	91 (47,6)			
<b>Age (months)</b>					

0 – 12	110 (40,1)	76 (38,8)			
13 – 24	75 (27,4)	53 (27)	0,93	0,49 – 1,76	0,8189
25 - 36	33 (12)	22 (11,2)	1,11	0,48 – 2,56	0,7926
37 – 48	32 (11,68)	24 (12,2)	0,75	0,30 – 1,83	0,5201
49 - 60	24 (8,76)	21 (10,8)	0,32	0,08 – 1,14	0,0794
<b>Occupation of parents</b>					
Student	93 (34)	72 (37,5)			
Employed	91 (33,2)	66 (34,4)	1,29	0,66 – 2,54	0,4441
Unemployed	90 (32,8)	54 (28,1)	2,28	1,20 – 4,35	0,0118
<b>Level of parent's education</b>					
Secondary	157 (57,3)	110 (58,5)			
University	99 (36,1)	69 (36,7)	1,02	0,59 – 1,76	0,9503
Primary	18 (6,6)	9 (4,8)	2,34	0,87 – 6,27	0,0907
<b>City of residence</b>					
1st district	253 (92,3)	173 (91,5)			
2nd district	11 (3,7)	8 (4,2)	0,81	0,2 – 3,14	0,7615
3rd district	3 (1)	1 (0,5)	4,33	0,39 – 48,40	0,2346
Libreville	4 (1,4)	4 (2,3)	0,24	0,01- 4,50	0,3396
Kango	2 (0,7)	2 (1)	0,43	0,02 – 9,08	0,5884
Andem	1 (0,3)	1 (0,5)	0,72	0,03- 17,83	0,8401
<b>General symptoms</b>					



Fever	263 (30,2))	185 (28,3)			
Coughing	157 (18)	112 (17,1)	0,72	0,03 – 17,83	0,8401
Headache	56 (6,5)	45 (6,9)	0,95	0,62 – 1,47	0,8283
Diarrhea	82 (9,4)	67 (10,2)	0,58	0,28 – 1,18	0,1326
Vomiting	103 (12)	83 (12,7)	0,53	0,29 – 0,99	0,0451
Asthenia	163 (18,8)	124 (18,9)	0,75	0,47 – 1,17	0,1984
Chills	45 (5,1)	38 (5,9)	0,44	0,19 – 1,02	0,0558
<b>Use of Insecticide Spray</b>					
Yes	58 (21,2)	41(21,5)			
No	216 (78,8)	150 (78,5)	1,06	0,56 – 2,00	0,8546
<b>Use of Bed net</b>					
Yes	195 (71,2)	132 (69,8)			
No	79 (28,8)	57 (30,2)	0,80	0,45 – 1,44	0,4702

## DISCUSSION

The aim of this study was to determine the prevalence of malaria, the socio-demographic characteristics and the clinical profile of children aged 0-5 years attending Ntoum hospital in north-west Gabon.

The study revealed that the majority of the children's parents or guardians had secondary or university education (93.4%), and that 6.6% of the children had completed primary school, indicating a literacy rate of 100%. Our results are similar to those found in south-eastern Gabon, among households in the mining town of Moanda [10]. The signing of ministerial decree no. 21/2011 of February 14, 2012 on access to education and training for any young person, Gabonese or foreign, aged between 3 and 16 residing on its territory, may justify the high school enrolment rate in Gabon [11]. Our results are also higher than those found in Benin, where over 60.59% of their study population had no schooling, putting the literacy rate at 45.88% [12]. The low literacy rate observed in their study is justified by social tensions due to the lack of infrastructure in Benin's border areas [13]. The implementation of mosquito-bite control tools in Gabon is certainly due to a better understanding of the disease [14, 15]. The results also revealed that unemployment

was significantly associated with malaria, a finding which consistent with previous studies conduction in Cameroon and South Africa (1,2).

Fever (263 cases, 30.2%) was the most recurrent clinical symptom among children attending the HDN. Our results are lower than those found in the Bafoulabé health district and those observed in Yemen in rural communities in the Al-Mahweet governorate, where respectively 74% and 71% of the population suffered from fever [16, 17]. These results could be explained by self-medication by parents, who administer inappropriate medication to their offspring before going to the nearest hospital when the situation is no longer controllable. The clinical symptoms observed in malarial children, such as fever, asthenia and cough, confirm the polymorphous nature of malaria [18].

The prevalence of malaria based on microscopy was slightly higher than that based on immunochromatography (70.1% and 69.7% respectively). The difference between microscopy and RDT results in the 7 cases can be explained by the fact that the individual abilities of microscopists influence the sensitivity of microscopy in infections with low parasite densities [19]. Consequently, in asymptomatic infections with low or submicroscopic parasitaemia, microscopic results may be declared “negative” [20]. The use of rapid diagnostic test (RDT) kits that detect parasite antigens in blood sometimes gives “negative” results, due to the resurgence of plasmodial strains with genetic deletions (pfrp2 and pfrp3) [21]. False-positive” RDT results can be explained by the presence of high levels of rheumatoid factors in blood samples [20]. These problems can lead to discrepancies in malaria prevalence depending on the diagnostic tool used. The need to evaluate the sensitivity and specificity of RDTs, compared with a molecular biology test such as polymerase chain reaction (PCR), would be a major asset for the biological diagnosis of malaria [22, 23, 24].

With regard to the prevalence of malaria by age group, the results of this study are similar to those observed in south-east Gabon, where the 0-12 months age group was in the majority with 113 cases of malaria infection (37.42%), followed by the 13-24 months age group with 76 cases (25.17%) [25]. Our results differ slightly from those reported at Sikasso Hospital in Mali, where the 12-35 month age group was most affected (45.3%) [26]. The results of our study can be justified by the fact that in the 0-12 months age bracket, the newborn's immune system is still very immature, and therefore more vulnerable to malaria infection.

In terms of region, the highest prevalence of malaria infection is reported in the 1st arrondissement of the commune of Ntoum (91.6%), followed by the 2nd arrondissement (4.2%). The high prevalence rates in these regions of the Estuary are probably due to their position in the lake zone and the presence of lush vegetation favorable to the hatching of mosquito larvae.

According to the microscopic reading, 64.1% of children suffering from malaria had a low parasite density. Our results are slightly higher than those observed in Yemen, where 51.4% of their target population suffered from low parasitaemia. But as for moderate parasite density, it was higher in their

study (48.6%) than in ours (18.2%) [17]. As shown by a study carried out in Latin America, parasite density criteria are not relevant for defining severe or non-severe malaria. [27]

Mass distribution of insecticide-treated mosquito nets (ITNs) is one of the actions recommended by the WHO to protect local communities against mosquito bites [28]. The results of this study showed that 71.2% of the parents or guardians of the target children owned an ITN. Our results are greater to those found in Burundi, where 40.2% of parents or guardians of children under five owned an impregnated mosquito net [29]. Despite the massive malaria awareness and control campaigns carried out by the malaria control programs of every African country, the negligence of parents to acquire an insecticide-treated net free of charge is probably the reason why these results are disproportionate. A large body of literature attests to the fact that sleeping under an ITN at night, when mosquitoes are in search of their blood meal, greatly reduces the prevalence of malaria in children under five [30, 31].

Indoor residual spraying is one of the malaria control strategies proposed by Gabon's National Malaria Control Program (PNLP). However, the results of this study showed that few Gabonese households use insecticides (58 cases, 21.2%), compared with 216 households (78.8%) that do not use them at all. Our results are less significant than those found in Burundi, where 40.9% of Burundian households used insecticides [32]. This difference can be explained by the fact that, as Burundi's economy is essentially based on agriculture, the use of pesticides is strongly recommended to combat plant diseases, while at the same time providing protection against mosquito bites. Over half the pesticides registered in Burundi are insecticides [33].

## CONCLUSION

The prevalence of childhood malaria is high in the commune of Ntoun, particularly in the 0-12 month's age group. The proximity of the place of residence to inlets, mangroves and lush forests, mainly in the first arrondissement of this Gabonese locality, favors malaria transmission. The use of microscopy and RDTs for the biological diagnosis of malaria in the medical analysis laboratory has produced satisfactory results, confirming the usefulness of using RDTs in this commune with its limited resources. Finally, well-planned health education interventions could reduce the risk of malaria among the Ntoun population.

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