



The Severity of Malarial-Anemia in Pregnant Women in Biyem-Assi, Yaounde

**Judith Lum Ndamukong-Nyanga^{1*}, Ngo Batandi Helen Virginie¹,
Tchanga Chanceline Flore¹ and Fegue Celestine Nadege¹**

¹*Department of Biological Science, Higher Teacher Training College, University of Yaounde 1, Cameroon.*

Authors' contributions

This work was carried out in collaboration among all authors. Author JLNN designed the study, wrote the protocol, assisted in the data collection and edited the manuscript. Author NBHV participated in data collection, performed the statistical analysis and wrote the first draft of the manuscript. Authors TCF and FCN managed the literature searches and assisted in data collection. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/ACRI/2021/v21i230233

Editor(s):

(1) Dr. Mitasha Singh, ESIC Medical College and Hospital, India.

Reviewers:

(1) Khairul Mohd Fadzli, Universiti Sains Malaysia, Malaysia.

(2) Margaret Rose Smith, Wake Forest University, USA.

(3) Hamza N Hameed, university of Mosul, Iraq.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/68538>

Original Research Article

Received 20 March 2021

Accepted 26 May 2021

Published 08 June 2021

ABSTRACT

Malaria is a parasitic disease endemic in Sub-Saharan Africa especially in Cameroon. Pregnancy is associated with increased susceptibility to malaria. Closely associated to malaria is anaemia. It is generally accepted that pregnancy ends with childbirth. The outcome of the pregnancy is highly affected by the presence of malaria and anaemia. The aim of this study was to determine the prevalence and severity of malaria and anemia among pregnant women and the influence of socio-demographic factors on malaria and anaemia prevalences in pregnant women in Biyam- Assi Yaounde. Information on socio-demographic factors was collected from 302 pregnant women attending prenatal clinics in health institutions within the Biyem-Assi Health District of Yaounde VI subdivision using a pretested questionnaire. Peripheral blood was collected and thick smears were prepared for screening *Plasmodium* parasites. The level of hemoglobin was measured using a haemoglobinometer URIT- 12. Analysis was done using SPSS version 20.0. Out of the 302 women, 146 (51.7%) had *Plasmodium falciparum* infected red cells. Among the 146 infected women, 36% had mild parasitaemia, 45% had moderate parasitaemia and 19% had severe

*Corresponding author: Email: ndamju@yahoo.com;

parasitaemia. The prevalence of anemia in the study population was 53%. There was no significant association between the severity of malaria and the severity of anaemia ($p > 0, 05$). Parity had a significant influence on the severity of malaria. The level of school education significantly ($p < 0, 05$) influenced the severity of anaemia. Multiparous women were more affected by malaria than primiparous women. However, in relation to disease severity, primiparous women parasitized by *Plasmodium* presented a significantly higher risk of severe malaria compared to multiparous women. Malaria and anaemia prevalences in the study population were high ($>50\%$), anaemia severity was directly associated to level of education. We recommend that more sensitization of women should be done to reduce ignorance, prevent malaria and in turn reduce anaemia and improve on the health of mother and baby.

Keywords: Anaemia; malaria; *Plasmodium falciparum*; haemoglobin.

1. INTRODUCTION

Malaria is one of the most widespread parasitic diseases worldwide responsible for approximately 225 million clinical cases each year [1]. It is a potentially fatal parasitic disease caused by parasites of the genus *Plasmodium* transmitted to the vertebrate host by the infesting bite of the female mosquito "*Anopheles*" which is its vector. There are five types of parasites responsible for malaria in humans: *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale*, *Plasmodium malariae* and *Plasmodium knowlesi* [2,3]. However, *Plasmodium falciparum* is the most prevalent parasite on the African continent (i.e., 86%) and is responsible for most of the world's fatalities; while *Plasmodium vivax* is the predominant parasite outside of Africa [4]. This disease is responsible for several million deaths worldwide each year, most of which occur in sub-Saharan Africa [5]. In Cameroon, recent data show that this disease accounts for approximately 31% of medical consultations, 46% of hospitalizations, and 19% of mortality in health facilities [6,7]. Immunocompromised people, pregnant women, and children under 5 years of age are the most vulnerable [8,9].

Indeed, each year, millions of women living in malaria-endemic areas of Africa become pregnant and are at risk of developing malaria complications [10]. The placenta is the preferential site for sequestration and development of *Plasmodium* during pregnancy. Thus, the pregnant woman has a high susceptibility to being infested with *Plasmodium falciparum*. This results in a high frequency of malaria episodes with a high parasite density compared to non-pregnant women [11].

Malaria infection in pregnant women is characterized by maternal anemia. Anemia is a common problem in developing countries and in

Cameroon in particular [5]. It is a weakening of the body produced by the decrease in the number of red blood cells (due to destruction of parasitised erythrocytes), hemoglobin level or hematocrit level below normal values [12]. Malaria causes anemia even more in pregnant women and is responsible for 20% of maternal deaths, infant deaths and fetal growth abnormalities [1].

In view of the consequences of malaria during pregnancy, it is important that pregnant women living in malaria endemic areas be on malaria prophylaxis [13,14]. In sub-Saharan Africa, the WHO has recommended, since 2012, prevention strategies during pregnancy based on the administration of intermittent preventive treatment to all pregnant women during antenatal care visits from the beginning of the second trimester; and the use of insecticide-treated bed nets [15,16]. However, if prophylaxis is to have a serious impact on malaria and the fetus, it should begin during early gestation period, and probably not in the last few weeks of pregnancy. The prevalence of malaria as a major cause of anemia in pregnant women in malaria endemic areas, needs to be fully elucidated in all localities. This will help policy makers to know if the control measures put in place are working to reduce the prevalences of malaria and anemia. Therefore, studies on the relationship between anemia in pregnant women and malaria are needed. Determining the severity of anemia in pregnant women with malaria will help to monitor the health of pregnant women, thus contributing to reduce maternal morbidity and mortality in particular, and infant mortality and fetal growth problems. The objectives of this work was to determine the prevalence and severity of malaria and anemia in pregnant women in the city of Yaounde. Specifically the work was designed to determine the prevalence and severity of malaria in pregnant women,

determine the prevalence and severity of anemia among pregnant women and to determine the influence of sociodemographic factors on malaria and anemia among pregnant women in the Biyem-Assi - Yaoundé.

2. MATERIALS AND METHODS

2.1 Study Period, Design and Site

The study was a descriptive cross-sectional study that lasted from January 2018 to November 2018. It was conducted at the Biyem-Assi District Hospital in Yaounde and at the Zoology Laboratory of the Ecole Normale Supérieure in Yaounde. The choice of the site was made on the basis of the climatic and environmental conditions prevailing in the area, which are favorable for the development of female *Anopheles* and the stability of malaria transmission. Indeed, Yaoundé is a city in the Central Region of the Republic of Cameroon, located in the Division of Mfoundi. It is located between 3°47'- 3°56' North latitude and 11°10'- 11°45' East longitude, with an estimated population of 2,685,136 in 2007 [17]. It has a particular equatorial climate, characterized by the presence of two dry seasons (a long one, December - February and a short one, July - August) and two rainy seasons (a long one, March - June and a short one, September - November). Rainfall is abundant (about 1600 mm³/year). The average annual temperature is 23°C, which makes the city a favorable zone for the development of female *Anopheles*, the vectors of malaria [17]. The entomological inoculation rate is about 10 infected bites per person per year [18]. Biyem-Assi is a popular neighborhood in the city of Yaoundé; it is located in the heart of the 6th arrondissement.

2.2 Study Population

The study population consisted of consenting pregnant women regardless of age, who came for prenatal consultation at the Biyem-Assi District Hospital. The inclusion criteria for the study were as follows

- any woman of child bearing age who had previously completed a biological pregnancy test and/or obstetrical ultrasound and confirmed the pregnancy
- have voluntarily given written consent,
- was free of diseases such as typhoid fever, sickle cell disease, hookworm and HIV as

indicated by hospital records following screening.

- Exclusion factors for the study included:
- unavailability of information in relation to parity, gravidity,
- HIV positive, and diagnosis of certain serious diseases (sickle cell disease, hookworm, typhoid fever), refusal to participate and failure to sign the informed consent form.

The sample size was calculated according to the Lorentz formula $N = (Z^2 \times P \times Q) / d^2$

Z=statistical power (1.96);
P=the estimated prevalence of disease; 23% from Tonga et al. 2013 [19];
Q=1-P;
d= level of significance (0.05).
N=272 pregnant women.

At a minimum, 272 pregnant women were to be involved in the study. However, to maximize sample collection a total of 302 pregnant women were recruited.

2.3 Recruitment Strategy and Sample Collection

2.3.1 Strategy for recruiting women

Women were recruited from the moment they were admitted to the antenatal clinic. Registration in the study was done through an oral interview. Participants were given explanations on the purpose and benefits of the study, the amount of blood that would be collected as well as its experimental protocol. Those who met the inclusion criteria were asked to participate in the study. For this, only those who voluntarily accepted to be part of the study, signed the informed consent form and were HIV free were included in the study. All pregnant women who were HIV positive, did not sign the consent form nor express their willingness to participate were excluded in the study.

2.3.2 Sample collection

A pre-tested, well-structured questionnaire and blood samples were collected from all participants.

A code was assigned to each pregnant woman willing to participate in the study. The code and the day's date were written directly with a pencil on a clean slide and the questionnaire. The code

consisted of the abbreviations of the Biyem-Assi District Hospital followed by the registration number of each participant.

2.3.2.1 Collection of socio-demographic information

The questionnaire had two sections:

- Section A, which collected demographic information: neighborhood of residence, tribe, level of education, marital status, religion, occupation;
- Section B, which collected information on pregnancy: health facility, name, mother's age, age of pregnancy, parity.

2.3.2.2 Collection of blood samples

After sanitizing the pregnant woman's middle finger with an alcohol-soaked cotton ball, applying several firm pressures to stimulate blood flow, three drops of peripheral blood were collected by pricking the pulp of the middle finger with a sterile lancet.

The first two drops of blood were placed in the center of a clean slide. With the corner of a second slide, the thick drop was made. The two drops of blood were spread to obtain a circle of about one centimeter in diameter thanks to the circular movements, allowing also to defibrillate the blood. The slides were air-dried, stored in a slide box and transported to the Zoology laboratory of the Ecole Normale Supérieure de Yaoundé for processing.

Blood remaining on the participant's finger was wiped off with an alcohol swab and pressure was applied to stop bleeding.

2.4 Analysis of Blood Samples

2.4.1 Anemia test

A hemoglobinometer strip was first installed on the URIT-12 Hemoglobin meter, and then the device was switched on. A third drop collected according to the above protocol was placed in the well of this hemoglobinometer strip. The hemoglobin result was displayed automatically when the drop of blood was sufficient.

A hemoglobin (Hb) level <11 g/dl was classified as anemic. Further classification was performed with severe, moderate, and mild moderate

anemia having values ≤ 6 g/dl, 6.1 - 8 g/dl, and 8.1-10.9 g/dl respectively [20].

2.4.2 Staining of the thick drop slides

Slides were stained using the May-Grunwald-Giemsa staining technique.

- Principle: It is based on the complementary action of two neutral dyes and the affinity of the cellular elements for acid or basic dyes, which are May-Grunwald and Giemsa which are neutral and all contain eosin (acid dye), which selectively stains basic cellular elements (cytoplasm of red blood cells pink, nucleus of plasmodium pinkish blue) and methylene blue (basic dye), which stains acidic cellular elements (DNA, cytoplasm of lymphocytes and plasmodium) blue. Giemsa also causes hemolysis of the unfixed red blood cells in the thick drop and release of the parasites.
- Method: The thick drop was stained for 20 minutes with Giemsa solution diluted to 20% with buffer water (1 volume of Giemsa diluted in 19 volume of water), washed with tap water and air dried in a slanted position [20].

2.4.3 Microscopic observation of slides and evaluation of parasite density

The slides were read under a UNICO® light microscope at the x100 objective using oil immersion. Malaria parasites were counted against 200 leukocytes in thick films. Parasite density (or parasitemia) was expressed as the number of parasites per microliter (μL) of blood. Parasitemia was classified as low (<500 parasites/ μL of blood), moderate (501 - 5000 parasites/ μL of blood), and high (> 5000 parasites/ μL of blood [20,21]. A slide was only declared negative after examining at least 100 high-power fields [20].

2.5 Statistical Analyses

Data were entered into spreadsheets using Microsoft Excel and analyzed with statistical software (SPSS) version 20. The data were summarized into proportions were used for the evaluation of descriptive statistics. Proportions were compared using the chi-square test and the Fischer accuracy test. Significant levels were measured at the 95% confidence level with significant differences recorded at $p < 0.05$.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Description of the study population

The basic characteristics of the women involved in the study are summarized in Table 1. It shows that the study population consisted of a total of 302 pregnant women whose ages ranged from 16 to 42 years and the predominant age range was 26-34 years (53.3%). Most of the women enrolled were multiparous (56.3%), single (56.6%), and in their 2nd trimester of pregnancy (56.3%). Of all the women enrolled, 2 (0.7%) had no schooling and the rest had at least primary

education, with a predominance of higher education (48%). Thus, 48.7% of our study population were workers, while 9.6% of women were students. The vast majority of women who came for prenatal consultation were Christians (97.7%).

3.1.2 Prevalence and severity of malaria among pregnant women in Biyemassi-Yaoundé

Among the 302 women studied, 146 (51.7%) had red blood cells infected with *P. falciparum* on microscopic examination of the thick drop, with a parasite density between 40-11880 parasites/ μ L of blood (Fig. 1).

Table 1. Socio-demographic characteristics of the study population

Facteurs	Categories	No examined	Proportions (in %)
Age	≤ 25ans	115	38,1
	26-34 ans	161	53,3
	≥ 35 ans	26	8,6
Age of pregnancy	1 st trimester	61	20,2
	2 nd trimester	128	42,4
	3 rd trimester	113	37,4
Parity	Primipare	132	43,7
	Multipare	170	56,3
Level of Education	Non	2	0,7
	Primary	20	6,6
	Secondary	135	44,7
	University	145	48,0
Marital status	Married	131	43,4
	Single	171	56,6
Religion	Christian	295	97,7
	Muslim	4	1,3
	Others	3	1,0
Profession	Student (Secondary)	29	9,6
	Student (University)	65	21,5
	Housewife	61	20,2
	Informal/formal worker	147	48,7

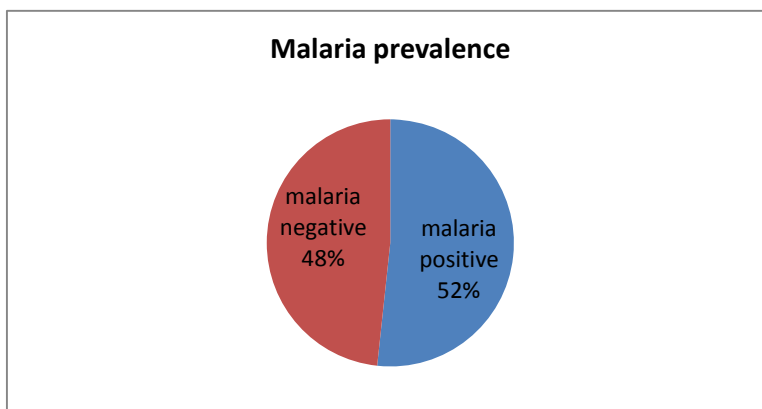


Fig. 1. Prevalence of malaria in the study population

Of these 146 women infected with *P. falciparum*, 36% had mild parasitemia, 45% had moderate parasitemia, and 19% had severe parasitemia (Fig. 2).

3.1.3 Prevalence and severity of anemia among pregnant women in the Biyemassi-Yaoundé

The hemoglobin test showed that 53% of women were anemic (Hb<11 g/dl) (Fig. 3).

Of the 160 pregnant women reported to be anemic, the vast majority had mild anemia (91.9%) compared to a small proportion with moderate (6.9%) and severe (1.3%) anemia (Fig. 4).

3.1.4 Prevalence and severity of anemia in pregnant women with malaria in the Biyem-Assi - Yaoundé

3.1.4.1 Prevalence of anemia in pregnant women with malaria

Of the 302 pregnant women who participated in the study, 68 (22.5%) were found to have malaria and anemia (Table 2).

In order to determine a possible relationship between the presence of malaria and anemia, the chi-square and the Fischer accuracy test were performed. It was found that there was a significant association between the microscopic presence of parasites and maternal anemia ($p=0.031$) (Table 2).

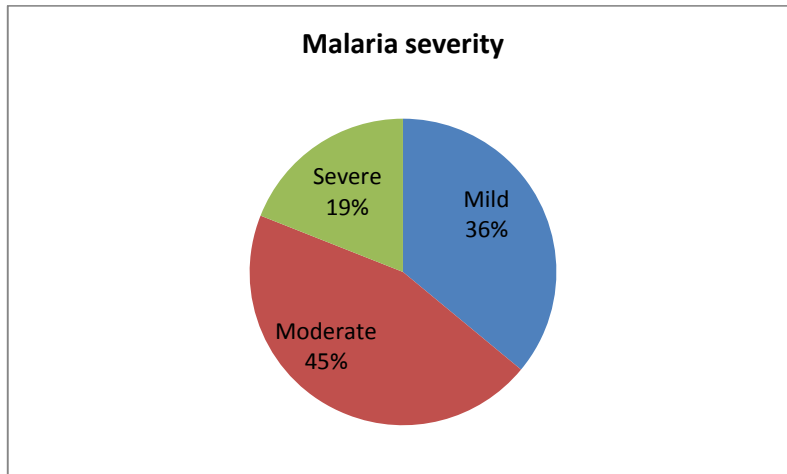


Fig. 2. Severity of malaria among pregnant women

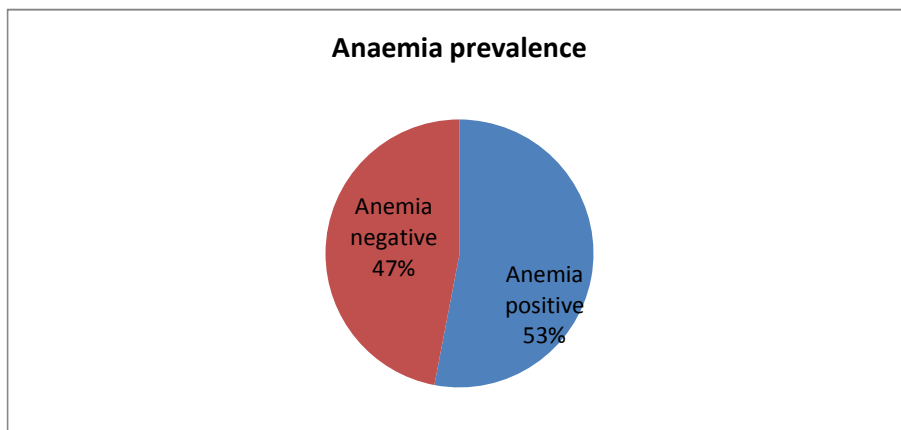


Fig. 3. Prevalence of anemia in the study population

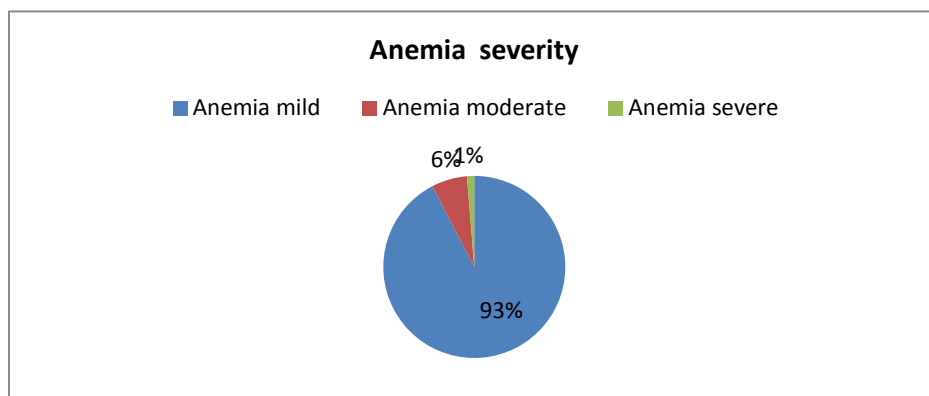


Fig. 4. Severity of anemia among pregnant women

Table 2. Relation between the prevalences of malaria and anemia

Facteur	Category	Anemia			P
		Positive (%)	Negative (%)	Total (%)	
Malaria	Positive	68 (22,5)	78 (25,8)	146 (48,3)	0,031
	Negative	92 (30,5)	64 (21,2)	156 (51,7)	
	Total	160 (53)	142 (47)	302 (100)	

Table 3. Relationship between severity of malaria and severity of anemia

Facteur	Category	Severity of anemia				P
		Mild (%)	Moderate (%)	Severe (%)	Total (%)	
Severity of Malaria	Mild	25 (36,8)	24 (35,3)	13 (19,1)	62 (91,2)	0,369
	Moderate	1 (1,5)	4 (5,9)	0	5 (7,4)	
	Severe	0	1 (1,5)	0	1 (1,5)	
	Total	26 (38,2)	29 (42,6)	13 (19,1)	68 (100)	

3.1.4.2 Severity of anemia in pregnant women with malaria

In order to determine whether the severity of malaria influences the severity of anaemia, a test of independence was performed in pregnant women with malaria and anaemia (68 women corresponding to 22.5% of the total population studied). There was a non-significant association between the severity of malaria and anemia ($p > 0.05$). Furthermore, it was found that there were no pregnant women with severe anemia and moderate or severe malaria (Table 3).

3.1.5 Influence of sociodemographic factors on malaria and anemia among pregnant women in the Biyem-Assi - Yaoundé

3.1.5.1 Influence of socio-demographic factors on malaria

The details of the association between maternal sociodemographic characteristics and malaria severity are presented in Table 4. It shows that there is a non-significant relationship between the severity of gestational malaria and the

participant's age, marital status, education level, religion, occupation, and age of pregnancy ($P > 0.05$).

However, there was a significant relationship between parity and malaria severity ($P = 0.01$). No significant relationship was observed between this maternal characteristic and the occurrence of mild malaria ($P = 0.73$). On the other hand, parity significantly influenced the occurrence of mild (0.019) and severe malaria ($P = 0.01$). Multiparous pregnant women were more likely to have moderate malaria than primiparous women. On the other hand, primiparous pregnant women were more likely to have severe malaria than multiparous women.

3.1.5.2 Influence of socio-demographic factors on anemia in pregnant women

Details of the relationship between maternal sociodemographic characteristics and anemia severity are presented in Table 5. It is shown that there is a non-significant relationship between the severity of gestational anemia and the

participant's age, marital status, religion, occupation, age of pregnancy, parity (p 0.05).

observed between this maternal characteristic and the occurrence of moderate anemia (p2=0.19).

However, there was a significant relationship between education level and severity of anemia (p1= 0.01). No significant relationship was

In contrast, the level of education significantly influenced the occurrence of mild (p2=0.007) and severe (p2=0.017) anemia.

Table 4. Relationship between severity of malaria and socio-demographic characteristic

Factor	Category	Malaria Severity				p ₁		
		Mild (%)	Moderate (%)	Severe (%)	Total (%)			
Age	≤ 25 years	28 (19,2)	19 (13)	9 (6,2)	56 (38,4)	0,60		
	26-34 years	23 (15,8)	38 (26)	17 (11,6)	78 (53,4)			
	≥ 35 years	2 (1,4)	8 (5,5)	2 (1,4)	12 (8,2)			
	Total	53 (36,3)	65 (44,5)	28 (19,2)	146 (100)			
Marital Status	Married	26 (17,8)	28 (19,2)	13 (8,9)	27 (45,9)	0,82		
	Single	27 (18,5)	37 (25,3)	15 (10,3)	79 (54,1)			
	Total	53 (36,3)	65 (44,5)	28 (19,2)	146 (100)			
Level of Education	Non	0	1 (7)	0	1 (7)	0,40		
	Primary	5 (3,4)	6 (4,1)	1 (7)	12 (8,2)			
	Secondary	24 (16,4)	29 (19,9)	8 (5,5)	61(41,8)			
	University	24 (16,4)	29 (19,9)	19 (13)	72(49,3)			
	Total	53 (36,3)	65 (44,5)	28 (19,2)	146 (100)			
Religion	Christian	51 (34,9)	63 (43,2)	27 (18,5)	141 (96,6)	0,92		
	Muslim	1 (7)	1 (7)	0	2 (1,4)			
	Others	1 (7)	1 (7)	1 (7)	3 (2,1)			
	Total	53 (36,3)	65 (44,5)	28(19,2)	146 (100)			
Profession	Student (Secondary school)	6 (4,1)	4 (2,7)	3 (2,1)	13 (8,9)	0,27		
	Student (University)	13 (8,9)	8 (5,5)	9 (6,2)	30 (20,5)			
	Housewife	11 (7,5)	16 (11)	5 (3,4)	32 (21,9)			
	Formal/informal workers	23 (15,8)	37 (25,3)	11 (7,5)	71 (48,6)			
	Total	53 (36,3)	65 (44,5)	28 (19,2)	146 (100)			
	Age of pregnancy	1 st trimester	11 (7,5)	17 (11,6)	5 (3,4)		33 (22,6)	0,75
		2 nd trimester	19 (13)	26 (17,8)	10 (6,8)		55 (37,7)	
3 rd trimester		23 (15,8)	22 (15,1)	13 (8,9)	58 (39,7)			
Total		53 (36,3)	65 (44,5)	28 (19,2)	146 (100)			
Parity	Primiparous	25 (17,1)	22 (15,1)	19 (13)	66 (45,2)	0,01		
	Multiparous	28 (19,2)	43 (29,5)	9 (6,2)	80 (54,8)			
	Total	53 (36,3)	65 (44,5)	28 (19,2)	146 (100)			
	p₂	0,73	0,019	0,01	-			

Table 5. Relationship between severity of anemia and socio-demographic characteristics

Categories	Factor	Severity of anemia				p ₁
		Mild	Moderate	Severe	Total	
Age	≤ 25 ans	60 (37,5)	6 (3,8)	1 (0,6)	67 (41,9)	0,7
	26-34 ans	76 (47,5)	4 (2,5)	1 (0,6)	81 (50,6)	
	≥ 35 ans	11 (6,9)	1 (0,6)	0	12 (7,5)	
	Total	147 (91,9)	11 (6,9)	2 (1,3)	160 (100)	
Marital status	Married	56 (35)	5 (3,1)	2 (1,3)	63 (39,4)	0,24
	Single	91 (56,9)	6 (3,8)	0	97 (60,6)	

Categories	Factor	Severity of anemia				p ₁
		Mild	Moderate	Severe	Total	
Level of education	Total	147 (91,9)	11 (6,9)	2 (1,3)	160(100)	0,01
	Non	0	0	1 (0,6)	1 (0,6)	
	Primary	11 (6,9)	0	0	11 (6,9)	
	Secondary	71 (44,4)	2 (1,3)	0	73 (45,6)	
	University	65 (40,6)	9 (5,6)	1 (0,6)	75 (46,9)	
	Total	147 (91,9)	11 (6,9)	2 (1,3)	160 (100)	
Religion		0,007	0,19	0,017	-	0,9
	Christain	145 (90,6)	11 (6,9)	2 (1,3)	158 (98,8)	
	Muslim	1 (0,6)	0	0	1 (0,6)	
	Other	1 (0,6)	0	0	1 (0,6)	
	Total	147 (91,9)	11 (6,9)	2 (1,3)	160 (100)	
Profession	Student (secondary)	15 (9,4)	3 (1,9)	0	18 (11,3)	0,2
	Student (University)	32 (20)	1 (0,6)	0	33 (20,6)	
	Housewife	30 (18,8)	0	0	30 (18,8)	
	Formal/Informal worker	70 (43,8)	7 (4,4)	2 (1,3)	79 (49,4)	
	Total	147 (91,9)	11 (6,9)	2 (1,3)	160 (100)	
	1 st trimestre	26 (16,3)	2 (1,3)	1 (0,6)	29 (18,1)	
Age of pregnancy	2 nd trimestre	72 (45)	3 (1,9)	1 (0,6)	76 (47,5)	0,28
	3 rd trimestre	49 (30,6)	6 (3,8)	0	55 (34,4)	
	Total	147 (91,9)	11 (6,9)	2 (1,3)	160 (100)	
Parity	Primipare	67 (41,9)	7 (4,4)	1 (0,6)	75 (46,9)	0,6
	Multipare	80 (50)	4 (2,5)	1 (0,6)	85 (53,1)	
	Total	147 (91,9)	11 (6,9)	2 (1,3)	160 (100)	

3.2 Discussion

Malaria in pregnant women is a public health problem in Cameroon since it contributes directly or indirectly to increasing maternal and perinatal morbidity and mortality. Malaria infection in pregnant women is characterized by maternal anemia. However, the importance of malaria as a major cause of anemia in pregnant women in malaria endemic areas, particularly in Cameroon, has not been fully elucidated, hence the interest of this study. The aim of this study was to evaluate the prevalence and severity of anemia in pregnant women in Biyem-Assi infected with *P. falciparum* and to determine the relationship between these and sociodemographic factors.

We found that the prevalence of malaria was 51.7% in the study population. This prevalence shows us that the susceptibility of pregnant women to malaria is well established and is not uncommon in malaria endemic areas. This result was essentially identical to the 57% prevalence obtained by Bouyou-Akotet et al. in Gabonese pregnant women with malaria [22]. We also found that the prevalence of malaria was higher in multiparous women than in primiparous women, contrary to the results obtained by

Rogerson et al. in 2007 [23] and Bouyou-Akotet et al. in 2005 [22] showing that the prevalence of malaria was higher in primigravidae than in secundigravidae and in women less than 20 years old due to a protective immunity acquired by the latter during successive malaria pregnancies. Indeed, the level of antibodies responsible for blocking the adhesion of parasitized red blood cells to the syncytiotrophoblast via Chondroitine Sulfate is low during the first pregnancies in endemic areas [24], which makes primiparous women more vulnerable to the consequences of *malaria anemia* than multiparous women. In our case, this high prevalence in multiparous women could be due to the relative state of immunity present before pregnancy and to the parasite load itself due to non-use of long lasting insecticide treated bed nets. As for the severity of malaria, this study found that severe parasitaemia levels were high in primiparous women compared to multiparous women who had moderate parasitaemia levels. This is in agreement with the results of Akanni, 2013 [25] who showed that pregnancy is a real immunological "stress" that can cause acquired immunodeficiency and unmask latent malaria or favor the occurrence of a severe form. During pregnancy, specific and non-specific defenses

are depressed. This depression is more profound in primiparous than in multiparous women. In endemic areas, multiparous women would have acquired a protective immunity during successive malaria pregnancies unlike primiparous women. This study showed that: age of the participant, marital status, education level, occupation, age of pregnancy, religion, had no influence on the prevalence and severity of malaria. Parity appeared to be the main influence on malaria prevalence. *Plasmodium* infection can cause a decrease in hemoglobin, iron and folate levels that can lead to anemia [26], or cause complications during pregnancy. Anemia in pregnant women is a major public health problem since it contributes directly or indirectly to increased maternal and perinatal morbidity and mortality.

However, the anemia rate in the general population was 53% and did not differ significantly among different groups of women (parity, age, marital status, religion, occupation, age of pregnancy). Women were slightly affected. This observation is in agreement with the UNICEF report in 2001 which indicated that 42% of all women worldwide and 52% of pregnant women in developing countries were anemic. However, this high rate could be explained by the high parasitaemia observed in most patients, since parasitaemia correlated significantly with the hemoglobin level. Although anemia rates were not significantly different between primiparous and multiparous women in this study, other studies have shown a higher rate of anemia in primiparous women compared to multiparous women, due to a protective immunity acquired by the latter during successive malaria pregnancies [23].

In addition, this study showed that *P. falciparum* infection was generally associated with anemia or reduced hemoglobin levels. In agreement with the results obtained in a study of primigravida and seondigravida in Mali, 61% of pregnant women who had a positive thick blood drop were anaemic [27]. Indeed, several mechanisms are involved in the genesis of anaemia: direct destruction of parasitized red blood cells by haemolysis, phagocytosis of parasitized or unparasitized red blood cells in the spleen, dyserythropoiesis, folate deficiency and autoimmune phenomena [28]. However, the severity of malaria was not associated with the severity of anemia. The level of school education seemed to be the main influence on the severity of anemia among pregnant women in Biyem-

Assi. Indeed, illiterate women or those with primary education had less anemia than those with secondary or higher education. This could probably be because of the low representativeness of the sample of illiterate women or women with a primary education level, and this category uses self-medication or phytotherapy. However, the severity of anemia in pregnant women with secondary or higher education is due to negligence and late treatment.

4. CONCLUSIONS AND RECOMMENDATION

4.1 Conclusions

At the end of this study, it was concluded that the prevalence of malaria and anemia among pregnant women living in Biyem-Assi was high, multiparous women were more affected by malaria than primiparous women, primiparous women infected with *Plasmodium falciparum* seemed to have a significantly higher risk of severe malaria than multiparous women, malaria in pregnant women was associated with a decrease in maternal hemoglobin levels, the severity of malaria was not associated with the severity of anemia and the severity of anemia was related to the level of school education.

4.2 Recommendations

From the study, some recommendations were proposed.

At the Ministry of Public Health and at the hospital level, more sensitization on malaria, malaria associated with pregnancy, and on gestational anemia for an effective prevention of the consequences of anemia on the fetus and the mother.

At the community level, the involvement of more informed women in the process of sensitizing less informed women in neighborhoods, households, and churches in order to reduce the prevalence and severity of malaria and anemia in pregnant women.

Researchers, scientists, and academics should conduct more studies of this nature in other regions of Cameroon, particularly in rural areas, in order to collect data on malaria, pregnancy-associated malaria, and gestational anemia, with the aim of developing and

proposing effective measures to control these diseases.

ETHICAL APPROVAL AND CONSENT

A total of two administrative/ethical authorizations were obtained: an administrative authorization from the Department of Biological Sciences. An authorization from the Ministry of Public Health was also obtained through the research directorate of the Biyem-Assi District Hospital autorisation (N° 906/AR/MINSANTE/DRSPC/ DSBA/HDBA). The study was conducted in accordance with the ethical principles of the Ministry of Public Health of Cameroon, relating to good practices in human clinical research. Subjects enrolled in the study were voluntary pregnant women who had given their informed written consent. Data were processed with strict respect for anonymity. As a motivation, the rapid diagnostic tests for hemoglobin and the thick drop were performed free of charge in all pregnant women, and the results were given to the physician.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Quintero JP, Machado Siqueira A, Tobón A, Blair S, Moreno A, Arévalo-Herrera M, Guimarães Lacerda MV, Herrera SV. Malaria-related anaemia: a Latin American perspective, Rio de Janeiro. 2011; 106(Suppl. I):91-104.
- W.H.O, Organisation Mondiale de la Santé, Rapport 2016 sur le paludisme dans le monde. WHO/HTM/GMP/2017.4, Genève, Suisse. 2016;24.
- W.H.O, OMS. Rapport 2012 sur le paludisme dans le monde. Résumé et points essentiels. 2012;178.
- Egan AF, Fabucci ME, Saul A, Kaslow D. C, Miller LH. Aotus NewWorld monkeys: model for studying malaria-induced anemia. Blood Journal of Hématologie. 2012 ;10(99).
- Nsagha Shey D, Longdoh Njunda A, Fomou Kamga H. L, Mboshi Nsagha S, Nguedia Assob JC, Shey Wiysonge C, Njih Tabah E, Kongnyu Njamnshi A. Knowledge and practices relating to malaria in Ndu community of Cameroon: Signs and symptoms, causes and prevention. Journal of Public Health and Epidemiology. 2011;3(6):294-300.
- NMCP: National Malaria Control Program. Entomological profile for malaria in Cameroon. 2010;47-59.
- MSP: Ministère de la Santé Publique du Cameroun. Plan stratégique national de lutte intégrée contre les vecteurs au Cameroun. 2010 ;94.
- Guerra CA, Howes RE, Patil AP, Gething PW, Van Boeckel TP, Temperley WH, Kabaria CW, Tatem AJ, Bui Manh H, Iqbal Elyazar RF, Baird JK, Snow RW, Hay SI. A new world malaria map: *Plasmodium falciparum* endemicity in 2010. Journal list, Malar J. 2011;10: 378.
- MSP: Ministère de la Santé Publique du Cameroun. Plan stratégique national de lutte intégrée contre les vecteurs au Cameroun. 2010;94.
- Ugwu EO, Dim CC, Uzochukwu BS, Iloghalu EI, Ugwu AO. Malaria and anaemia in pregnancy: a cross-sectional study of pregnant women in rural communities of Southeastern Nigeria. Int Health. 2014;6(2):130-7.
- Desai M, Ter Kuile FO, Nosten F, McGready R, Asamo K, Brabin B, Newman RD. Epidemiology and burden of malaria in pregnancy. The Lancet Infectious Diseases. 2007 ;7:93-104.
- Filagot Kefiyalew, Zemene E, Yaregal Asres, Lealem Gedefaw. Anemia among pregnant women in Southeast Ethiopia: prevalence, severity and associated risk factors; 2014.
- Tettamanti M, Lucca U, Gandini F, Recchia A, Mosconi P, Apolone G, Nobili A, Tallone M. V, Detoma P, Giacomini A, Clerico M, Tempia P, Savoia L, Fasolo G, Ponchio L, Della Porta M. G, Riva E. Prevalence, incidence and types of mild anemia in the elderly: the "Health and Anemia" population-based study. Hoematologica. 2010;95 (11).
- Menendez C, Ismail MR, Ordi J, Menendez C, Ventura PJ, Aponte JJ, Kahigwa E, Hirt R, Cardesa A, Alonso PL. The impact of placental malaria on gestational age and birth weight. Journal of Infectious Disease. 2000;181(5):5-1740.
- Rogerson SJ, Boeuf P. New approaches to pathogenesis of malaria in pregnancy. Parasitology. 2007;557(134):1883-1893.

16. Ndamukong-Nyanga JL, Kimbi HK, Ule Ngole Sumbele I, Lum Emmaculate, Nain Nweboh M, Nana Y, Kenneth Ndamukong Kennet JN. Socio-demographic and environmental factors influencing a symptomatic malaria and anaemia incidence among school children in Fako Division, South West Cameroon. *British Journal of Medicine & Medical Research*. 2014 ;4(20):3814-3827.
17. MSP: Ministère de la Santé Publique du Cameroun. Plan Stratégique National de Lutte contre le Paludisme au Cameroun. 2007;145.
18. Manga L, Robert V, Mess J, Desfontaine M, et Carnevale P. Le paludisme urbain à Yaoundé, Cameroun. L'étude entomologique dans deux quartiers centraux. *Mémoire de la Société Royale belge d'Entomologie*. 1992;35:155-162.
19. Tonga C, Kimbi HK, Anchang-Kimbi JK, Nyabeyeu HN, Bissemou ZB, Lehman LG. Malaria risk factors in women on intermittent preventive treatment at delivery and their effects on pregnancy outcome in Sanaga-Maritime, Cameroon. *PLoS ONE*. 2013;8(6):65876.
20. Cheesbrough M. Microscope. In: *District Laboratory Practice in Tropical Countries*. Part 1, Low price Egyptian edition 2004. The Anglo-Egyptian Bookshop & Cambridge University Press. 2004; 110.
21. Ndamukong-Nyanga JL, Kimbi HK, Sumbele NUI, Lum E, Nweboh MN. Socio-demographic and environmental factors influencing asymptomatic malaria and anaemia incidence among school children in Fako Division, South West Cameroon. *British Journal of Medical Research*. 2014; 4(20): 2814-3827.
22. Bouyou-Akotet MK, Adegnika AA, Agnandji ST, Ngou-Milama E, Kombila M, Kremsner PG, Mavoungou E. Cortisol and susceptibility to malaria during pregnancy. *Microbes Infectious*. 2005;7(11-12):23-1217.
23. Rogerson SJ, Pollina E, Getachew A, Tadesse E, Lema VM, Molyneux ME. Placental monocyte infiltrates in response to *Plasmodium falciparum* malaria infection and their association with adverse pregnancy outcomes. *Am J Trop Med Hyg*. 2003;68(1):115-119.
24. Fried M, Nosten F, Brockman A, Brabin BJ, Duffy PE. Maternal antibodies block malaria. *Nature*. 1998;395:851-852.
25. Akanni AASI. Paludisme associé à la grossesse : Conséquences immunologiques chez la femme enceinte et le nouveau-né. Thèse de doctorat en science de la vie/ immunologie. Université Paris Descartes Faculté des sciences pharmaceutiques et biologiques institut de formation doctorale. 2013;75.
26. Dondorp AM, Angus BJ, Chotivanich K, Silamut K, Ruangveerayuth R, Hardeman R, Kager PA, Vreeken J, White NJ. Red blood cell deformability as a predictor of anemia in severe falciparum malaria. *American Journal of Tropical Medicine and Hygiene*. 1999;6:733 -737.
27. Maiga H. Efficacité chez les primigestes et secondigestes de trois schémas de prophylaxie antipaludique au Mali. Thèse de médecine, Université de Bamako, Mali. 2002;123. Mc.
28. McGregor IA. Epidemiology, malaria and pregnancy. *American Journal of Tropical Medicine and Hygiene*. 1984 ;33(4):25-517.

© 2021 Ndamukong-Nyanga et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/68538>