



American Journal of Life Science and Innovation (AJLSI)

ISSN: 2833-1397 (ONLINE)

VOLUME 4 ISSUE 1 (2025)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

Malaria Prevalence and Associated Risk Factors among Pregnant Women Attending the Prenatal Care Unit of the Ntoum Departmental Hospital (NDH), Northwest Gabon

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Article Information

Received: March 02, 2025

Accepted: April 10, 2025

Published: June 15, 2025

Keywords

Gabon, Malaria, Ntoum, Pregnant Women, Prevalence

ABSTRACT

Malaria during pregnancy is a significant public health problem in endemic countries. This study aimed to determine the prevalence of malaria and associated risk factors among pregnant women attending the Departmental Hospital of Ntoum (Northwest Gabon) for prenatal care. A cross-sectional survey was conducted for 6 months (July to December 2024), among pregnant women attending the prenatal care unit of the Ntoum departmental Hospital (NDH). Pregnant women selected for the study were asked to complete a structured questionnaire. At the end of the interview, a nurse drew a blood sample in an EDTA tube. Malaria was detected by thick blood smear using the WHO method. A P-value < 0.05 was considered statistically significant. Blood samples were collected from 202 pregnant women. Malaria was diagnosed in 23.3%. Patients aged between 20 and 30 years (53.2%), with a gestation of 4 to 6 months (46.8%) and living in the first district of Ntoum city (70.2%) were the most infected with the disease. Most of these women had completed secondary education (87.2%) and were unemployed (68.1%). Fever and headache were the most frequently reported symptoms, accounting for 51.1% and 42.5% of cases, respectively. Women who slept under an insecticide-treated net or used insecticide spray were less prone to malaria infection; but, the difference was not significant (P>0.05). In contrast, pregnant women who reported episodes of fever were significantly less likely to test positive to malaria (OR = 0.24 [0.09 - 0.61]; P = 0.002). Among the women who tested positive, 83% had a low parasitemia. Plasmodium infection in the Komo Mondah department is high. The development of a malaria vaccine would make it possible to immunize all participants and thus reduce the spread of malaria worldwide.

INTRODUCTION

Worldwide, malaria is a major public health problem (Organization, 2023). In 2023, nearly 263 million cases and 597,000 deaths were recorded across the globe, with Africa remaining the continent most affected by the disease, accounting for 94% of malaria cases and 95% of deaths (Organization, 2024). Pregnant women and children under 5 are the most vulnerable group to the disease (Organization, 2019). The WHO's 2021 World Malaria Report highlighted that one in three pregnancies is exposed to a malaria infection in the African region, and that the continent's West Zone has the highest rate of exposure to malaria (40%), followed by the Central Zone (39%) and the East and Southern Zone (22%) (Organization, 2022). Every year, nearly 25 million pregnant women are confronted with the consequences of malaria, and the risk of infestation is greatest during the first trimester of pregnancy (Steketee *et al.*, 2001). According to one study, a fifth (20%) of all stillbirths and 11% of all neonatal deaths are the result of this disease (Obossou *et al.*, 2024). Gabon, like most African countries, is aiming to achieve universal health coverage.

In this Central African country crossed by the equator, the incidence of malaria and its lethality fell in 2022 (OMS Gabon, 2023). More than one household in five (21%) owns at least one insecticide-treated mosquito net (ITN), and the proportion of households with an ITN is higher in rural compared to urban areas (29% versus 21%) (EDSG, 2022). Faced with the rapid spread of mosquitoes worldwide, the use of insecticides has become widespread (Fu & Guanli, 2024). Just over half (51%) of the population of the communes of Libreville, Owendo and Akanda use aerosol insecticides, and a quarter (25%) of these households appreciate spiral fumigants (Pamba *et al.*, 2021). In the south-east of the country, 47% of people in Franceville city use indoor insecticide spraying, compared to 21.1% in Moanda city (Kenguele *et al.*, 2022; Mabilia *et al.*, 2021).

According to several publications, not sleeping under an insecticide-treated net, nor spraying one's home with residual aerosol insecticides, contribute to the spread of malaria. Likewise, being unemployed, living in unhealthy neighborhoods and having a low level of education are risk factors associated with malaria (Okiring *et al.*, 2019; Rek *et al.*, 2020; Ramharter *et al.*, 2007).

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The detection, identification and quantification of malaria parasites are strategies advocated by the WHO to combat malaria worldwide (Organization, 2020) effectively. Microscopic observation of parasites using thin and thick blood smears remains the reference method for adapting therapeutic management (Organization, 2014). This parasitological technique is sometimes combined with a rapid diagnostic test (RDT) based on immunochromatography (Al-Quhaiti *et al.*, 2022; Bah *et al.*, 2020).

The third demographic and health survey in Gabon indicated that the Estuary province, which includes seven communes, had a high prevalence of malaria infection among pregnant women (EDSG, 2022). To the best of our knowledge, no study of gestational malaria has been carried out in the commune of Ntoum. In order to address this problem, new reliable and accurate data on malaria prevalence and associated factors among pregnant women living in this commune are needed. This study will provide updated information on the extent of malaria infection in this vulnerable group residing in north-west Gabon, in the Komo Mondah department.

MATERIAL AND METHODS

Study Setting and Location

A prospective, observational study was conducted at Ntoum Hospital for 6 months, from July to December 2024. Ntoum Hospital is the only public health facility in the commune of Ntoum, capital of the Komo Mondah Department. The hospital operates every day of the week, day and night.

The town of Ntoum is 34 km away from the capital city Libreville, and is geolocated at 0° 17' 18" North and 9° 46' 0" East. It is a rural community estimated in 2012 to have 11,813 inhabitants (DGS, 2015). The region's relief is made up of flooded areas and numerous rivers. The vegetation is characterized by riparian forests, located in swampy areas, marked by a predominance of mangroves, forests under fallow land located mainly along the main roads and dense evergreen rainforest located inland. The locality's hot, humid conditions favor the life cycle of Anopheles mosquitoes, the main vectors of malaria in Gabon (Mbouloungou *et al.*, 2019; Agyekum *et al.*, 2021). In the commune of Ntoum, malaria transmission is intense and permanent (Meye *et al.*, 2024).

Study Population and Inclusion Criteria

The study population consisted of all pregnant women who had given informed consent to participate in the study and who, during the study period, had attended a prenatal consultation at Ntoum hospital. All pregnant women who had been screened for malaria during their antenatal visit were included in the study, and those who were not screened for malaria were excluded from the study.

Data and Biological Material Collection

Pregnant women who signed the informed consent form were included in the study and interviewed by a midwife. The self-administered questionnaire asked about the

respondent's socio-demographic characteristics (age, level of education, place of residence, occupation, etc.), obstetrical factors (gestational age), malaria preventive measures (use of insecticide-impregnated mosquito nets, use of insecticide spray) and malaria symptoms. At the end of the interview, the pregnant woman was taken to the sampling room, where a nurse performed a venipuncture on an EDTA tube.

Study Approval and Ethical Considerations

The study was approved by the NDH General Management. All procedures contributing to this project comply with the ethical standards of the relevant national and institutional committees on human experimentation, and with the Declaration of Helsinki of 1975, as revised in 2008.

Statistical Analysis

The data collected were entered into a database using Microsoft Excel version 2016. All statistical analyses were performed using R software version 1.4.2. Descriptive statistics were used in the analysis of sociodemographic characteristics, obstetric history, prevalence of malaria infection and preventive measures for malaria infection, and variables were presented as frequencies and percentages. ODDS ratio and Pearson's Chi square test used to determine the degree of association between the disease and independent variables. A p-value < 0.05 was considered statistically significant.

Biological Analysis and Measurements

A microscopic blood test was carried out as a standard screening test on all participants. Parasitological examinations of the thick blood smears were carried out by a trained laboratory technician. Briefly, after identifying the end of an object slide, 5 µL of whole blood was pipetted into the center of the slide using a calibrated pipette. Using the corner of another clean, degreased slide, the drop of blood was spread evenly to form a circle approximately 12 mm in diameter. A hairdryer was then used to heat the spread. After cooling, the entire preparation was covered for 10 minutes with a 10% solution of Giemsa. The dye was then removed with a gentle trickle of tap water, and the slide dried at room temperature. Slides were read using a light microscope (Leica DM500), and 200 microscopic fields were systematically examined for malaria hematozoa using a 100X immersion objective. These were counted alongside leukocytes. The number of parasites was reported per 1 microliter of blood (based on 8,000 leukocytes per microliter of blood).

RESULTS AND DISCUSSION

Results

Sociodemographic and Obstetric Characteristics, Clinical Symptoms, and Preventive Measures of Study Participants

Two hundred and two (202) survey forms were completed

and used for data analysis, indicating a participation rate equal to 100%. At the time of inclusion, the average age of the participants was 27.5 years with an age range between 15 and 44 years. Patients aged 20 to 30 were the most represented (n = 117, 58%), followed by those over 30 (n = 57, 28.2%). The main clinical signs reported in the survey were headaches (n =71, 35.1%), cough (n =38, 18.8%), diarrhea (n =22, 10.8%) and general fever (n =58, 28.7%). Most participants (n =156, 77.2%) lived in the first district of neighboring Ntoum commune. The remainder lived in the second district (n=24, 11.8%) and

surroundings (Andem, Kango, Libreville and Cocobeach) (n=22, 11%). More than two-third (n=138, 68.3%) of participants had completed secondary school, and a few hold a university degree (n=37, 18.3%).. A large number (139, 68.8%) were unemployed.. The majority of respondents (n= 105, 52%) were in their second trimester of gestation, 24.7% were carrying a first-trimester pregnancy and 23.3% a third-trimester pregnancy. The survey revealed that more than half the participants did not sleep under an ITN (52%) or use a mosquito repellent (58.4%) (Table 1).

Table 1: Sociodemographic and obstetric characteristics, clinical symptoms, and malaria preventive measures, of pregnant women attending the Ntoum Departmental Hospital

Measured variables	(n) (%)
Age (years)	
< 20	28 (13,8)
20 – 30	117 (58)
>30	57 (28,2)
Respiratory signs	
Dyspnea	03 (1,5)
suffocation	09 (4,5)
Cough	38 (18,8)
Choking/Fever	03 (1,5)
None	149 (73,7)
Neurological signs	
Dizziness	46 (22,7)
Headache	71 (35,1)
Asthenia	1 (0,6)
None	84 (41,6)
Digestive signs	
Diarrhea	22 (10,8)
Vomiting	21 (10,4)
Epigastralgia	12 (6,1)
Vomiting / headache	2 (1,0)
None	145 (71,7)
General signs	
Asthenia	54 (26,8)
Fever	58 (28,7)
None	90 (44,5)
Place of residence	
1st district	156 (77,2)
2nd district	24 (11,8)
3rd district	00 (00)
Neighboring towns (Libreville, Kango, Cocobeach, Andem, Kougouleu, Donguila)	22 (11)
Education level	
Primary	19 (9,4)
Secondary	138 (68,3)
University	37 (18,3)
Illiterate	8 (4,0)

Occupation	
Unemployed	139 (68,8)
Employed	63 (31,2)
month of pregnancy	
1 - 3 (1st trimester)	50 (24,7)
4 - 6 (2nd trimester)	105 (52)
7 - 9 (3rd trimester)	47 (23,3)
Insecticide-treated nets (ITN)	
Yes	97 (48,0)
No	105 (52,0)
Insecticide spray	
Yes	84 (41,6)
No	118 (58,4)

Parasite Density

Thick blood smears were used to assess parasite density in line with WHO recommendations (Organization, 2020). Plasmodium falciparum was the only plasmodial species observed in all examined biological samples. Among the pregnant women infected with this parasite, 83% (n = 39) had a low parasite density (< 1,000 parasites/μL), 12.8% (n = 6) a moderate parasitaemia (1,000 - 9,999

parasites/μL) and 4.2% (n = 2) a high parasitaemia (≥ 10,000 parasites/μL). Of the 39 patients with low parasitaemia, 42.6% were aged between 20 and 30, 23.4% were over 30 and 17% under 20. Among women with moderate parasitaemia, 8.6% were aged between 20 and 30, and 4.2% were under 20. Two cases (4.2%) of high parasitaemia were recorded, one in the age group 20 -30 and the other in the over 30 (Table 2).

Table 2: Parasite density by age among pregnant women in the commune of Ntoum (2024)

Age (years)	Low (< 1000 p/μL)		Moderate (1000 – 9 999 p/μL)		High (≥ 10 000 p/μL)	
	n	%	N	%	n	%
< 20	8	17	2	4,2	0	0
20 – 30	20	42,6	4	8,6	1	2,1
>30	11	23,4	0	0	1	2,1
Total	39	83	6	12,8	2	4,2

Malaria Prevalence According to Sociodemographic and Obstetric Characteristics, Clinical Symptoms, and Preventive Measures among Pregnant Women Attending the Ntoum Departmental Hospital

All participants (n = 202) were tested for malaria. The results were positive in almost a quarter of the participants, giving a prevalence of malaria 23.3%. Of the 47 pregnant females with malaria hematozoa in their circulating blood, 53.2% were aged between 20 and 30, and 25.5% were over 30. Plasmodium infection was diagnosed predominantly (46.8%) in women in their second trimester of pregnancy, followed by those

in their first and third trimesters (31.9% and 21.3%, respectively). Clinically, cough was encountered in one-fifth (21.3%) of them, and two-fifth (42.5%) complained of headaches. Almost a sixth (15%) suffered from acute diarrhea, and over half (51.1%) had a fever. The largest number of participants (70.2%) lived in the first district of Ntoum commune and had completed secondary school (87.2%)., Malaria was detected in the majority (68.1%) of pregnant women with no income-generating activity. More than half of them did not use insecticide sprays or sleep under an insecticide-impregnated net (Table 3).

Table 3: Clinical symptoms, Preventives measures, Sociodemographic and obstetric characteristics

Variables	(Frequency (%))	Malaria + (%)	Odds ratio	95% CI	P-value
Age (years)					
< 20	28 (13,8)	10 (21,3)			
20 – 30	117 (58)	25 (53,2)	2.04	0.84 - 4.98	0.115
>30	57 (28,2)	12 (25,5)	2.08	0.76 - 5.67	0.150
Month of pregnancy					
1 - 3 (1st trimester)	50 (24,7)	15 (31,9)			
4 - 6 (2nd trimester)	105 (52)	22 (46,8)	1.61	0.75 - 3.47	0.218

7 - 9 (3rd trimester)	47 (23,3)	10 (21,3)	1.58	0.63 - 3.99	0.328
Respiratory signs					
Dyspnea	03 (1,5)	2 (4,3)			
suffocation	09 (4,5)	4 (8,5)	2.50	0.16 - 38.60	0.511
Cough	38 (18,8)	10 (21,3)	5.60	0.45 - 68.68	0.178
Choking	03 (1,5)	1 (2,1)	4.00	0.13 - 119.23	0.423
None	149 (73,7)	30 (63,8)	7.66	0.67 - 87.42	0.100
Neurological signs					
Dizziness	46 (22,7)	9 (19,1)			
Headache	71 (35,1)	20 (42,5)	0.62	0.25 - 1.51	0.294
Asthenia	1 (0,6)	00 (00)	0.76	0.03 - 20.17	0.869
None	84 (41,6)	18 (38,4)	0.89	0.36 - 2.18	0.802
Digestive signs					
Diarrhea	22 (10,8)	7 (15)			
Vomiting	21 (10,4)	5 (10,6)	1.49	0.39 - 5.74	0.559
Epigastralgia	12 (6,1)	5 (10,6)	0.65	0.15 - 2.8	0.566
Vomiting	2 (1,0)	00 (00)	2.42	0.10 - 56.97	0.583
None	145 (71,7)	30 (63,8)	1.79	0.66 - 4.78	0.246
General signs					
Asthenia	54 (26,8)	8 (17)			
Fever	58 (28,7)	24 (51,1)	0.24	0.09 - 0.61	0.002
None	90 (44,5)	15 (31,9)	0.86	0.34 - 2.21	0.769
Place of residence					
1st district	156 (77,2)	33 (70,2)			
2nd district	24 (11,8)	9 (19,1)	0.44	0.18 - 1.11	0.083
3rd district	00 (00)	00 (00)	0.27	0.005 - 13.92	0.516
Neighboring towns	22 (11)	5 (10,7)	0.91	0.31 - 2.65	0.866
Education level					
Primary	19 (9,4)	3 (6,4)			
Secondary	138 (68,3)	41 (87,2)	0.44	0.12 - 1.60	0.215
University	37 (18,3)	1 (2,1)	6.75	0.65 - 69.97	0.109
Illiterate	8 (4,0)	2 (4,3)	0.56	0.07 - 4.24	0.576
Occupation					
Unemployed	139 (68,8)	32 (68,1)			
Employed	63 (31,2)	15 (31,9)	0.95	0.47 - 1.93	0.902
Use of Insecticide Spray					
Yes	84 (41,6)	19 (40,4)			
No	118 (58,4)	28 (59,6)	0.94	0.48 - 1.82	0.854
Use of Bed net					
Yes	97 (48,0)	21 (44,7)			
No	105 (52,0)	26 (55,3)	0.84	0.43 - 1.61	0.601

Factors Associated with Malaria Infection

This study revealed that pregnant women aged 20-30 and over 30 were two times more likely to test positive to malaria compared to those under 20. Likewise, women in their second trimester were more susceptible to malaria infection (OR = 1.61 [0.75 – 3.47]). Women with university education were nearly seven (7) times less prone

to malaria infection compared to the other groups (OR = 6.75 [0.65 – 69.97]). Employed women appeared to be less exposed to malaria infection than the unemployed ones (OR = 0.95 [0.47 – 1.93]).

Neither the clinical manifestations, nor the obstetric or the preventive measures were significantly associated with malaria (P>0.05). In contrast, women who reported

episodes of fever during the survey were less prone to malaria infection, and the difference was found statistically significant (OR = 0.24 [0.09 - 0.61]; P = 0.002).

Discussion

A six-month cross-sectional study was conducted at the departmental Hospital of Ntoum to assess the prevalence and risk factors associated with malaria among pregnant women. Among participants in this study, the prevalence of malaria infection was 23.3%. This is comparable to the prevalence of malaria reported in north-west Ethiopia (Almaw *et al.*, 2022) and Burkina Faso (Rouamba *et al.*, 2021), but these results are higher than those found in studies carried out in Kenya (Okoyo *et al.*, 2021) and Nigeria (Oyerogba *et al.*, 2023). Nevertheless, the prevalence among pregnant women in Komo Mondah is lower than that found in the San District of Mali (Diarra *et al.*, 2022), or that reported in south-east Nigeria (Okoroiwu, 2023) and Uganda (Mangusho *et al.*, 2023). These discrepancies in prevalence observed in high-transmission countries justify the view that malaria prevalence is a function of sample size and socio-environmental factors.

In our study, the average age of pregnant women surveyed was 27.4 years, with extremes of 15 and 44 years. These values are similar to those found in many African health facilities. Indeed, the average age of pregnant women attending antenatal clinics were 27.3 years, 26, and 24.6 years respectively in Cameroon, Burkina Faso, and Mali, (Nguefack, 2018; Yameogo, 2023; Delbaere *et al.*, 2020). These similar results are due to the fact that a woman's fertility is at its peak between the end of adolescence and the approach of her thirties. After the age of 30, fertility begins to decline, collapsing around the age of 38 due to a decrease in the number and quality of oocytes (Delbaere *et al.*, 2020).

This study revealed that 21.3% of pregnant women under 20 suffered from malaria. These results are lower than those found in the peripheral maternity wards of Parakou in Benin and at the Toamasina University Hospital in Madagascar, where malaria rates among pregnant women under 20 were 56.9% and 47.5% respectively (Obossou *et al.*, 2024; Botolahy *et al.*, 2011). Among pregnant women aged between 20 and 30, malaria prevalence was 53.2% in our study. These results are slightly lower than those observed in Benin (Obossou *et al.*, 2024), but higher than those observed at the commune II reference health center in Bamako, Mali (Santara, 2024). In the case of pregnant women over 30 years of age, 25.5% of our participants suffered from malaria, compared with 42.1% in the peripheral public maternity units of Parakou, Benin. (Obossou *et al.*, 2024). Younger women and primiparous women are traditionally considered to be at greater risk of malaria, as they do not benefit from sufficient immunity with age (Nankabirwa *et al.*, 2014).

In our study, malaria was more frequent in pregnant women in their second trimester (46.8%) than in those in their first or third trimester (31.9% and 21.3% respectively). Our results are in line with those found in

Ghana, and north-eastern Nigeria (Dwumfour *et al.*, 2023; Ali, 2022). Where the categories of pregnant women most affected were those in their second trimester, followed by those in their third trimester. Those in their first trimester had the lowest malaria prevalence. Nevertheless, our results contrast with those found in the Democratic Republic of Congo (DRC) and eastern Sudan. Indeed, their work emphasizes that it is during the third trimester of pregnancy that women are more likely to suffer from malaria (Bihingoyi, 2013; Idris Nour *et al.*, 2023). Other studies carried out in southern Ghana and southern Malawi, on the other hand, showed that pregnant women were at greater risk of contracting malaria during the first trimester of pregnancy (Ahadzie-Sogle *et al.*, 2022; Verhoeff *et al.*, 1999). These discrepancies could be explained by the fact that there is no significant association between gestational age and malaria, as highlighted by a study carried out in Burkina Faso (Tahita *et al.*, 2013).

Level of education also influenced the frequency of malaria in pregnant women. The highest incidence of malaria was found among pregnant women with secondary education (87.2%), followed respectively by primiparous (6.4%), illiterates (4.3%) and university graduates (2.1%). In general, the risk of contracting malaria decreases with the level of education, which is associated with better knowledge of malaria prevention measures and better access to health services. However, significant disparities may exist within study groups (Salissou *et al.*, 2016).

Most participants with malaria (70.2%) lived in the first district of the Ntoum commune, followed by those living in the second district and neighboring towns; 19.2% and 10.7% respectively. In addition, to the tropical climate that prevails throughout Gabon, the first district of the commune of Ntoum is a region rich in bodies of water (inlets, mangroves, rivers and streams). The proximity habitations with watercourses and dense vegetation favors human contact with mosquitoes, and hence the occurrence of malaria (Chaves *et al.*, 2021; Dufera *et al.*, 2020).

The study showed that the unemployment rate among participants was 68.8% (Tonda, 2024). In our study, the prevalence of malaria among these unemployed people was equal to 68.1%. The low purchasing power of the poor means that they cannot afford medical consultations in Gabonese hospitals, nor can they afford anti-mosquito bite tools (aerosol sprays, spiral fumigants) or antimalarial drugs. In most cases, the latter are forced to turn to cheaper traditional medicines, thus encouraging the transmission of malaria (Diallo *et al.*, 2007; Kodio *et al.*, 2023).

In this study, clinical symptoms were dominated by fever (51.1%), followed by headache (42.5%). According to the results of a study carried out in Malawi, the main clinical signs in favor of malaria were headaches (24.3%) and chills (16.9%). Fever and muscle pain were less common, with 7.1% and 6.7%, respectively (Namwera *et al.*, 2025). In another study, carried out in north-west Ethiopia, the clinical signs of malaria encountered in pregnant women were mainly fever (91.8%) and headache (81.4%) (Almaw *et al.*, 2024). The probability of malaria was significantly

higher in pregnant women presenting with fever and headaches than in asymptomatic pregnant women. A study conducted in Burkina Faso also found that fever, history of fever and headache were the most common malaria-related clinical signs in pregnant women (Tahita *et al.*, 2013). On the basis of these findings, the presence of fever and headaches in pregnant women in tropical zones points to malaria and emphasizes the need for early detection.

To protect themselves from mosquito bites in the mining town of Moanda (south-east Gabon), 21.1% of people used insecticide sprays (Nno Mabiala *et al.*, 2021). This frequency of chemical agent use is lower than that found in our study (41.6%), but higher in households in Niger (63%) (Mahaman Toudou *et al.*, 2021). The proliferation of insect pests on agricultural fields in Niger has prompted farmers to use large volumes of synthetic insecticides on legumes and in irrigated perimeters, justifying the high use of insecticides in this country (Abdou *et al.*, 2024).

This study revealed that more than half (59.6%) of malaria sufferers did not use chemical agents to protect themselves from mosquitoes, justifying that the risk of contracting malaria is lower when insecticides are used as an alternative to ITNs. However, the massive use of insecticides can, on the other hand, cause gene mutations in *Anopheles gambiae* strains, making them resistant to many insecticides (DDT and pyrethroids), as some studies have shown (Organization, 2023 ; Akono *et al.*, 2022). Sleeping under an insecticide-treated mosquito net to prevent insect bites is a practice recommended by the WHO [1]. In this study, 48.0% of pregnant women declared sleeping under an ITN. Our results are similar to those found in Nigeria (42.2%) (Ogomaka, & Obeagu, 2021); but, lower than those obtained in Rwanda (57.9%) (Kawuki *et al.*, 2023). This discrepancy in results may be explained by the sample size and the study region, which differed from one study to another. Nevertheless, this study reveals that more than half (55.3%) of pregnant women who did not sleep under an ITN suffered from malaria. This finding is consistent with the fact that sleeping under an ITN reduce the incidence of malaria (Organization, 2023).

Study Limitations

Our study has a number of limitations which must be taken into account when interpreting the results. Indeed, the relatively small sample size, the absence of data on intermittent preventive treatment during pregnancy (IPTp), and the lack of explanatory variables such as the reasons why participants did not sleep under an insecticide-treated net, or did not use aerosol sprays may reduce the statistical power to detect a true association in the population.

CONCLUSION

This study shows that the rate of malaria during pregnancy is widespread among women consulting for antenatal care at Ntoun Hospital. The study also shows that

regular use of malaria control tools (insecticide-treated nets, indoor residual spraying) and early antenatal care visits can significantly reduce the risk of malaria during pregnancy. To reduce the burden of malaria in the region, we recommend the distribution of free insecticide-treated mosquito nets to all pregnant women attending antenatal care at Ntoun hospital. Biological diagnosis and early treatment of malaria should be combined with the use of insecticide-treated nets. Municipal authorities should implement environmental control measures to control the population of *Anopheles* larvae. Finally, the Gabonese government should ensure the implementation of vector control interventions based on entomological surveillance, the correct and rational use of insecticides, and the monitoring and management of insecticide resistance.

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