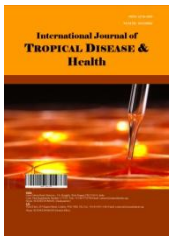

International Journal of TROPICAL DISEASE & Health

42(20): 23-35, 2021; Article no.IJTDH.78107
ISSN: 2278–1005, NLM ID: 101632866

Prevalence of Malaria and the Use of Long-lasting Insecticide Treated Bed Nets in Households of Rural and Semi-urban Communities in Mbengwi Health District, North West Region, Cameroon

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Authors' contributions

This work was carried out in collaboration among all authors. Authors RBN and MFF-conceptualization of the research topic. Authors MFF, RBN, CNWP and AND – participated in data analysis. Authors RBN and AND– supervised the research. Author RBN– wrote the original draft of the manuscript. Authors MFF, RBN, CNWP and AND– reviewed and edited the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJTDH/2021/v42i2030545

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/78107

Original Research Article

Received 08 October 2021
Accepted 16 December 2021
Published 18 December 2021

ABSTRACT

Aims: In Cameroon, on August 2011 and October 2015 the Ministry of Public Health launched the national campaign for distribution of long-lasting insecticide-treated bed nets (LLINs) to all families as a means of effectively fighting malaria transmission. The study area Mbengwi Health District found in the North West Region of Cameroon benefitted from this distribution of LLINs, but the impact of this intervention has not been evaluated. This study was designed to assess the use of LLINs in selected households of rural and semi-urban communities in Mbengwi Health District.
Study Design: A cross sectional study was conducted in households, between July 2017 to September 2017 in Mbengwi health district.
Methodology: Two questionnaires were administered; one to the household head and the other to the occupants. Blood samples were obtained to diagnose and quantify malaria parasite and to

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determine hemoglobin concentrations (HB). A total of 93 households and 440 inhabitants of all sexes and age groups were surveyed.
Results: Of the 440 participants, 49 were positive for malaria parasite giving an overall prevalence of 11.1%. From the questionnaires it was observed that 87 (93.5%) of the households owned LLINs, with up to 82 (94.3%) sleeping under the nets. All the owners of LLINs (87; 100%) obtained the nets from the government free of charge. There was no significant difference in bed-net ownership (p=0.978) and usage (p=0.664) between the rural and semi-urban communities. Malaria prevalence was significantly lower among users of LLINs (4.8%) than non-users (23.5%, p<0.001). Malaria parasite density negatively correlated significantly with HB (r= -0.097, p=0.041).
Conclusion: Overall, there was a high degree ownership and usage of LLINs by households in both rural and semi-urban communities, which was associated with protection from malaria infection.

Keywords: Long-lasting insecticide treated bed nets; malaria; Mbengwi health district; Cameroon, semi-urban; rural.

ABBREVIATIONS

HA : Health Area.
HB : Hemoglobin concentrations.
LLINs: Long-Lasting Insecticide treated bed Nets.

1. INTRODUCTION

Malaria is a life-threatening disease caused by protozoan parasite of the genus *Plasmodium*. It remains one of the main threats to public health, and economic productivity of endemic countries despite decades of control efforts [1]. As of 2020, there were over 240 million new cases of malaria worldwide and approximately 627,000 malaria deaths with the African region accounting for most global cases of malaria [2]. Malaria is a major cause of anaemia in tropical countries and severe malaria increases erythrocyte rigidity. Anaemia is an important measurement in the efficacy of anti-malarial treatment and the effectiveness of malaria control programs [3].

Malaria control interventions involving vector and parasite control are highly effective. In 2003, the WHO recommended the distribution of free LLINs to all endemic areas [4]. However, disparities in access between rural and semi-urban locations exist with rural areas found to be less accessible to malaria control interventions [5]. In Cameroon, on August 20, 2011 the Ministry of Public Health (MPH) launched the national campaign for distribution of 8,654,731 LLINs to all Cameroon families as a means of effectively fighting malaria transmission [6]. Also from October 2015-2016, the MPH organized a subsequent mass distribution of 12,193,500 LLINs covering the entire national territory in order to strengthen malaria prevention within communities in the country [7]. These increasing control efforts have led to a significant reduction in malaria prevalence and a consequent decline in morbidity and mortality in some areas. Insecticide treated mosquito nets is a key prevention tool that has been found to reduce malaria cases by 50% and decrease all-cause mortality in young children by 15%–30% in controlled efficacy trials, where coverage rates are high [8].

Mbengwi Health District found in the North West region of Cameroon has benefitted from the distribution of LLINs to be used in the fight against malaria in 2011 and 2015. Since 2011, no study attempting to evaluate the effect of this intervention nor the current disease epidemiology has been done in Mbengwi Health District and this is a serious handicap towards attempting to control the disease. This study was designed to investigate, if bed nets were available, acceptable, accessible and utilized by the households in Mbengwi Health District and if they are associated with protection from malaria.

2. METHODS

2.1 Study Population

The denizen of Mbengwi health district are “Meta” people, and a few settlers from neighboring tribes like Ngie and Oshie who have immigrated into the area. It is an agrarian community and majority of its inhabitants are farmers. Crops like palm oil, coffee, kola nuts, cassava, banana, plantain cocoyams, maize, groundnuts etc, are produced in large quantities. The proceeds from these endeavors are the main source of livelihood for most of the

inhabitants. Malaria is the most common disease in this population.

2.2 Study Site

Mbengwi is the headquarters of Momo Division in the North West Region of Cameroon. It is located 22 km from Bamenda, the regional capital of the North West Region. It is situated 6°0166700′N, 10°0000000′E and is at an altitude of 1222m (4009ft) above sea level. The climate is characterized by a long rainy season starting from March to October, and peaks in July and August, and a short dry season starting from November to February. The rainy season is the period during which farming activities are intense, because of the availability of rain water for plant growth, which also favors the development of malaria vectors. Mbengwi Health District also have some interesting touristic sites, which include the Abi waterfalls and the Catholic monastery.

Mbengwi health district has 18 health areas with a total population of 54810 people (data from Health District Service). Two of the health areas were selected for this study; Bome Health Area from the semi-urbanized settings and Munam Health Area from the rural settings (Fig. 1). Bome Health Area is situated 5°99052′N, 9°99685′E, at an altitude of 1283m above sea level and is 5km from Mbengwi health district service. It has 7 communities with a total population of 4086 inhabitants. Two communities; Ku-Bome and Funam were selected for this study because of their large population size. Munam health area is situated 6°20026′N, 10°60036′E, at an altitude of 1217m above sea level and is 18km from Mbengwi health district service. It comprises of 6 communities with a total population of 1535 inhabitants. Three communities; Sang, Munam and Tonkwen were selected for this study because of their large population sizes.

2.3 Study Design

This was a cross-sectional community-based study conducted from July to September 2017 during the rainy season, designed to assess the use of LLINs, the prevalence and the associated risk factors of malaria in households of rural and semi-urban communities in Mbengwi health district. This was achieved by selection of two health areas; one from a rural setting and the other from a semi-urban setting. Munam health area was randomly selected amongst the health areas located in rural settings and Bome health area from semi-urbanized settings, for sample collection, following the stratified random sampling technique.

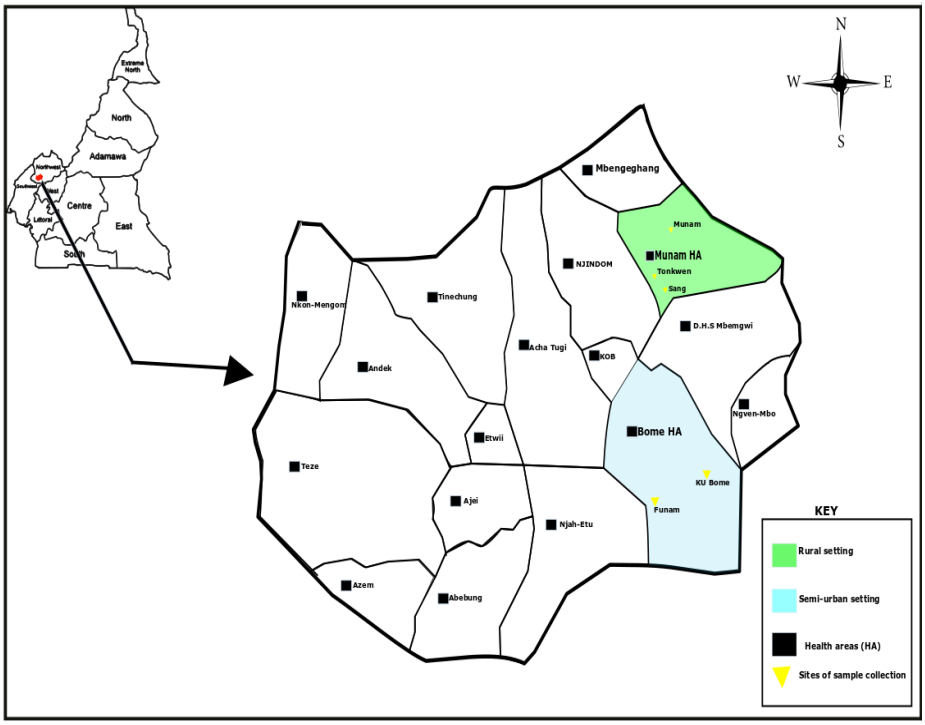

Fig. 1. Map of Mbengwi health district in Cameroon

The households recruited into the study were selected from each community making sure that at least, a child of less than 10years old was present in the home. After providing information sheets and obtaining written consent from the household head or a representative, a questionnaire was administered, to obtain information on, availability (presence and number of LLINs owned), acceptability (usage or non-usage of LLINs), accessibility (means of acquisition of LLINs), effectiveness of usage (frequency of LLINs use), method of usage (if the LLINs were correctly used), and challenges faced with LLINs usage. While socio-demographic parameters such as age, sex, occupation, level of education of household members were also obtained. Blood samples were collected from all consenting individuals of each household for malaria parasite diagnosis and determination of hemoglobin concentrations.

2.4 Sample Collection

Blood samples were collected from consenting individuals in the households. Using cotton moistened in 70% alcohol, a finger of the subject was cleaned. A sterile lancet was used to prick the finger. Two drops of blood obtained from the pricked finger was used for the thick and thin film preparation on a labeled grease free slide and allowed to air-dry. A drop of blood was also collected on a test strip already inserted in a portable HemoStart Hemoglobin screening meter (ApexBio Taiwan, as stated by the manufacturer), and hemoglobin concentrations (g/dl) was obtained after 5seconds.

2.5 Sample Processing

The air dried thick blood films were transported to the Clinical Diagnostics Laboratory of the University of Buea, stained with 10% giemsa for 20 minutes, and examined under 100x objective of microscope with oil immersion for the presence of malaria parasites. The parasite density was determined by counting the number of parasites present; >100 parasites per 200 white blood cells or <100 parasites per 500 white blood cells in a thick smear and applying the formula below to arrive at an approximate parasite count per microlitre (µL) of blood.

Parasites / µL of blood = Number of parasites counted x 8000 white blood cells/µL / No. of white blood cells counted

2.6 Data Analysis

Data from the questionnaire, laboratory diagnosis of malaria and hemoglobin measurement were entered into a template created in EpiData v 3.1. and exported into SPSS version 20 for analysis. Kolmogorov-Smirnov test was used to determine normality of the data before application of further tests. Frequency tables were used to display data on the availability, accessibility, acceptability, effective use and problems encountered with the use of LLINs and Chi square test was used to compare these data between the rural and semi urban communities. The arithmetic and geometric means were used to express intensity of parasitaemia per microlitre of blood in the rural and semi urban health area. The Chi square test was used to compare prevalence between health areas, communities, gender, age groups and those who used/did not use LLINs. The ANOVA was used to compare parasite intensities between health areas, gender, age groups and those who use/do not use LLINs. Malarial anaemia was categorized as described elsewhere [9]. Spearman's correlation was used to establish a relationship between malaria intensity and Hemoglobin concentration.

3. RESULTS

3.1 Demographic Characteristics of Study Participants

A total of 93 households with 440 participants of both sexes and all age groups were examined in 3 and 2 communities of Munam and Bome Health Areas respectively, Table 1. Of the 93 households surveyed, 46 (49.5%) were from Munam HA and 47 (50.5%) were from Bome HA. The maximum number of people residing in a single household was 12 and the minimum was 2, thus giving an average household size of six people.

3.2 Availability of LLINs

Of the 93 households surveyed in the study area, 93.5% (87) reported they had LLINs in their homes (Table 2). Specifically, of the 46 households surveyed in Munam HA, 93.5% (43) had LLINs and in Bome HA, 93.6% (44) of the 47 surveyed households had LLINs. There was no significant difference in the availability of LLINs between the two health areas (p =0.978).

Table 1. Gender and age groups of study participants

Health area	Community	Gender	Age group (%)					Total
			0-5	6-15	16-30	31-50	>50	
Munam	Munam	Males	9(27.3)	11(33.3)	5(15.2)	5(15.2)	3(9.1)	33
		Females	7(18.4)	11(28.9)	9(23.7)	3(7.9)	8(21.1)	38
		Sub-total	16(22.5)	22(31.0)	14(19.7)	8(11.3)	11(15.5)	71
	Sang	Males	13(24.5)	16(30.2)	7(13.2)	8(15.1)	9(17.0)	53
		Females	6(12.2)	14(28.6)	12(24.5)	8(16.3)	9(18.4)	49
		Sub-total	19(18.6)	30(29.4)	19(18.6)	16(15.7)	18(17.6)	102
	Tonkwen	Males	2(13.3)	10(66.7)	1(6.7)	1(6.7)	1(6.7)	15
		Females	5(35.7)	2(14.3)	2(14.3)	3(31.4)	2(14.3)	14
		Sub-total	7(24.1)	12(41.4)	3(10.3)	4(13.8)	3(10.3)	29
	Total	Males	24(23.8)s	37(36.6)	13(12.9)	14(13.9)	13(12.9)	101
		Females	18(17.8)	27(26.7)	23(22.8)	14(13.9)	19(18.8)	101
		Sub-total	42(20.8)	64(31.7)	36(17.8)	28(13.9)	32(15.8)	202
Bome	Funam	Males	16(26.2)	20(32.8)	9(14.8)	7(11.5)	9(14.8)	61
		Females	8(11.9)	17(25.4)	19(28.4)	11(16.4)	12(17.9)	67
		Sub-total	24(18.8)	37(28.9)	28(21.9)	18(14.1)	21(16.4)	128
	Ku-Bome	Males	18(43.9)	13(31.7)	4(9.8)	2(4.9)	4(9.8)	41
		Females	11(15.9)	20(29.0)	13(18.8)	14(20.3)	11(15.9)	69
		Sub-total	29(26.4)	33(30.0)	17(15.5)	16(14.5)	15(13.6)	110
	Total	Males	34(33.3)	33(32.4)	13(12.7)	9(8.8)	13(12.7)	102
		Females	19(14.0)	37(27.2)	32(23.5)	25(18.4)	23(16.9)	136
		Sub-Total	53(22.3)	70(29.4)	45(18.9)	34(14.3)	36(15.1)	238
Grand-total		Males	58(28.6)	70(34.5)	26(12.8)	23(11.3)	26(12.8)	203
		Females	37(15.6)	64(27.0)	55(23.2)	39(16.5)	42(17.7)	237
		Total	95(21.6)	134(30.5)	81(18.4)	62(14.1)	68(15.5)	440

Table 2. Availability of LLINs in Mbengwi health district

	Health Area (%)		Total (%)
	Munam	**Bome**	
No	3 (6.5)	3 (6.4)	6(6.5)
Yes	43 (93.5)	44 (93.6)	87(93.5)
Total	**46**	**47**	**93**

p =0.978

3.3 Accessibility of LLINs

On a whole, 87 households possessed bed nets, and 74.7% (65) acquired them through mass government distribution, 25.3% acquired the nets through Antenatal clinic (ANC) visit but none of the households bought the nets (Table 3). Specifically, of the 43 households that possessed bed nets in Munam HA, 79.1% (34) acquired through mass government distribution. Also of the 44 households that owned bed nets in Bome HA, 70.5% (31) acquired them through mass government distribution. There was no significant difference in the accessibility of bed nets between the two health areas (p=0.355).

3.4 Utilization of LLINs

Out of the 87 households that possessed LLINs, 94.3% (82) slept under the nets (Table 4). Base on health areas, 95.3% (41) of the 43 households in Munam HA slept under bed nets

and in Bome HA, 93.2% (41) of the 44 households that possessed bed nets, sleep under the nets. There was no significant difference in the acceptability or bed net usage between the two health areas (p=0.664).

3.5 Effective Use of LLINs

Amongst the 82 households that slept under bed nets, 80.5% (66) slept under the bed nets everyday, 18.3% (15) slept under the bed nets once in 2 days and 1.2% slept under the nets every 2 weeks (Table 5). Particularly of the 41 households that slept under bed nets in Munam HA, 82.9% (34) slept under the bed nets every day. Likewise of the 41 households that slept under bed nets in Bome HA, 78.0% (32) slept under the bed nets every day. There was no significant difference between the two health areas on how often the households slept under the bed nets (p=0.569).

3.6 Method of LLINs Usage

Of the 82 households that slept under bed nets, 74.4% (61) tucked their bed nets into the mattress when sleeping (Table 6). Of the 41 households that slept under bed nets in Munam HA, 65.9% (27) tucked their bed nets into the mattress when sleeping while in Bome HA, 82.9% (34) of the 41 surveyed households tucked their bed nets into the mattress. There was no significant difference between the two health areas on how they placed their bed nets when sleeping (p=0.077).

Table 3. Accessibility of bed nets in Mbengwi health district

	Health Area (%)		Total (%)
	Munam	**Bome**	
Community Government donation	34 (79.1)	31 (70.5)	65 (74.7)
Antenatal clinic visits	9 (20.9)	13 (29.5)	22 (25.3)
Self Purchase	0 (0.0)	0(0.0)	0 (0.0)
Total	**43**	**44**	**87**

p=0.355

Table 4. Utilization of LLINs in Mbengwi health district

	Health Area (%)		Total (%)
	Munam	**Bome**	
No	2 (4.7)	3 (6.8)	5 (5.7)
Yes	41 (95.3)	41 (93.2)	82 (94.3)
Total	**43**	**44**	**87**

p=0.664

Table 5. Frequency of LLIN utilization in Mbengwi health district

	Health area (%)		Total (%)
	Munam	**Bome**	
Everyday	34 (82.9)	32 (78.0)	66 (80.5)
After 2days	7 (17.1)	8 (19.5)	15 (18.3)
After 2wks	0 (0.0)	1 (2.4)	1 (1.2)
Total	**41**	**41**	**82**

p=0.569

Table 6. Method of LLINs usage in Mbengwi health district

	Health area (%)		Total (%)
	Munam	**Bome**	
Not tucked in mattress	14 (34.1)	7 (17.1)	21 (25.6)
Tucked in mattress	27 (65.9)	34 (82.9)	61 (74.4)
Total	41	41	82

p=0.077

3.7 Problems Encountered with the use of LLINs

Amongst the 82 households that slept under bed nets, 25.6% (21) experienced heat during sleep, 1.2% were inconvenienced during its use, 2.4% (2) had skin irritation and 70.7% (58) had no problem (Table 7). Specifically, in Munam HA of the 41 households that slept under bed nets, 24.4% (10) experienced heat during sleep, and in Bome HA, of the 41 households that slept under bed nets, 26.8% (11) experienced heat during sleep. There was no significant difference between the two health areas on problems faced with bed net usage (p=0.525).

3.8 Prevalence of Malaria Infection

Generally, the prevalence of malaria was 11.1% and it was higher in females (12.2%) than in males (9.9%) (Fig. 2), but the difference was not significant (p=0.428). Specifically, in Munam HA, out of 202 people screened, 11.4% (23) were positive for malaria parasite. In Bome HA, out of 238 people screened, 10.9% (26) were positive for malaria parasite.

The prevalence of malaria parasite in the two health areas increased from 0-5years to 6-15years, then reduced with ageing and there was no significant difference (p=0.187). The highest and lowest prevalence of malaria infection were seen in the age groups 6-15years (15.7%) and >50years (5.9%) respectively (Fig. 3). In Munam HA and Bome HA, the prevalence of malaria parasite infection in the different age groups followed same trend, with no significant difference between the age groups in the health areas (p=0.392 and p=0.451 respectively).

Table 7. Problems faced during LLINs usage in Mbengwi health district

	Health area (%)		Total (%)
	Munam	**Bome**	
Heat	10(24.4)	11(26.8)	21 (25.6)
Inconvinience	1(2.4)	0(0.0)	1 (1.2)
No problem	30(73.2)	28(68.3)	58 (70.7)
Skin irritation	0(0.0)	2(4.9)	2 (2.4)
Total	**41(100)**	**41(100)**	**82 (100)**

p=0.525

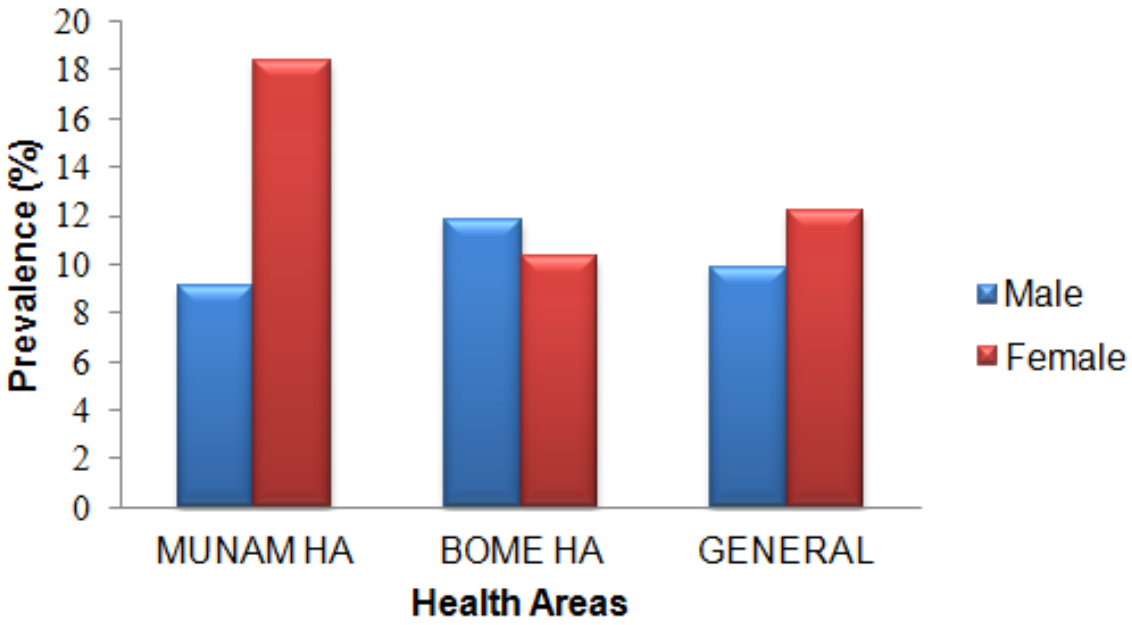

Fig. 2. Prevalence of malaria with respect to sex in the two health areas

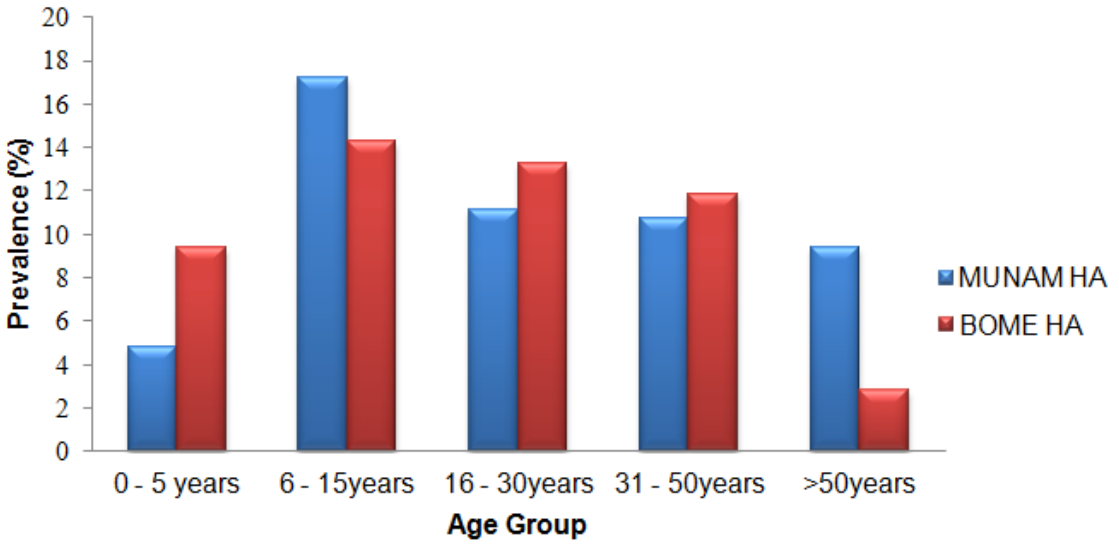

Fig. 3. Prevalence of malaria parasite in the different age groups surveyed in the two health areas

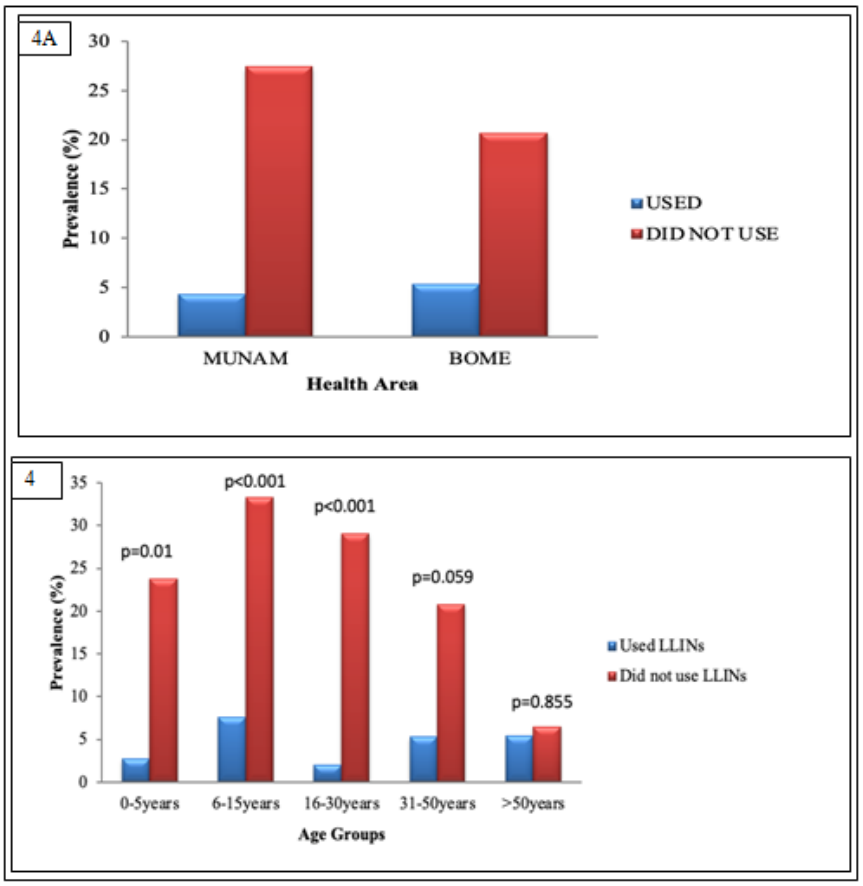

Fig. 4. Prevalence of malaria infection amongst users and non-users of LLINs in (4A) Munam and Bome health area and (4B) amongst different age groups in Mbengwi health district

Generally, in the two health areas, the prevalence of malaria parasite infection was higher in those who didn't use LLINs (23.5%) than in those who used LLINs (4.8%) (Fig. 4A) and the difference was significant (p<0.0001). The prevalence of malaria parasite infection was significantly higher among individuals who did not use LLINs in all the age groups except for age groups above 30years old, where the differences were not significant (Fig. 4B).

3.9 Intensity of Malaria Infection

The arithmetic mean intensity of malaria parasite infection was 92.32 parasite/uL of blood in Munam HA and 139.24 parasite/uL of blood in Bome HA but there was no significant difference (p=0.660) (Table 8). Also, the geometric mean intensity was 1.1221 parasite/uL of blood in Munam HA and 1.1251 parasite/uL of blood in Bome HA and the difference was not significant (p=0.802). With respect to sex, the arithmetic mean intensity of malaria infection was 193.23 parasite/uL of blood in males and 53.00 parasite/uL of blood in females, and the difference was not significant (p=0.769). While the geometric mean intensity was 1.1135 parasite/uL of blood in males and 1.1326 parasite/uL of blood in females with no significant difference (p=0.189).

The age groups, 0-5years registered the highest arithmetic mean intensity of malaria parasite infection (271.28 parasite/uL of blood) and >50years registered the lowest arithmetic mean intensity (3.06 parasite/uL of blood). There was no significant difference in the arithmetic mean intensity of malaria parasitaemia in the different age groups (p=0.370) (Table 9). The age group 5-15years registered the highest geometric mean intensity of malaria parasite infection (1.1833 parasite/uL of blood) and >50years registered the lowest geometric mean intensity (1.0569 parasite/uL of blood). There was no significant difference in the geometric mean intensity of malaria parasitaemia in the different age groups (p=0.2).

The arithmetic mean intensity of malaria infection was 9.78 parasite/uL of blood in the study participants who used LLINs and 328.55 parasite/uL of blood in the those who did not use LLINs (Table 10). While the geometric mean intensity of malaria infection was 1.0445 parasite/uL of blood in participants who used LLINs and 1.2962 parasite/uL of blood in those who did not use LLINs. There was a significant difference in both arithmetic and geometric mean intensity of malaria parasitaemia (p=0.004 and p=<0.0001 respectively) between study participants who used and did not use LLINs.

3.10 Relationship between Intensity of Malaria Infection and Hemoglobin Concentrations

A total of 180 (40.9%) of the study participants were anemic, amongst whom 25 of them were infected with malaria. Generally, there was a significant negative correlation between malaria parasitaemia intensity and hemoglobin concentration in the study population (r= -0.097, p=0.041) (Fig. 5). Specifically, there was a negative correlation between parasitaemia and hemoglobin concentration both in the participants who used and did not use LLINs (r= -0.74, n=291 and r= -0.116, n= 149 respectively) but the difference was not significant (p=0.206 and p=0.161 respectively).

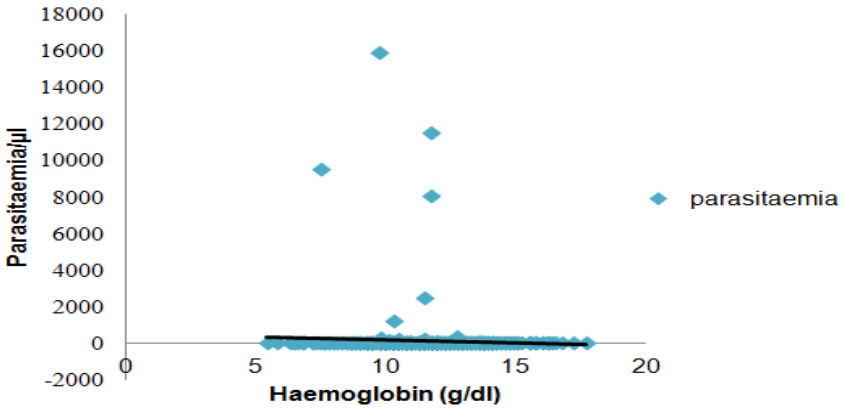

Fig. 5. Relationship between malaria parasitaemia and hemoglobin concentration in Mbengwi health district

Table 8. Intensity of malaria parasitaemia (parasite/uL of blood) from thick blood film results surveyed in the two health areas

Health area	Mean	Std. Deviation	N	Minimum	Maximum	Geometric Mean
Munam	92.32	±878.211	202	0	9560	1.1221
Bome	139.24	±1282.757	238	0	15924	1.1251
Total	**117.70**	**±1114.451**	**440**	**0**	**15924**	**1.1237**

Table 9. Intensity of malaria parasitaemia (parasite/uL of blood) from thick blood film results surveyed with respect to age groups

Age group	Mean	Std. Deviation	N	Minimum	Maximum	Geometric Mean
0 - 5years	271.28	±1896.232	95	0	15924	1.0901
6 - 15years	181.24	±1231.224	134	0	11534	1.1833
16 - 30years	13.23	±54.423	81	0	368	1.1344
31 - 50years	7.23	±30.063	62	0	208	1.1126
>50years	3.06	±16.414	68	0	128	1.0569
Total	**117.70**	**±1114.451**	**440**	**0**	**15924**	**1.1237**

Table 10. Intensity of malaria parasitaemia (parasite/uL of blood) from thick blood film results surveyed with respect to use/non use of LLINs

Use LLINs	Mean	Std. Deviation	N	Minimum	Maximum	Geometric Mean
No	328.55	±1890.741	149	0	15924	1.2962
Yes	9.73	±145.462	291	0	2480	1.0445
Total	**117.70**	**±1114.451**	**440**	**0**	**15924**	**1.1237**

4. DISCUSSION

Insecticide treated mosquito bed net is a key prevention tool that has been found to reduce malaria cases by 50% and decrease all-cause mortality in young children by 15%–30% [8]. The results of this study revealed the availability of at least one bed net in each household of 93.5% of homes in Mbengwi health district, with no significant difference between rural (Munam HA) and the semi-urban areas (Bome HA). The very high level of bed net ownership reported in this study, contradicts what was observed in 2015 in Buea health district, Cameroon, where only 47 % of households interviewed owned at least one mosquito bed net [10]. Likewise in the same locality (Buea), it was reported that ownership of LLINs was higher in semi-urban communities than rural settings [5], contrary to what was observed in Mbengwi health area. The high availability of bed nets in households of the two health areas of Mbengwi health district may stem from a more efficient method used by the health service in Mbengwi to distribute LLINs during the mass distribution of LLINs in Cameroon by making sure households in all areas (urban and rural) have equal opportunity of net ownership.

LLINs were also very acceptable by the people of Mbengwi health district, as 94.3% of the households who had the bed nets slept under them, with no significant difference between the rural and the semi-urban areas. These results confirm studies in Nkwen and Bambui, neighboring towns to the study area where a high utilization rate of 91.3% was observed amongst participants [11]. The high usage of LLINs among households in this locality may be due to public health awareness of the dangers of malaria attack in the studied population and the emphasis by the hospital staff on the importance of LLINs to reduce the prevalence of malaria during antenatal and postnatal clinics. Furthermore, the fact that there was no significant difference between semi-urban and rural areas may be due to efforts made by Mbengwi district health service, in organizing several workshops to educate the chiefs of centers and the community health workers from all the health areas on the danger of not using LLINs.

The Ministry of Public Health of Cameroon in collaboration with some funding bodies like UN, WHO and UNICEF with the intention of achieving the Sixth MDGs (Millennium Development Goals), made sure that LLINs were available and are given for free to the communities during mass distribution, to women and children during antenatal and postnatal clinic visits. In the study area, all the households who had bed nets reported to have received it at no cost (100%) either through mass government distribution or antenatal visits. This indicates that LLINs was highly accessible to the study population through the free donations despite the socio-economic differences between the two health areas. This study is contrary to that carried out in Blantyre District, Malawi, where most net owners bought their nets from a shop (70.1%) and 3.9% obtained from clinics [12]. Among the households that possessed bed net, 80.5% slept under it every day and 74.4% tucked it into the mattress when sleeping, with no significant difference between the two health areas. This is not consistent with what was observed in Nkwen and Bambui which are neighboring towns to Mbengwi health district, where only 30.4% of respondents tucked their bed nets into the mattress before sleeping. This shows that LLINs were effectively used in the study area and this offers a degree of protection against the biting of the female *Anopheles* mosquito, which is mostly at night. The main problem faced by LLINs users was heat during sleep- 70.7% of households faced no problem while 25.6% complained of heat produced by the mosquito bed nets. This is similar to what has been reported in Nkwen and Bambui, where 91.8% of respondents were comfortable with the use of mosquito nets [11]. It is also in line with the observation that discomfort; primarily due to heat was the most widely identified reason (47.5%) why mosquito net owners chose not to use a mosquito net on one or more nights [13].

Malaria was ranked as one of the most frequently occurring diseases in Mbengwi health district as reported by the Mbengwi Health District Services. As a result of concerted intervention strategies, malaria transmission in endemic areas has been declining in the last decade, in line with a cumulative drop in the incidence of malaria cases worldwide (WHO, 2016). However, this study revealed an overall prevalence of 11.1%. These results are consistent with the 13.4% prevalence reported among pregnant women in Buea health district, Cameroon [14], but are slightly higher than the 6.09% prevalence observed in Nkwen and Bambui, which are neighboring towns to Mbengwi health district [11]. The higher prevalence in this study was probably due to the fact that the field studies were carried out during the rainy season when

malaria transmission is at its maximum. The mean malaria parasite intensity was highest in the age group 0-5years, which could be due to the absence of natural acquired immunity against malaria. This study also revealed that malaria prevalence and intensity was significantly higher in non-users than users of LLINs ($p<0.0001$) and significantly higher among individuals who did not use LLINs in all the age groups except for the age groups above 30years old. This confirms the report of Henry et al. [15,16], on the use of LLINs as a means to reduce the lethal impact of malaria. There was no significant difference in the prevalence of malaria parasite between those who used and did not use LLINs in age groups above 30years, which may indicate that, immunity against the infection increases with age irrespective of use of LLINs.

5. CONCLUSION

In conclusion, Mbengwi health district is an example of a locality where LLINs have been used to drastically reduce the burden of malaria, but there is need for additional strategies, to move towards elimination of malaria.

CONSENT

Participation in the study was voluntary and Individuals who accepted to take part in the study signed a consent form, while consent was gotten from guardians of children. Each study participant was aware he/she could withdraw from the study at any point in time.

ETHICAL APPROVAL

Ethical clearance for this study was obtained from the Faculty of Health Sciences- Institutional Review Board of the University of Buea (Ref: 2017/042/UB/SG/IRB/FHS). Administrative authorizations were obtained from the Regional Delegation of Public Health for the North West Region (Ref: 517/NWR/RDPH) and from the District Chief of Service for Mbengwi Health District (Ref: 21/MIN/RDPHNW/DHS).

ACKNOWLEDGEMENT

The authors are grateful to the people of Mbengwi for their participation in this study and to Mr. Fuanyi Awatboh who drew the map of the study area.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sarma N, Patouillard E, Cibulskis RE, Arcand JL. The economic burden of malaria: Revisiting the evidence. Am J Trop Med Hyg. 2019;101(6):1405-1415. DOI: 10.4269/ajtmh.19-0386.
2. World Malaria Report 2021: An in-depth update on global and regional malaria data and trends; 2021. Available:https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2021
3. Lee SJ, Stepniewska K, Anstey N, et al. The relationship between the haemoglobin concentration and the haematocrit in *Plasmodium falciparum* malaria. Malar J. 2008;7:149. Published 2008 Aug 2. DOI: 10.1186/1475-2875-7-149
4. World Health Organization. Malaria Control Unit, UNICEF. The Africa Malaria Report 2003. Geneva: World Health Organization; 2003.
5. Apinjoh T, Anchang-Kimbi K, Mugri N, Tangoh A, Nyingchu V, Chi F, et al. The effect of Insecticide Treated Nets (ITNs) on *Plasmodium falciparum* infection in rural and semi-urban communities in the South West region of Cameroon. Plos One. 2015;10(2). Available:https://doi.org/10.1371/journal.pone.0116300 PMID: 25714837
6. Boussougou-Sambe ST, Awono-Ambene P, Tasse GC, Etang J, Binyang JA, Nouage LD, et al. "Physical integrity and residual bio-efficacy of used LLINs in three cities of the south-west region of Cameroon 4 years after the first national mass-distribution campaign," Malar J. 2017;16(1):31. DOI: 10.1186/s12936-017-1690-6.
7. Minsante. XIième Journée mondiale de lutte contre le paludisme "prêt à vaincre le paludisme" Nous sommes la génération qui peut éliminer le paludisme. Dossier de Presse. Minsante. 2018:1–20.
8. Hill J, Lines J, Rowland M. Insecticide-treated nets. Adv Parasitol. 2006;61:77-128. DOI: 10.1016/S0065-308X(05)61003-2. PMID: 16735163.
9. Mensah-Brown HE, Abugri J, Asante KP, et al. Assessing the impact of differences in malaria transmission intensity on clinical and haematological indices in children with malaria. Malar J. 2017;16(1):96. Published 2017 Mar 1.

DOI: 10.1186/s12936-017-1745-8.

10. Kimbi HK, Nkesa SB, Ndamukong-Nyanga JL, Sumbele IU, Atashili J, Atanga MB. Socio-demographic factors influencing the ownership and utilization of insecticide-treated bed nets among malaria vulnerable groups in the Buea Health District, Cameroon. BMC Res Notes. 2014;7:624. Published 2014 Sep 10.
DOI: 10.1186/1756-0500-7-624.
11. Ntonifor NH, Veyufambom S. Assessing the effective use of mosquito nets in the prevention of malaria in some parts of Mezam division, Northwest Region Cameroon. Malar J. 2016;15(1):390. Published 2016 Jul 26.
DOI: 10.1186/s12936-016-1419-y.
12. Holtz TH, Marum LH, Mkandala C, Chizani N, Roberts JM, Macheso A, Parise ME, Kachur SP. Insecticide-treated bednet use, anaemia and malaria parasitaemia in Blantyre district, Malawi. Trop Med Int Health. 2002;7(3):220-30.
DOI: 10.1046/j.1365-3156.2002.00846.x.
PMID: 11903984.
13. Pulford J, Hetzel MW, Bryant M, Siba PM, Mueller I. Reported reasons for not using a mosquito net when one is available: A review of the published literature. Malar J. 2011;10:83. Published 2011 Apr 11.
DOI: 10.1186/1475-2875-10-83.
14. Fokam EB, Ngimuh L, Anchang-Kimbi JK, Wanji S. Assessment of the usage and effectiveness of intermittent preventive treatment and insecticide-treated nets on the indicators of malaria among pregnant women attending antenatal care in the Buea Health District, Cameroon. Malar J. 2016;15:172. Published 2016 Mar 17.
DOI: 10.1186/s12936-016-1228-3.
15. Henry M-C, Assi S-B, Rogier C, Dossou-Yovo J, Chandre F, Guillet P, Carnevale P. Protective efficacy of lambda-cyhalothrin treated nets in Anopheles gambiae pyrethroid resistance areas of Côte d'Ivoire. Am J Trop Med Hyg. 2005;73:859–864. [PubMed] [Google Scholar]
16. Pryce J, Richardson M, Lengeler C. Insecticide-treated nets for preventing malaria. Cochrane Database Syst Rev. 2018;11(11):CD000363. Published 2018 Nov 6.
DOI: 10.1002/14651858.CD000363.pub3.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/78107