

1 **Original Research Article**
2 **Epidemiology of *Plasmodium falciparum* Malaria in**
3 **the Ikata-Likoko Area of Mount Cameroon: A Cross**
4 **Sectional Study**

5 **ABSTRACT**

6 Aims: This study was aimed at evaluating socio-demographic, clinical, as well as preventive
7 measures associated with malaria parasite prevalence and anaemia in the Ikata-Likoko
8 area.

9 Study design: It was a cross-sectional survey.

10 Place and duration of study: This study was carried out in the Ikata-Likoko area of the Mount
11 Cameroon area in the South West Region, from June to July 2014.

12 Methodology: Five hundred and sixteen participants (273 females, 243 males) were included
13 in the study. Information on socio-demographic data, febrile/clinical history and malaria
14 prevention methods were recorded on a structured questionnaire. Venous blood was
15 collected for the detection of malaria parasite in Giemsa-stained blood smears and for
16 determination of haematological parameters using an electronic blood cell analyser.

17 Results: Out of 516 participants, 183 (35.5%) were positive for malaria parasite. Parasite
18 prevalence varied significantly with age ($P=.001$) where children 5-15 years were the most
19 infected (47.7%, 72). Individuals with no formal or primary education were significantly more
20 infected (38.0%, 145) than their counterparts with secondary or tertiary education ($P=.046$).
21 With respect to occupation, pupils and students (41.7%, 108) were the most infected and the
22 difference was significant ($P=.009$). Prevalence was not affected by gender and locality. The
23 overall geometric mean parasite density (GMPD) was 1967 (CI: 64-31680) parasites/ μ l of

24 blood. GMPD was significantly higher in participants from Mile 14 (21178, CI: 64-24000)
 25 than those from other localities. GMPD did not vary with gender, age, level of school
 26 attainment and occupation. Fever (48.9%, 216), (OR: 47.1, 95%CI: 15.1-71.2, $P=.00$),
 27 vomiting (1.17%; 7), (OR: 11.15, 95%CI: 1.2-107.8, $P=.04$) and anaemia (26.1%, 110), (OR:
 28 2.39, 95%CI: 1.3-3.0) were clinical factors associated with malaria parasitaemia. Individuals
 29 living in plank houses had a higher prevalence of malaria (36.3%, 182), (OR: 0.097 95%CI:
 30 0.1-0.8, $P=.03$) as well as GMPD (1943, CI: 64-31680, $P=.044$) than those in cement block
 31 houses.
 32 Conclusion: Malaria and anaemia remain high in the area. Education and the intensification
 33 of prevention strategies could reduce the prevalence.

34 **Key words:** *Malaria, Prevalence, anaemia, risk factors, preventive measures*

35 **Abbreviations:** LLINs, IPTp, IPTi, RBCs, IPT, IHC, EDTA, WBC, MP, Hb, MCV,
 36 MCH, MCHC, LRM, GMPD, SD, CI, a.s.l

37 1. INTRODUCTION

38 Malaria remains the most common parasitic disease on the globe [1]. And its burden is conspicuous in
 39 sub-Saharan Africa including Cameroon. The disease is characterized by paroxysms of fever, joint
 40 pains, headache, abdominal discomfort diarrhea, nausea and vomiting [2]. *Plasmodium falciparum* is
 41 the most pathogenic and commonest species and its infection leads to severe complications including
 42 anaemia. However, it has been reported that malaria case incidence and mortality rates have reduced
 43 by 18% and 48% respectively on a global scale during the past fifteen years [1]. As such an estimated
 44 214 million cases with 438000 deaths were reported in 2015 by the WHO [3]. In the year 2000, an
 45 estimated 262 million cases of malaria were reported globally, leading to 839000 [3]. Eighty-eight (88)
 46 percent of these cases occur in Africa with children under five and pregnant women accounting for the
 47 majority of cases. In Cameroon, between 3,400,000 and 7,500,000 cases were recorded for 5,200-
 48 14,000 deaths in 2013 [1, 3].

49 This improvement in the malaria situation is thought to be as a result of anti-malarial strategies that
 50 have been put in place by WHO and state governments including Cameroon. The measures include
 51 the free distribution of insecticide treated bed nets (lately long lasting insecticide treated bed nets
 52 (LLINs)), intermittent preventive treatment for pregnant women (IPTp) and infants (IPTi), prompt
 53 diagnosis and treatment, and the use of more effective drug combinations such as artemisinin
 54 combination therapies. Unfortunately, the strategies do not seem to have been very effective in
 55 certain communities in remote areas in South West Cameroon such as the Ikata-Likoko area. It has
 56 been reported that though ITNs and LLINs have been distributed free of charge, ownership does not
 57 necessarily imply utilisation [4]. Several factors could also influence the level of endemicity of malaria
 58 and these include climatic factors (high temperatures and rainfall) which favour the growth of malaria
 59 vector as well as poor socio-economic conditions [5], low level of education and occupation such as
 60 farming. These conditions are prevalent in the Ikata-Likoko area. The area is also plagued with bad
 61 roads and accessibility to the area is a major problem. The Ikata-Likoko area is endemic for malaria.
 62 Consequently, malaria and anaemia continue to pose a serious hindrance to well-being. Although,
 63 several varied levels of malaria prevalence have been reported in the Mount Cameroon Region [6,
 64 7,8,9,10], none has been reported in the Ikata-Likoko area and the situation needs to be ascertained.
 65 Findings from this study will be complimentary and helpful to the Ministry of Public health in the
 66 orientation of the strategies against this infection in the country and especially in areas with difficult
 67 accessibility. Against this background, the objective of this study was to determine the prevalence of
 68 malaria and evaluate the socio-demographic, clinical and preventive factors that are associated with
 69 malaria infection in the Ikata-Likoko area.

70 **2. METHODOLOGY**

71 **2.1 Study area**

72 The study was carried out in the Ikata-Likoko area which is comprised of four rural communities Ikata,
 73 Bafia, Mile 14 and Likoko of the Muyuka Health District of the Mount Cameroon region. Muyuka is
 74 located about 31km away from Buea the capital of the South West Region of Cameroon. Mile 14 and
 75 Likoko communities make up one village with a common chief, but are separated by a distance of
 76 about two kilometres. Ikata is located between longitude 9.363 to 9.352, latitude 4.329 to 4.328 and
 77 between 87m and 132m above sea level (a.s.l). Bafia is between longitude 9.324 to 9.311, latitude

78 4.350 to 4.363 and is 229m to 256m a.s.l. Mile 14 is located between longitude 9.302 to 9.292,
 79 latitude 4.396 to 4.401 and between 157m and 168m a s level. Likoko is located between longitude
 80 9.319 to 9.320, latitude 4.399 to 4.393 and is 108m to 116m a s l. Access to these villages from
 81 Muyuka is through an earth, stony road that is usually muddy and sometimes impassable in the rainy
 82 season. In the dry season, it becomes dusty and full of potholes. The topography is characterized by
 83 hills and valleys. Most of the valleys are actually riverbeds that overflow their banks in the rainy
 84 season due to very high amounts of rainfall. It is also very common to find stagnant pools of water
 85 that last for weeks, which serve as breeding sites for mosquitoes. Rainfall averages 3126.7mm
 86 annually while temperatures vary between 23°C and 33°C with an annual average of about 26.2°C.
 87 The highest temperatures are recorded during the months of February to March, while the coldest
 88 months are between June and October. Two major seasons exist in the area, the rainy (March to
 89 October) and the dry (November to February) seasons. The vegetation is mainly the tropical forest
 90 type. The main occupation here is farming with cocoa as the main cash crop. Each of the villages has
 91 a primary school. Bafia and Ikata have a secondary school and a government owned Integrated
 92 Health Centre (IHC) each. Bafia has a second health centre belonging to the Cameroon Baptist
 93 Convention. The main religion practised is Christianity. Likoko and Bafia have pipe-borne water,
 94 though not all parts of the villages are connected to it. All the villages have streams which are used by
 95 the populations for their daily needs even where tap water is available.

96 **2.2 Study population**

97 Participants in this study were inhabitants of Ikata, Bafia, Mile 14 and Likoko villages of the Muyuka
 98 Health District in the South West Region of Cameroon. Individuals above one year of age who had
 99 sojourned in the area for at least two months were consecutively included in the study. Participation in
 100 the study was totally voluntary.

101 **2.3 Study design**

102 This cross sectional survey was carried out between June and July 2014. After obtaining
 103 administrative and ethical clearances, acquaintance visits were made to the village chiefs and their
 104 quarter heads to explain the procedures, the benefits of the study and to fix appropriate dates and
 105 collection sites for the study. The village authorities informed the inhabitants about the study and the
 106 chosen dates. Informed consent forms carrying information about the procedures were issued on the

spot during the study and only those who gave their consent were admitted in the study. A structured questionnaire was used to collect data on socio-demographic, febrile/clinical factors and preventive measures. Blood samples were collected and transported to the Malaria Laboratory of the University of Buea for parasitological and haematological analyses.

2.4 Ethical approval

Ethical approval was obtained from the University of Buea Faculty of Health Sciences Institutional Review Board after an administrative authorisation had been obtained from the Regional Delegation of Public Health for the South West Region, Cameroon. Authorisation was also obtained from the village heads. Participants were informed of the procedures of the study and the potential benefits prior to seeking their consent. Assent for minors was approved by parents or legal guardians. All participants who were positive for malaria were freely treated with artesunate amodiaquin.

2.5 Administration of questionnaire

A structured questionnaire was used to collect data on socio-demography of the participants, history of febrile illness, as well as associated signs and symptoms of malaria and preventive measures practised. Socio-demographic data included age, sex, level of education, religion and occupation, while the associated signs and symptoms of malaria included headache, joint pains, vomiting and abdominal pains. Data on malaria prevention methods such as use of ITNs and LLINs, use of window nets and nature of house (plank or cement bricks) were also recorded on the questionnaire. A case report form was used to record laboratory results. Questionnaires were administered in English and exceptionally in Pidgin English where necessary.

2.6 Sample collection

Four (4) mL of venous blood sample were collected using a syringe (Cathy Yougo) into ethylenediaminetetraacetate (EDTA) anticoagulant tubes. Thick and thin blood smears were prepared from the blood samples and used for parasitological analyses as described by Cheesbrough [11]. The remainder of the blood was used for complete blood cell counts. The slides were labelled, air dried and placed in slide boxes. They were then transported with the remainder of the blood in a cool box to the Malaria Research Laboratory of the University of Buea.

2.7 Laboratory analyses

After fixing the thin smears with absolute methanol for two minutes, all the slides were stained with 10% Giemsa solution for 20 minutes, dried and observed using the x100 (oil immersion) objective of the light microscope (Olympus NY-USA). Each smear was read by two parasitologists and in case of disparity, the reading of a third parasitologist was recorded. Asexual parasites and gametocytes were counted against 200 white blood cells and counts were expressed as parasites per μL with reference to white blood cell (WBC) count from haematological analysis [11]. The thin smears were used to determine the species of *Plasmodium* by referring to an identification chart [11]. The haematological analyses were done using an electronic blood cell analyser (URIT 3300 ANALYSER) following the manufacturer's instructions. The following blood parameters were obtained: WBC count, lymphocytes, granulocytes and red blood cell (RBC) counts, haemoglobin (Hb) concentration, mean cell volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concentration (MCHC). Anaemia was defined as $\text{Hb} < 11\text{g/dL}$ [11].

2.8 Statistical analysis

Data was entered into Excel version 2013 and analysed using the IBM Statistical Package for Social Sciences (IBM SPSS) version 20 (IBM Inc. 2012). Data was summarised into proportions and means. Proportions were compared using the Cramer's V, while the Mann-Whitney U test was used to compare mean parasite densities for two groups whereas the Kruskal-Wallis H test was used to compare mean parasite densities of more than two groups. Factors that influenced malaria occurrence were determined using the logistic regression model (LRM). The level of significance was set at $P < 0.05$.

3. RESULTS

3.1 Characteristics of the study population

A total of 516 participants were sampled from the four localities (Bafia: 122, Ikata: 126, Likoko: 117, Mile 14: 151) and out of this 273 (53%) were females while 243 (47%) were males. The age range was 2 - 76 years with a median age of 19 years. Most of the participants had completed primary school (299, 57.9%) and just 3 (0.6%) had attained tertiary education. In terms of occupation, a majority of the participants (259, 50.2%) were pupils/students, while 23 (4.5%) were housewives.

163 Overall 35.5% of the participants had malaria parasitaemia with an overall geometric mean parasite
164 density (GMPD) per μL of blood of 1967(CI: 64-31680). Two hundred and sixteen (41.9%) had fever
165 while 110 (26.1 %) were anaemic (Table 1).

166 Table 1. Baseline characteristics of the study population

Characteristic	Category	Frequency/Value	Percentage (%)
Sex	Male	243	47
	Female	273	53
Age group (years)	<5	71	13.8
	5-15	151	29.3
	>15	294	57
Median age (years)		19.0	
Overall Mean temperature ($^{\circ}\text{C}\pm\text{SD}^{\text{a}}$)		37.16 $\pm$ 0.9	
<i>Plasmodium</i> prevalence		183	35.5
Overall GMPD ^b		1967 (CI: 64-31680)	
Overall mean haemoglobin (g/dL $\pm$ SD)		11.98 $\pm$ 2.99	
Overall anaemia		110 (n=422)	26.1
Overall fever		216	41.9
Highest level of school attainment	No formal education and primary	382	75
	Secondary and tertiary	134	25
Nature of house	Plank	501	97.1
	Block	15	2.9
Occupation	Semi-skilled workers	30	5.8
	Babies/children	9	1.7
	Farmers	195	37.8
	Housewife	23	4.5
	Pupils and students	259	50.2
Religion	Christianity	513	99.
	Islam	1	0.2
	None	2	0.4

167 a: standard deviation, b: Geometric Mean Parasite Density (parasite/ μL of blood)

3.2 Prevalence and density of malaria parasite with respect to socio-demographic factors

A total of 183 (35.5%) participants were infected with the malaria parasite. All malaria parasites detected (100%) were *P. falciparum*. This prevalence varied with the different demographic factors (Table 2). Although not statistically significant, more males (36.2%) were infected than females (34.8%) while the GMPD/ μ L of blood was higher in females (1989) than males (1944).

Malaria parasite prevalence varied significantly among age groups ($V=0.194$, $P=.001$) where the 5-15 years age group was the most infected (47.7%) while those aged >15 years were the least infected (27.6%). The highest GMPD/ μ L of blood was observed in the <5years age group (2478), while the least was in the >15 years age group (1640) but the difference was not statistically significant ($H=1.484$, $P=.48$) (Table 2).

Although not significant among the localities, the highest prevalence of malaria parasite was observed in participants from Mile 14 (40.4%), while the least was recorded in those from Likoko (29.9%). Conversely, the significantly highest ($H=8.46$, $P=0.04$) GMPD/ μ L of blood was observed in participants of Likoko (2574) while the least was in those from Bafia (1300) as shown in Table 2.

With respect to level of school attainment, people with no formal or with primary education had a significantly higher ($V=0.088$, $P=.046$) prevalence of malaria parasite (38.0%) than those with secondary or tertiary education (28.4%). Similarly, although not significant the GMPD was higher in those with no formal or primary education (2050) than their counterparts with secondary or tertiary education (1679).

With reference to occupation, malaria parasite prevalence was significantly highest ($V=0.162$, $P=.009$) in pupils and students (41.7%) while housewives were the least infected (8.7%). Similarly, the highest GMPD/ μ L of blood was observed among the pupils and students (2218) while the least was among farmers (1588) but the difference was not statistically significant ($H=3.101$, $P=.54$).

Participants living in plank houses (36.3%) had significantly higher ($V=0.104$, $P=0.018$) malaria parasite prevalence than those in block houses (6.7%) and in like manner, the GMPD/ μ L of blood was higher in those in plank houses ($U=3.00$, $P=0.044$).

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198 **Table 2: Prevalence and density of malaria parasite with respect to socio-demographic factors**

Characteristics	Category	Number of participants tested	Prevalence (n)	GMPD (CI)
Age group (years)	<5	71	42.3 (30)	2479 (400-24000)
	5-15	151	47.7 (72)	2191 (80-31680)
	>15	294	27.6 (81)	1640 (64-16000)
Level of significance		V=0.194, P=.001		H=1.484, P=.48
Sex	Male	243	36.2 (88)	1944 (80-31680)
	Female	273	34.8 (95)	1989 (64-16000)
Level of significance		V=0.015, P=.74		U=4014.50, P=.64
Highest level of school attainment	No formal and primary education	382	38.0 (145)	2050.39 (80-31600)
	Secondary and tertiary	134	28.4 (38)	1679 (64-16000)
Level of significance		V=0.088, P=.046		U=2679.50, P=.80
Occupation	Semi-skilled worker	30	30.0 (9)	2120 (1024-7200)
	Babies and children	9	33.3 (3)	1856 (960-6400)
	Farmers	195	31.3 (61)	1588 (80-12800)
Level of significance	Housewife	23	8.7 (2)	1600
	Pupils and students	259	41.7 (108)	2218 (64-31680)
		V=0.162, P=.009		H=3.101, P=.54
Locality	Bafia	122	33.6 (41)	1301 (80-7600)
	Ikata	126	36.5 (46)	2101 (80-31680)
	Lykoko	117	29.9 (35)	2574 (80-14400)
	Mile 14	151	40.4 (61)	2118 (64-24000)
Level of significance		V=0.081, P=.33		H=8.46, P=.04

Nature of house	Block	15	6.7 (1)	19200
	Plank	501	36.3 (182)	1943 (64-31680)
V=0.104, P=0.018				U=3.00, P=0.044

V: Cramer's V test, H: Kruskal-Wallis test; U: Mann-Whitney U test.

3.3 Clinical and risk factors associated with malaria parasite occurrence

Malaria parasite prevalence was significantly higher in people with: fever (76%, OR: 47.1, 95% CI (15.1-71.2), $P=.00$), vomiting (85.7%, OR: 11.15, 95%CI 1.15-107.81, and $P=.04$) and anaemia (50%, OR: 2.39, 95%CI: (1.25-2.99) and $P=.007$).

Although not significant, the prevalence of malaria parasite was equally higher among persons with: fever in the past few days before the survey (40.7%, OR: 1.20 CI: 0.69-2.09, and $P=.50$), fever in the past three months (40.4%, OR: 1.516, CI: 0.79-2.90, and $P=.20$), diarrhea (50%, OR: 1.28, CI: 0.08-21.58 and $P=.86$), self-medication during sickness (40.1%, OR: 1.07, CI: 0.65-1.77, $P=.78$) and those who were on herbal malaria treatment at the time of study (37.5%, OR: 0.88, CI:0.46-1.67, and $P=.7$).

3.4 Malaria prevention methods influencing malaria occurrence

As shown in Table 3 below, the prevalence of malaria was higher among people who did not use mosquito bed-nets (36.1%) than mosquito bed-nets users (36.1%) but the difference was not statistically significant (OR: 0.79, 95%CI: 0.53-1.17, and $P=.25$). Malaria parasitaemia was comparable among those who have nets on their windows (37.1%) and those who do not have (35.3%).

Table 3: Clinical factors and malaria prevention measures associated with malaria occurrence

Characteristic	Factor	Category	Number of participants tested	Prevalence of malaria (n)	OR (95% CI)	P-Value (LRM)
Clinical factors	Fever	Yes	216	76% (164)	47.1 (15.1-71.2)	.00
		No	300	6.3% (19)		
	Fever in the past few	Yes	243	40.7% (99)	1.209 (0.697-2.095)	.50
		No	273	30.8% (84)		

	days					
	Fever in the past three months	Yes	312	40.4%(126)	1.516 (0.795-2.890)	.20
		No	204	27.9% (57)		
	Self-medication during sickness	Yes	272	40.1% (109)	1.074 (0.651-1.772)	.78
		No	244	30.3% (74)		
	Headache	Yes	42	31.0% (13)	0.497 (0.211-1.167)	.11
		No	474	35.9% (170)		
	Joint pains	Yes	28	32.1% (9)	0.986 (0.379-2.569)	.98
		No	488	35.7% (174)		
	Vomiting	Yes	7	85.7% (6)	11.151 (1.153-107.811)	.04
		No	509	34.8% (177)		
	Diarrhea	Yes	2	50.0% (1)	1.279 (0.076-21.582)	.86
		No	513	35.5% (183)		
	Anaemia	Yes	110	50.0%% (55)	2.39 (1.25-2.99)	.007
		No	312	29.5% (92)		
	currently on herbal malaria treatment	Yes	56	37.5% (21)	0.881 (0.464-1.673)	.70
		No	458	35.4% (162)		
Malaria prevention methods	Sleep under mosquito bed net	Yes	243	34.6% (84)	0.793 (0.534-1.176)	.25
		No	269	36.1% (97)		
	Have mosquito net on windows	Yes	97	37.1% (36)	1.413 (0.855-2.333)	.18
		No	417	35.3% (147)		

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219 3.5 Haematological indices and malaria status

220 The haematological analyses revealed higher values of parameters in persons negative for malaria
221 than those positive except for WBC and MCHC (Table 4). Significant statistical difference was
222 however recorded only in RBC (U: 15110.0, $P<.001$) haemoglobin (U: 1564.5, $P<.001$) and
223 haematocrit (U: 15623.0, $P<.001$) values.

224 Table 4: Haematological parameters with respect to malaria status in the Ikata-Likoko area

Indices	Malaria status	N	Mean (SD)	Range	U-test <i>P</i> -value
WBC x 10 ⁹ /L	Positive	147	8.97 (4.17)	0.1-29.9	19558.00
	Negative	276	8.81 (5.30)	3.0-21.0	.54
Platelets x 10 ⁹ /L	Positive	147	192.76 (92.36)	2.0-530.0	18634.50
	Negative	275	200.17 (85.71)	18.0-500.0	.19
RBCx10 ¹² /L	Positive	146	4.18 (0.90)	1.42-9.56	15110.50
	Negative	272	4.47 (0.92)	2.03-9.00	<.001
Hb (g/dL)	Positive	147	11.38 (2.78)	4.0 -26.0	15640.5
	Negative	275	12.29 (3.04)	7.0- 28.0	<001
Hct (%)	Positive	146	34.18 (7.70)	13.0-76.0	15623.00
	Negative	272	36.77 (8.48)	21.0-85.0	<.001
MCV (fl)	Positive	146	81.98 (8.2)	58.0-109.0	18809.00
	Negative	272	82.63 (8.50)	50.0-118	.37
MCH (pg)	Positive	146	27.02 (2.61)	20.0- 35.0	19052.50
	Negative	272	27.23 (3.23)	17.0-56.0	.49
MCHC (g/dL)	Positive	146	33.04(1.30)	30.0-37.0	19279.00
	Negative	272	33.01 (1.51)	30.0-47.0	.61

226 4. DISCUSSION

227 Malaria remains endemic in several parts of the tropics despite efforts put in place by governments to
228 fight the disease. Its burden is most conspicuous among the poor populations. The measures put in
229 place seem not to be effective in all areas and so malaria and malaria related anaemia remain in high
230 prevalence in such localities.

231 The overall prevalence of malaria parasite was 35.5%. The high prevalence could be attributed to
232 among other reasons, the likelihood that measures put in place by the Cameroon Government

particularly the distribution of long lasting insecticide treated bed nets (LLINs) have not been effective in this area. The prevalence is comparable to others obtained in different studies in other rural communities in the Mount Cameroon region [10,12].

More males were positive for malaria than the females though the difference was not statistically significant. Men have the tendency of staying bare bodied as compared to women especially in places with hot weather as is the case with the Ikata-Likoko area. This finding which corroborates others [3, 10, 12, 13], could also be justified by the nocturnal farming practiced by the males who become more exposed to the malaria *Anopheles* vector which is naturally more nocturnal.

With respect to age group, children aged 5-15 years were most infected. Male children of this age group in the rural communities generally accompany their male parents in their farming process including the nocturnal farming, and so become more exposed. It is also worthy of note that the malaria burden is reported to witness a shift to individuals in age groups above five years [14, 15, 16] following measures in endemic areas such as use of insecticide treated nets (ITNs) and LLINs which earlier targeted risk groups including children less than five. Adults being the list infected in this study is in line with other studies that have reported increased anti-parasite immunity with exposure [17].

In terms of occupation, pupils and students were the most infected. Students in the rural communities indulge in several temporal economic activities including farming and petty trade during the holidays that may sometimes keep them out into the night thus exposing them to infection from *Anopheles* mosquitoes and consequently resulting to an increase in malaria prevalence in this group.

In line with the findings of Dike *et al* in Nigeria [18] and Sharma *et al* in India [19], individuals with no formal or with primary education were more infected with the malaria parasite than those with secondary or tertiary education. Higher levels of education are generally associated with improved knowledge and practices in relation to appropriate prevention and treatment strategies. Though this study did not evaluate the knowledge of the participants on malaria prevention methods, it is likely that nation-wide campaign on media related to malaria prevention has not been effective in this area.

Likoko community with the least malaria parasite prevalence had the highest parasite density. This could be linked to its lowest altitude with respect to the others, which correlates with reports from other studies [20, 21, 22, 23] which depicted higher malaria parasitaemia in lower altitudes. Nonetheless, it is likely that inhabitants here have developed anti-parasite immunity due to possible

high transmission rates associated with lower altitudes as reported by Idro *et al* [24] and Castello *et al*, [25]. On the other hand, those with lesser or no immunity within the same community suffer higher parasite densities. Lower altitudes generally have higher temperatures which relatively favour malaria parasite and vector development and hence malaria transmission intensity [26]. These parasite densities may manifest differently from one individual to another.

Observations from this study reveal significant association between fever, vomiting and anaemia with malaria. Malaria generally manifests with clinical signs including, headache, joint pains, diarrhea, vomiting, fever and anaemia. The high value of malaria associated anaemia indicates that malaria contributes to anaemia given that the value is higher than that of the overall anaemia and individuals who are negative for malaria in the study population. Though malaria generally causes fever and reduces haemoglobin and red cell indices [27, 28], these parameters could also be exacerbated by co-infections such as parasitic, viral or bacterial which were not taken into consideration in this study.

In line with the objective of using LLINs, findings in this study show a higher prevalence of malaria parasitaemia among people who do not use LLINs. LLINs prevent contact with *Anopheles* vector and eventually reduce malaria infection. They have been associated with decreased malaria burden in other endemic countries [29, 30]. Similarly, as has been reported by Nkuo-Akenji *et al* [31] and Kimbi *et al* [27] people living in plank houses were more infected than those in block houses. Plank houses unlike cement block houses may have holes on them through which the *Anopheles* vector enters the house *ad-libatum* and infects the occupants.

The higher prevalence of malaria among inhabitants having nets on their windows when compared to those without nets is unexpected since window nets are supposed to be protective against malaria infection. Nets on windows however may not serve as sufficient screens especially in an area where plank houses dominate.

The significantly lower values of RBCs, Hb and Hct in malaria infected individuals is an expected observation, given that lower Hb and red cell indices are common markers of *P. falciparum* infection [15]. These reflects the influence of the malaria parasite on haematological parameters. These findings are consistent with other studies on malaria and malaria associated anaemia [32, 33, 34].

5. CONCLUSIONS

Findings from this study depict a high prevalence of malaria with varying degrees of parasite load in the Ikata-Likoko area. Malaria parasite prevalence varied with level of education and age. It is also shown to contribute significantly to anaemia. Living in plank houses and the non-use of mosquito bed-nets are risk factors for malaria parasite occurrence. Encouraging education, use of bed-nets, and the building of cement block houses, may considerably reduce malaria and anaemia in the area.

INFORMED CONSENT

All participants gave their consent before being admitted into the study. Minors were admitted into the study only after the assent of their parents or legal guardians.

ETHICAL APPROVAL

Ethical approval was obtained from the University of Buea Faculty of Health Sciences Institutional Review Board after an administrative authorisation had been obtained from the Regional Delegation of Public Health for the South West Region, Cameroon..

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