Manuscript N°: A2-08 | Received : 11th September 2025 | Accepted in revised form 31 t October 2025

Original Article

African Annals of Health Sciences

Severe malaria in children admitted in three health facilities in the Bamenda health district, North West region of Cameroon

Nguemaïm Ngoufo F.[1,2*] Farikou Oumarou[1], Essoke Mbomo E.F.[3], Bisong Calvin E.[2], Nana G.[3], Angwafor S.[3] Nini Yesih Ngwengi [3], Chiabi A.[3]

Abstract

Introduction: Malaria is a life-threatening disease caused by parasites of genus *Plasmodium.* It is transmitted to people through the bite of infected female *Anopheles mosquito*. In Cameroon, it accounts for 25.8% of consultations in 2021, including 31.5% in children under 5, and 14.3% of deaths. The objective was to determine the epidemiological, clinical, hematological features and outcome of severe malaria in children admitted in the Bamenda Health District.

Materials and methods: We consecutively recruited from 1st March to 30th June 2021. Children from 3 months to 15 years admitted in 3 randomly selected hospitals (Regional Hospital Bamenda, Nkwen District Hospital, and Nkwen Baptist Health Centre), in the Bamenda health district, and presenting with one or more signs of severity of malaria and confirmed by malaria Rapid Diagnostic Test (RDT) and/or Thick blood smear (TBS) were enrolled in this study.

Results: Two hundred and seventeen (217) children out of 990 consulted, were admitted for severe malaria in the three health facilities; making a global prevalence of 21.91%. Males were the most represented with sex ratio of 1.5. The mean age was 69.5± 52.09 months (5.79 years). The most frequent clinical features of severity were prostration (57.60%), persistent vomiting (36.41%) and hyperpyrexia (32.72%). TBS and RDT were positive (90.50% and 96.77% of cases respectively). Ninety-eight percent of cases had a favourable outcome, lethality rate was 1.38% and no child developed neurologic sequelae. The deaths were due to post-ictal coma, severe anaemia and renal failure.

Conclusion: Severe malaria was found to affects mostly children under 5 years, with highest transmission being during rainy saison.

Keywords: severe malaria, children, Bamenda, Cameroon

Résumé

Paludisme grave chez les enfants admis dans trois formations sanitaires dans le district de sanitaire de Bamenda, région du Nord-Ouest du Cameroun

Introduction : Le paludisme est une maladie mortelle causée par des parasites du genre *Plasmodium*. Il se transmet à l'homme par la piqûre d'une femelle moustique *Anopheles* infectée. Au Cameroun, il représente 25,8 % des consultations en 2021, dont 31,5 % chez les enfants de moins de 5 ans, et 14,3 % des décès. L'objectif était de déterminer les caractéristiques épidémiologiques, cliniques et hématologiques ainsi que l'issue du paludisme grave chez les enfants admis dans le district sanitaire de Bamenda.

Matériels et méthodes : Nous avons recruté des participants de manière consécutive entre 1er mars et 30 juin 2021. Les enfants âgés de 3 mois à 15 ans admis dans 3 hôpitaux, (l'hôpital régional de Bamenda, l'hôpital de district de Nkwen et l'hopital Baptiste de Nkwen), dans le district de sante de Bamenda, et présentant un ou plusieurs signes de gravité du paludisme, et confirmés par un test de diagnostic rapide (TDR) et/ou d'une goutte epaisse (GE) ont été inclus dans cette étude.

Résultats: Deux cent dix-sept (217) enfants sur 990 consultés ont été admis pour paludisme grave dans les trois formations sanitaires ; soit une prévalence globale de 21,91 %. Les garçons étaient majoritairement représentés avec un sex-ratio de 1,5. L'âge moyen était de 69,5± 52,09 mois (5,79 ans). Les signes cliniques de gravité les plus fréquents étaient la prostration (57,60 %), les vomissements incoercibles (36,41 %) et l'hyperpyrexie (32,72 %). La GE et le TDR étaient positifs (respectivement 90,50 % et 96,77 % des cas). L'évolution était favorable dans 98 % des cas, le taux de léthalité était de 1,38 % et aucun enfant n'a développé de séquelles neurologiques. Les décès étaient dus à un coma post-critique, une anémie sévère et une insuffisance rénale.

Conclusion : Le paludisme grave touche principalement les enfants de moins de 5 ans, la transmission étant la plus forte pendant la saison des pluies.

Mots clés : paludisme grave, enfants,Bamenda, Cameroon

[1] Faculty of Health Sciences, Department of Biomedical Sciences, University of Bamenda, Cameroon,

[2] Faculty of Health Sciences, Department of Medical Laboratory Sciences, University of Bamenda, Cameroon

[3] Faculty of Health Sciences, Department of Clinical Sciences, University of Bamenda, Cameroon.

*Correspondences to : Nguemaïm Ngoufo F.;

E mail: ngflorema@yahoo.fr

What is known on this topic

- Malaria is very prevalent in Cameroon
- Malaria is frequent in children under five years old
- Malaria leies a high morbidity and mortality in children

What this study adds

- The incidence of severe malaria was 21.91% in the Bamenda health district,
- The most affected age group was 3-60 months was 69.5 months (5.8years) peak frequency of malaria is between 1 and 3 years
- Hospital outcome was good in 98.62% of the patients following appropriate and adequate treatment.

1 INTRODUCTION

Malaria is a life-threatening disease caused by parasites of genus *Plasmodium* that are transmitted to people through the bites of infected female *Anopheles* mosquitoes. In 2020, the COVID-19 pandemic emerged as a serious additional challenge to malaria responses worldwide. In 2019, there were an estimated 229 million cases of malaria compared to 228 million cases in 2018 worldwide according to WHO. The estimated number of deaths stood at 409,000 in 2019. The World Health Organization (WHO) African Region carries a disproportionately high share of global malaria burden: in 2019, the region was home to 94% of malaria cases of deaths [1].

In Cameroon, a high number of suspected cases in health care facilities varying between 3.3-3.7 million per year. In 2018, malaria accounted for 25.8% of consultations, including 31.5% in children under 5 and 14.3% of deaths with 28.4 % of children under 5 years [2].

Severe malaria is most commonly caused by the progression of an infection with *P. falciparum* to a complicated stage characterized by one or many criteria of severity [3]. Children aged under 5 years are one of the most vulnerable groups who accounted for 67% of all the malaria deaths worldwide. After birth, susceptibility to severe malaria is slightly reduced, driven by immunity conferred by the mother. Moreover, pregnant women, HIV/AIDS patients and travelers to endemic areas are also vulnerable groups; with an incidence of 86.3 % for the worldwide [4]. When an individual has been inoculated with a *Plasmodium* parasite, the following sequence may follow: infection, asymptomatic parasitaemia, uncomplicated illness, resulting insevere malaria, that may cause death and sequelae [3].

In a study conducted by Kaushik et al. [5] in India on the clinical and epidemiological profiles of severe malaria in children, out of 1,680 children, 27 cases were categorized as severe malaria. Among them, *P. vivax* was found in 24 (88.8%) and *P. falciparum* in 3 cases (11.1%). Furthermore, Medina-Morales et al. [6], in Colombia did a similar investigation and realized that 32% of patient presented respiratory distress, 12% had hepatosplenomegaly , and 4% had seizures.

Kunuanunua et al. [7] in Democratic Republic of Congo, revealed 378 children with severe malaria. The most common clinical and laboratory features found were: metabolic acidosis (85.2%), prostration (80.2%), and hepatomegaly (67%). A similar study done by Akech et al. [8] in Kenya, demonstrated that at admission, 40.6% of children had severe malaria: 45.2% had severe anemia, 29.7% with an inability to drink or breastfeed, and 19.7% had severe respiratory distress. Achidi et al. [9] in Cameroon, in a study of 971 febrile children, about half had severe malaria were severe anemia and respiratory distress were the most frequent severe clinical syndromes with 28% and 20% of cases respectively. In 2020, Chiabi et al. [10] in the Yaound, Cameroon, reported 26.15% of severe malaria cases where the most frequent signs of severity on admission were prostration (61.9%), fever with a temperature ≥ 40°C (58.0%) and convulsions (30.3%). However, the data concerning epidemiological, clinical, hematological features and outcome of severe malaria in children admitted at the the Bamenda Health District is scarce. Also, considering the impact of the disease in the paediatric population in Cameroon, we have undertaken a study on these aspects in order to help reduce infant morbidity and the mortality rate in this region of the country. Since the features of severe malaria may vary according to climatic, demographic factors, health-seeking behaviour, clinical assessment and local case management, we conducted the study, one year after the study of Chiabi et al. [10].

This was to help in depicting a better insight on the scope of this disease and in order to improve case management in line with the 3rd sustainable development goal target 3.3.

This was in accordance with the United Nations that states: “by 2030, we should end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases” [11].

The objective of the study was to determine the epidemiological, clinical, hematological features and outcome of severe malaria in children from 3 months to 15 years admitted at the Bamenda Health District, North west Region of Cameroon in order to have a baseline data on severe malaria as far as a study setting is concern.

2 MATERIALS AND METHODS

Study design, period and setting

The study was a hospital-based descriptive prospective study carried out over a period of 4

months from 1st March to 30th June 2021. The study was achieved in the paediatric units of 3 following ramdomly selected hospital in the Bamenda Health District, North West Region of Cameroon: Regional Hospital Bamenda (RHB), Nkwen District Hospital (NDH) and Nkwen Baptist Health Centre (NBHC) in order to increase considerably the sample size.

The RHB is located in the Azire Health Area, one of the 17 health areas of the Bamenda Health District. This Health District is located in an urban and semi-urban area within the High Western Plateau of Cameroon, and it is one of the 19 health districts of the North West Region. The RHB is located in Bamenda, a town known for its cool climate and scenic hilly location; it is the main referral hospital in the North West Region. It is a healthcare facility belonging to theintermediate level of the health system pyramid. This health institution comprises the following units: emergency unit, imagery centre, obstetrics and gynaecology unit, dentistry department, ophthalmology unit, tuberculosis unit, paediatric unit, physiotherapy department, eye clinic, internal medicine department, reanimation unit, surgical unit, pharmacies and laboratory. The paediatric unit is made up of 28 beds and is distributed into 3 sections: a semiprivate section (with 5 beds); two general sections (male and female with 9 beds each) and the intensive care unit hall (with 4 beds). The staff comprises 2 general practitioners, one is the head of the service and 10 nurses: 04 State-registered nurses, 01 State-enrolled midwife, 01 with a bachelor in nursing sciences, 01 with a higher professional diploma and 03 nurse assistants.

The NDH is located in the Bamenda 3 municipality. It is part of the Nkwen Health District and the Nkwen Urban Health Area. It consists of the following units: emergency unit, obstetric/gynaecological, medical and surgical units, diabetic unit, diabetic unit, dentistry department, pharmacy and a laboratory. Our study was conducted in the paediatric unit that is made up of 17 beds and 3 sections: the general ward (8 beds), 1 semi private ward with 5 beds and another semi private ward with 4 beds for neonatal hospitalizations. The staff is made up of 2 general practitioners and 7 nurses: 5 State-registered nurses, 1 with higher professional diploma in nursing and 1 assistant nurse.

The Nkwen Baptist Health Centre is a health facility of the Cameroon Baptist Convention. It is made up of the following units: emergency unit, imagery department, obstetrics and gynaecology unit, dentistry department, ophthalmology unit, tuberculosis unit, paediatric unit, physiotherapy department, internal medicine department, reanimation unit, surgical unit, eye care, HIV support group, pharmacies and laboratory. The children ward where we have conducted our study is made up of 17 beds with the following personnels: 1 paediatrician, 2 general practitioners, 14 nurses.

Study population, sampling technique and sample size

The study population was children from 3 months to 15 years admitted at the RHB, NDH and, NBHC for severe malaria. Patients were admitted into the study consecutively as they were admitted in the paediatric wards. Children admitted for severe malaria, that is presenting with one or more signs of severity of severe malaria, and confirmed by a rapid diagnostic test (RDT) and thick blood smear (TBS) were included in this study. While, children with other diseases (urinary tract infection, pneumonia and bronchopneumonia, meningitis, ear-nose-throat infection and others), associated or not to severe malaria were excluded.

The sample size was calculated using the following the Cochran formula [12].

$$\frac{Z^2 P(1-P)}{d^2}$$, where:

n = minimal sample size

Z= statistics for a level of confidence at 95% =1.96

P = 9.13% corresponding to the prevalence of malaria in children admitted in Bambui-Tubah Subdivision of the North West Region Cameroon [13].

d= decision at 5% = 0.05

$n = 1.96^2 * 0.09\,(1-0.09)/\,(0.05)^2 = 126$

Study procedure

After explanation of the aim, the procedure, the benefits and potential risks of the study, in English, French and pidgin depending on the language best understood by the parent and children of ≥ 10 years. Then we requested the assent to participate in the study. All the children presenting with one or more signs of severity of severe malaria according to the 2019 National Malaria Control Program guidelines [2] whom the parents gave their consent verbally or signed, and including the one of their children (for

children ≥ 10 years) were recruited in the study with positive RDT and/or TBS. For each patient we conducted a brief face-to-face interview and carried out a physical examination, with RDT and urine dipsick at the end of the physical examination for all the patients, in order to collect the variables of interest. All the participants were followed up until discharge and relevant variables noted during that period was recorded using a structured questionnaire: General informations of study participants: code; gender; date of birth and age; level of education of father or mother, past history of the patient involving the date of onset of symptoms, and clinical signs of severity; laboratory investigations; treatment and hospital outcome.

Criteria of severity were those from the 2019 National Malaria Control Program guidelines [2]: consciousness disorders (irritability, confusion, delirium, obnubilation, drowsiness, coma), convulsion (s), acute respiratory distress (superficial breathing,rapid breathing, chest in drawing …), persistent vomiting (hindering oral treatment), dehydration (thirsty, dry lips, sunken eyes, depressed fontanel, persistent abdominal skin pinch,absence of tears in children), severe anaemia (pallor of the palms, plantar and conjunctiva, hemoglobin level < 5g/dl or hematocrit<15%), hypoglycaemia (< 40 mg/dl or 2.2 mmol/l), jaundice), abnormal bleeding (at injection site, nose bleeding or bleeding of the gum, etc.), black urine or « coca-cola urine » (massive hemoglobinuria), extreme fatigue (the patient is unable to sit up or stand up), absent or rare urine (acute kidney failure), clinical acidosis (deep and ample respiration), high temperature > 40ºC (rectal) or 39.5°C (axillary), shock (low blood pressure, rapid and thready pulse and cold extremities), hypoclycaemia (glycaemia <40mg/dl), metabolic acidosis (serum bicarbonates <15mmol/l), severe anaemia (Hb<5g/dl or hematocrite <15%), haemoglubinuria, hyperparasitaemia (parasitemia >5% of red blood cells or >250,000/µl), serum lactate (lactate >5mmol/l), kidney failure (serum creatinine >265µmol/l).

For laboratory investigations, the patients did the following tests: malaria RDT test and urine dipstick (to rule out urinary tract infections and haemoglobinuria).

The other data for paraclinical investigations like TBS for parasite count and parasite species, full blood count, and cerebro spinal fluid (CSF) for analysis when necessary.

Treatment taken before admission was also recorded and classified as: ACT, Quinine, Arthemeter, other drugs including antibiotics, antipyretics, anti-anemic drugs. Doses of all these drugs were assessed as inadequate or adequate. Artesunate was systematically administered to all patients; in its absence or in case of allergy, arthemeter or quinine was administered. This is according to the Cameroon Guidelines for Management of Malaria [2]**.** Patients were also given adjuvant therapy according to the clinical presentation: we had antipyretics, blood transfusion, anticonvulsants, and other drugs like vogalene, exacyl, oral rehydration solution, oxygenotherapy.

For the hospital outcome, follow up was done for all the patients on treatment every day. The following vital parameters were monitored: temperature, heart and respiratory rates, neurological signs admission. Outcome was assessed as: favourable, discharge against medical advice, neurological sequalae, and death (day and the cause). The day of discharge and the duration of hospitalization were also noted. Rainfalls data were obtained from the weather station of the Regional Delegation of Transports of the North West region.

Data management and analysis

To ensure confidentiality, each questionnaire was coded. The questionnaires were verified daily to ensure the completeness of the information recorded. Statistical analysis was done using the International Business Machines Statistical Package for Social Sciences (IBM-SPSS) version 21 and Microsoft Excel 2016. The socio-demographic, clinical, laboratory characteristics and outcome were summarized using means ± SD for quantitative variables and frequencies and percentages for categorical variables. Pearson correlation was used to determine the correlation between malaria parasitemia the platelet count. Results were represented on tables and figures.

Ethical considerations

This study was carried out after approval of the Institutional Review Board of the Faculty of Health Sciences, University of Bamenda (2021/024H/Uba/IRB), authorizations were gotten from the Regional Delegation of Public Health North West, the directors of the Regional Hospital Bamenda, Nkwen District Hospital and Nkwen Baptist Health Centre.

Consent were gotten from legal guardians or parents of children. Furthermore, all participants were informed of the aims and the procedures to be used in the study. They signed a consent form and were informed of their right to back out of the study at any time and that no personal identifying information would be collected from them.

3 | RESULT

Prevalence

During our study, 263 children were enrolled, 46 children were excluded because of another disease associated to severe malaria, therefore we finally had 217 children as study population, in the four hospitals.

The frequencies of severe malaria in children in each hospital were 21.3% at RHB, 23.5% at NDH and 19.8% at NBHC (Table I). The total number of admissions during the study period was 217 admissions for severe malaria over a number of 990 admissions within the study period giving a percentage of 21.9%.

Table I. Frequency of children admitted for severe malaria in each hospital

Hospitals	Frequency of admission for severe malaria	Total frequency of admissions within the study period	Percentage of admissions (%)
RHB	118	553	21.34
*	8	341	23.46
NDH**	0	9	19.79
Total	217	990	

*Regional Hospital Bamenda, **Nkwen District Hospital, ***Nkwen Baptist Health Centre

Sociodemographic characteristics

The most represented age group was 3-60 months, that 55.8%. The mean age was 69.5 ± 52.1 months, with range from 4 to 180 months. Out of the 217 children enrolled in our study, 60% were male and 40% were female; making a sex ratio was of 1.5 (Table II).

Table II. Socio demographic characteristics of the patients

		Frequency	Percentage (%)
Se	Female	8	39.
	Male	131	60.3
	Total	**217**	**100.0**
Age groups (months)	[3-60]	121	55. 8
	]60 -120]	51	23.
	]120 -180]	45	20.7
	Total	**217**	**100.00**

Monthly distribution of cases according to pluviometry

The monthly distribution of the cases was as follows: March, 22 patients (10.1%); April, 48(22.1%); May, 61(28.1%), June 86(39.6%).

The frequency of cases was increasing was increasing as a function of rainfalls.

There was a peak of rainfalls in the month of June (203.3 mm), which explains the highest number of cases during that month (Figure 1).

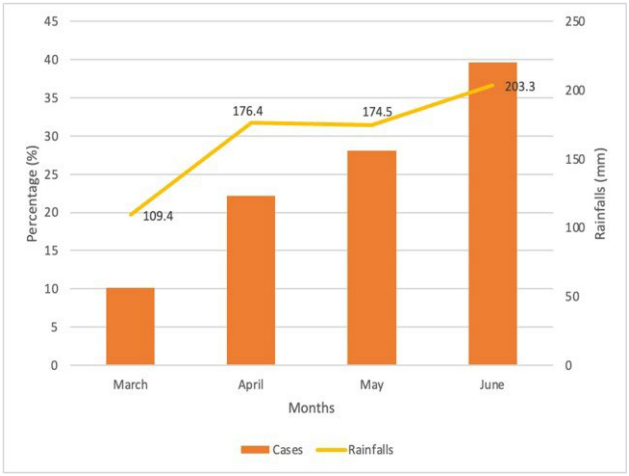

Figure 1. Monthly distribution of cases according to pluviometry

Clinical features

The main signs of severity at admission were as follows: prostration (57.6%), persistent vomiting (36.4%) and hyperpyrexia (32.7%).

The signs on physical examination that were most frequent were the signs of dehydration (26.3%), extreme pallor (14.3%) and splenomegaly (13.4%) (Table III).

The mean duration between onset of symptoms and admission was 3.2± 1.1 days, with a range of a range of 0 to 13 days

Table III. Distribution of patients according to signs of severity

	Frequency (n)	Percentage (%)
Functional signs		
Prostration	125	57.6
Persistent vomiting	79	36.4
Temperature =40°c	71	32.7
Convulsions	33	15.2
Respiratory distress	35	16.1
Bleeding disorders	30	13.8
Dark or "coca cola urine"	23	10.6
Shock	2	0.9
Altered level of consciousness	2	0.9
Absent or scanty urine	1	0.5
Signs on physical examination		
Signs of dehydration	57	26.3
Extreme pallor	31	14.3
Splenomegaly	29	13.4
Hepatomegaly	3	1.4
Jaundice	3	1.4

Distribution of cases according to thick blood smear (TBS) and rapid diagnostic test (RDT)

Out of 217 patients, 158 did TBS and 143 children had positive tests (90.5 %). Out of all the study population, a total of 96.8% had positive RDT tests. Among the children who did both RDT and TBS, 62.7% had both of them positive, 6.9% of them had only RDT positive and 3.2% of them had only TBS positive.

The species that was found on both RDT and TBS tests was Plasmodium falciparum.

The mean parasitaemia was 31,264.36 trophoz - oites/ µL with maximum 336,000 trophozoites/µL and minimum 100 trophozoites/µL.

Distribution of the patients according to the components of the full blood count

The components of FBC were white blood cell count, haemoglobin, haematocrit, MCV, MCHC, MCH, platelet count with mean values found in the table IV below. The percentage of microcytic normochromic anaemia was 25.9%.

Out of the 60 patients with thrombocytopenia, 26 (16.4%) had mild thrombocytopenia, 23(14.5%) had moderate thrombocytopenia and 11(6.9%) had severe thrombocytopenia.

Ninety-nine (62.3 %) patients had normal platelet count (Table IV). There was a decreasing platelet count as a function of the increasing parasitaemia with correlation coefficient of -0.3578.

Table IV. Variation of some components of full blood count

Components of FBC	Mean	Standard Deviation	Minimum	Maximum
White blood cells count (cells/µl)	11031.26242	21041.25	8.2	265000
Hemoglobine (g/dl)	9.8	2.576123	3.1	15.4
Hematocrit (%)	24.66878981	7.078143	6.2	41.7
MCV*(fl)	66.21719745	8.615164	45.2	88.1
MCHC**(g/l)	40.60063694	5.084434	23.6	53.2
MCH***(pg)	27.32993631	4.160705	20.5	56.4
Platelet count (cells/µl)	228,458.5987	158,295	29,000	415,000

*Mean corpuscular volume, **Mean corpuscular haemoglobin concentration, ***Mean cell haemoglobin.

Treatment

Medications taken before admission: The drugs taken before admission were ACT (18.9%), quinine (5.5%), arthemeter (3.4%) and other drugs (77.4%).

Medications taken during admission: All the patients in our study were systematically given Artesunate injectable and antipyretics (paracetamol injectable), except the 03 patients who died, they received only 2 doses of Artesunate.

Hospital outcome

The mean duration for hospitalisation was 3.6 days with 3 days as minimum and 6 days as maximum.

Out of our study population, 214 children (98.6%) had favourable outcome from the disease and 3 (1.4%) children died.

4 | DISCUSSION

The prevalence of severe malaria in the three difference hospitals during our study period was 21.9%. Our result is similar to the finding obtained by Forlack et al. [14] in two district hospitals in Cameroon (21.1%). It is different from the result obtained by Tabue et al. [15] in the NWR of Cameroon and Mutombo et al. [16] in Democratic Republic of Congo (DRC) who documented lower values of prevalence (14.6% and 19.6% respectively). It also far from the higher prevalence obtained by Chiabi et al. [10] (26.2%) and Kwenti et al. [17] in Cameroon (29.3%), Losimba et al. [18] in DRC (36.7%) and Odura et al. [19] in Ghana (45.2%). This declining pattern of severe malaria found in our

study can be explained by the efforts of the government in prevention of the disease such as the distribution of longlasting insecticidal nets. Moreover, the disparities can be attributed to the fact that our investigations were done in the different regions and in differents periods of the year.

Males were predominantly affected by the disease. The result is in conformity with the results obtained by Kwenti et al. [17] in Cameroon, Edelu et al. [20] in Nigeria and Kunuanunua et al. [6,7] in DRC. Contrary to the observations of Tchokonteu et al. [21] and Maka et al. [22] in Cameroon where females were the most affected. However, Zuk et al [23] suggested that females have better immunity to parasitic diseases, which is attributable to genetic and hormonal factors.

The majority of affected children was from 3 to 60 months of age. Our findings are in conformity in with the WHO [3] finding stating children under 5 years and pregnant women are the most predisposed to malaria. Furthermore, it is a constant result in similar studies conducted by Taylor et al. [24] in 19 endemic countries of sub-Saharan Africa and by Bassat et al. [25] in Mozambique**.** This is the reason why authors focus on children under 5years [16]. In fact, children less than five years of age, have less immunity to malaria since they may not have been exposed to falciparum malaria enough to develop sufficient level of specific acquired immunity.

The mean age was 69.5 months (5.8 years). Our result is in accordance with the estimate obtained by Kwenti et al. [17] in Cameroon. However, our finding was greater than the one of Oduro et al. [19] (18.9 months) in Ghana and lower than the one obtained by Body et al. [26] (96 months) in DRC. The disparities could be elaborated by the fact that the study populations differed in these studies.

Almost all the parents had secondary school level of education similar to the result obtained by Chiabi et al. [10] in Yaoundé-Cameroon.

The number of patients was increasing with pluviometry, with peaks in the months of May and June. This phenomenon can be illustrated by the fact that during rainy season, the parasite vector lays its eggs in breeding sites of stagnant body's water and also brings about overgrown bushes. Moisture will then accelerate the life cycle of the parasite, consequently the transmission rate.

The mean duration between onset of symptoms and admission was 3.2 ± 1.1 days. Our finding is comparable to the result of Moussa et al. [27] in Thailand**.** There exists relationship between rapid access to treatment and reduced risk of severe disease.

In order to carry out this research we made use of the Guidelines for the management of malaria in Cameroon 2019 to define the criteria of severity of the disease [2]. The most frequent clinical features were prostration (57.6%), persistent vomiting (36.4%) and hyperpyrexia (32.7%). This was almost in uniformity with the findings of Chiabi et al. [10], Geleta et al. [28] and Dongho Dongmo et al. [29].

All the children were submitted to malaria rapid diagnostic (RDT) which resulted in 96.8% of positive cases. This observation was consitent to the result obtained by Mohon et al. [30], Bharti et al. [31] and Akonte et al. [32] who demonstrated that sensitivity of RDT for *Plasmodium falciparum* ranges between 98-100% and specificity from 97-99%. These sensitivity and specificity could also be expounded by the following parameters: low parasite threshold detection, since RDT detects parasite as from 200 parasites/µl; conservation of the tests should be done at a temperature of 1-40° and tests should not be expired [21**,**33]. About 7% of children had RDT positive and Thick Blood Smear (TBS) negative and all of them were given arthemisin- based combination therapy (ACT) at home before admission. This was almost the reflection of the result obtained by Chiabi et al. [34] that is 74.4%. It was established that malaria RDT can be positive while TBS is negative (6.9% of cases); it occurs in the following situations: automedication with antimalarial drugs; low parasite density; and poorly-manufactured slides that cannot detect parasites as suggested by Payne et al. [13]. The total percentage of positive TBS was high 90.5%.

The mean parasite density was 31 , 264 . 3 trophozoites/µl with minimum of 100 and maximum of 336,000 and the species is *Plasmodium falciparum*. This finding was close to the result obtained by Utuk et al. [35] in 2014: 25.650,28 trophozoites/µl ranging from 500- 725,500 trophozoites/µl. The maximum parasite (336,000 trophozoites/µl) is according to WHO [2], a reflection of the hyperendemicity of malaria in Cameroon.

One hundred and seventy-eight (178) children did full blood count (FBC) and the mean values of the

haemoglobin, haematocrit, MCV, MCHC were respectively as follows: 9.8±2.6 g/dl; 24.7± 7.1%; 66.3± 8.6 fl; 40.6± 5.1g/dl, reflecting a mild microcytic normochromic anaemia at 25.9%. These results are different from the findings of Mabiala-Babela et al. [36] in Congo. They obtained a microcytic hypochromic anemia at 34.2% and normocytic normochromic anemia for their remaining cases. The disparities can be explained by the fact that, children less than 5 years are most likely to be affected by repeated infections with nutritional deficiency, which can lead to iron deficiency [36]. The mean hemoglobin (9.8±2.6 g/dl) was not far from the one obtained by Tchokonteu et al. [21] (8,7±2,3g/dl). We recorded thrombocytopenia as also reported by Joshi and Gamit [33] in India; and Arevalo-Herrera et al. [37] in Colombia. Kaushik et al. [5] in India demonstrated that thrombocytopenia can result from severe malaria caused by *Plasmodium vivax.*

There is a weak negative correlation between lower platelet count and parasite density ($r = -0.3578$, $p > 0.0001$) where the mean parasite density was increased as lower values of platelet count decreased as suggested Maina et al. [38] in their study in Kenya.

Most of our study population received some treatment at home before admission (Artemisin-based combination therapy (ACT), Quinine, Arthemeter) at the respective percentages: 18.9%, 5.5% and 3.4%. This finding was as contrary to the one obtained by Chiabi et al. [10] in Yaounde, where Quinine and ACT represented 23.7% and 17.8% respectively.

In our study, the mean duration of hospitalization was 3.6 days (86h 34min) with 3 days as minimum and 6 days as maximum. Chiabi et al. [10] found close results (68h52 min (2.9 days) ranging from 1h-9 days).

Hospitalisation outcome was favorable in 98.6% with 1.4% of lethality rate. There was no discharge against medical advice and no child has developed neurologic sequelae. This lethality rate was found lower than almost all the studies conducted in Africa [10**,** 13**,** 15, 18]**.** The lower lethality rate could be explained by the fact by the high index of clinical suspicion we developed with the use of national guidelines, for the diagnosis and management of severe malaria.

5 CONCLUSION

Malaria is a frequent public health problem in the Bamenda health district, affecting mostly children less than 5 years old. Severe malaria was mostfrequent during the rainy seasons during the months of May and June. Criteria of severity well elaborated by the National Malaria Control Program are fundamental to make the clinical suspicion before being confirmed by the RDT and/or microscopy.

The outcome of the disease was favourable in 98.6% of cases and a low lethality rate of 1.4%.

Preventive measures remain essential to to reduce as much as possible morbidity and mortality.

► Authors' contributions

CA, NNF: conceived and designed the study,

EMEF, AS, NYN: collected the data, analysed, interpreted the results,

NNF, FO, BCE: participated in the laboratory investigations and fieldwork,

NNF, FO, NYN, NG: drafted the original manuscript,

CA, NNF, NG, BCE, AS: critically revised the final manuscript,

All authors read and approved the final manuscript.

► Acknowledgments

We thank all participants of the Bamenda Health District who agreed voluntarily to take part of this study, the Institutional Review Board of the University of Bamenda for supporting the work. The chief of the Lab of the Regional Hospital Bamenda (Mr Fondoh Victor) whose name is not included in the author's contribution, who provided support on the project.

► Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

► Funding

This research work received no funding.

References

1. World Health Organisation 2020. WHO. World malaria report 2019. World Health Organisation . Available from: https://www.who.int/health-topics/malaria, consulted on the 20/05/2024
2. Ministry of Public Health-Republic of Cameroon. Guidelines for the management of malaria in Cameroon intended for health personel 2019. Yaounde-Cameroun; 2019.
3. World Health Organisation WHO. Severe Malaria. Trop Med Int Health. 2014;19:7-131.
4. World Health Organisation. Severe Malaria Observatory. Available from: https://www.severemalaria.org/countries/cameroon. Consulted on the 02/04/2024
5. Kaushik JS, Gomber S, Dewan P. Clinical and epidemiological profiles of severe malaria in children from Delhi, India. J Health Popul Nutr. 2012;30:113-6.
6. Medina-Morales DA, Montoya-Franco E, Sanchez-Aristizabal VDP., Machado-Alba JE, Rodríguez-Morales AJ. Severe and benign *Plasmodium vivax* malaria in Emberá (Amerindian) children and adolescents from an endemic municipality in Western Colombia. J Infect Public Health. 2016;9:172-80.
7. Kunuanunua TS, Nsibu CN, Bodi JM, Tshibola TK, Makusi Bura M, Magoga K, et al. Severe malaria in children: A descriptive report from Kinshasa, the Democratic Republic of Congo. J Trop Pediatr. 2015;61:272-8.
8. Akech S, Chepkirui M, Ogero M, Agweyu A, Irimu G, English M, et al. The clinical profile of severe pediatric malaria in an area targeted for routine RTS,S/AS01 malaria vaccination in Western Kenya. Clin Infect Dis. 2020;71:372-80.
9. Achidi EA, Apinjoh TO, Anchang-Kimbi JK, Mugri RN, Ngwai AN, Yafi CN. Severe and uncomplicated falciparum malaria in children from three regions and three ethnic groups in Cameroon: prospective study. Malar J. 2012,11:1-12.
10. Chiabi A, Djimafo ANM, Nguefack S, Mah E, Nguefack Dongmo F, Angwafo F. Severe malaria in Cameroon: Pattern of disease in children at the Yaounde Gynaeco-Obstetric and Pediatric hospital. J Infect Public Health. 2020;13:1469-72.
11. United nations. The 2030 Agenda for sustainable development. Available from: sustainabledevelopment.un.org. Consulted on the 20/05/2024
12. Winn T., Rusli B.N., Naing L. Practical Issues in Calculating the Sample Size for Prevalence Studies. Arch Orofac Sci. 2006;15:1–6.
13. Payne VK, Munjam BD, Yamssi C, Noumedem Anangmo CN. Prevalence of malaria among school children in Bambili-Tubah Sub Division, North West Region, Cameroon. J Bacteriol Parasitol. 2020,1–5.
14. Forlack ME, Abena Obama MT, Beyeme Owono M, Manga E, Same-Ekobo A, Ondoa MM, et al. Clinical presentation of severe malaria in children in two district hospitals in Cameroon. Clin Mother Child Health. 2005; 2:239–46.
15. Tabue RN, Njeambosay BA, Zeukeng F, Esemu LF, Fodjo BAY, Nyonglema P, et al. Case definitions of clinical malaria in children from three health districts in the North Region of Cameroon. BioMed Res Int. 2019:1–8.
16. Mutombo AM, Mukuku O, Tshibanda KN, Swana EK, Mukomena E, Ngwej DT, et al. Severe malaria and death risk factors among children under 5 years at Jason Sendwe Hospital in Democratic Republic of Congo. Pan Afr Med J. 2018;29:1–8.
17. Kwenti TE, Kwenti TDB, Latz A, Njunda LA, Nkuo-Akenji T. Epidemiological and clinical profile of paediatric malaria: a cross sectional study performed on febrile children in five epidemiological strata of malaria in Cameroon. BMC Infect Dis. 2017;17:1-13.
18. Losimba Likwela J, D'Alessandro U, Donnen P, Wilmet Dramaix M. Clinical aspects and outcome of suspected severe pediatric malaria. Med Mal Infect. 2012;42:315–20.
19. Oduro AR, Koram KA, Rogers W, Atuguba F, Ansah P, Anyorigiya T, et al. Severe falciparum malaria in young children of the Kassena-Nankana district of northern Ghana. Malar J. 2007;96:1–7.
20. Edelu BO, Ndu IK, Igbokwe OO, Iloh ON. Severe falciparum malariain children in Enugu, South East Nigeria. Niger J Clin Pract .. 2018; 21:1349–55.
21. Tchokoteu PF, Bitchong-Ekono C, Tietche F, Tapko JB, Same Ekobo A, Douala-Mouteng V, et

al. Severe forms of malaria in children in a general hospital pediatric department in Yaounde, Cameroon. BullSoc Pathol Exot 1990. 1999;92:153–6.

22. Maka DE, Chiabi A, Ndikum V, Achu D, Mah E, Nguefack S, et al. A randomized trial of the efficacy of artesunate and three quinine regimens in the treatment of severe malaria in children at the Ebolowa Regional Hospital, Cameroon. Malar J. 2015;14:1–9.
23. Zuk M, McKean KA. Sex differences in parasite infections: Patterns and processes. Int J Parasitol. 1996; 26:1009–24.
24. Taylor C, Namaste SML, Lowell J, Useem J, Yé Y. Estimating the fraction of severe malaria among malaria- positive children: Analysis of household surveys in 19 malaria-endemic countries in Africa. Am J Trop Med Hyg. 2021;104:1375-82.
25. Bassat Q , Guinovart C, Sigaúque B, Mandomando I, Aide P, Sacarlal J, et al. Severe malaria and concomitant bacteraemia in children admitted to a rural Mozambican hospital: Severe malaria and concomitant bacteraemia in children. Trop Med Int Health. 2009;14:1011-9.
26. Bodi J, Nsibu C, Aloni M, Lukute G, Kunuanuna T, Tshibassu P, et al. Black water fever associated with acute renal failure among Congolese children in Kinshasa. Saudi J Kidney Dis Transplant. 2014; 25:1352-7.
27. Mousa A, Al-Taiar A, Anstey NM, Badaut C, Barber BE, Bassat Q, et al. The impact of delayed treatment of uncomplicated P. falciparum malaria on progression to severe malaria: A systematic review and a pooled multicentre individual-patient meta-analysis. PloS Med. 2020; 17:e1003359.
28. Geleta G, Ketema T. Severe Malaria Associated with *Plasmodium falciparum* and *P. vivax* among Children in Pawe Hospital, Northwest Ethiopia. Malar Res Treat. 2016;1–7.
29. Dongho D, Gouado I, Pankoui Mfonkeu JB, Mbackop Kwemba V, Ngwa V, Fotso Kuate H Amvam Zollo PH. Predictors of childhood severe malaria in a densely populated area: Douala,
30. Mohon AN, Elahi R, Podder MP, Mohiuddin K, Hossain MS, Khan WA, et al. Evaluation of the OnSite (Pf/Pan) rapid diagnostic test for diagnosis of clinical malaria. Malar J. 2012;11:415.
31. Bharti PK, Silawat N, Singh PP, Singh MP, Shukla M, Chand G, et al. The usefulness of a new rapid diagnostic test, the First Response® Malaria Combo (pLDH/HRP2) card test, for malaria diagnosis in the forested belt of central India. Malar J. 2008,7:1–12.
32. Aponte JJ, Alonso P, Kahigwa E, Schellenberg D, Acosta C, Mshinda H, et al. African children with malaria in an area of intense *Plasmodium* falciparum transmission: features on admission to the hospital and risk factors for death. Am J Trop Med Hyg. 1999;61:431–8.
33. Joshi G, Gamit D. Platelet profile and its correlation to paediatric patients with acute malaria in a tertiary care hospital. Sri Lanka J Child Health. 2016;45:107-10.
34. Chiabi A., Nguefack S., Kewe I., , Mbono R., , Mah E., , Bogne JB., Bogne, et al. Case report: Massive epistaxis due to profound malaria-induced thrombocytopenia in a 16 Years old adolescent: A case report at the Yaounde Gynaeco-Obstetric and Pediatric Hospital, Cameroon. 2014;15:1–4.
35. Utuk E, Ikpeme E, Emodi I, Essien E. The prevalenceofthrombocytopenia in *Plasmodium falciparum* malaria in children at the University of Uyo Teaching Hospital, Uyo, Nigeria. Niger J Paediatr. 2013;28:41-4.
36. Mabiala-Babela J-R, Ollandzobo Ikobo LC, Nika ER, Diatewa B-G, Moyen G. Profile of severe anemia due to malaria in Congolese children. Arch Paediatr. 2015;22:325-7.
37. Arévalo-Herrera M, Rengifo L, Lopez-Perez M, Arce-Plata MI, García J, Herrera S. Complicated malaria in children and adults from three settings of the Colombian Pacific Coast: A prospective study. PloS One. 2017;12:185–200.
38. Maina RN, Walsh D, Gaddy C, Hongo G, Waitumbi J, Otieno L, et al. Impact of *Plasmodium falciparum* infection on haematological parameters in children living