Effects of long-lasting insecticide net (LLINs) ownership/ utilisation indicators on annual household malaria episodes (AHMEs) in Bamenda, Santa and Tiko Health Districts in Cameroon

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ABSTRACT

Introduction: Household residents in malaria endemic areas are at high risk of multiple malaria episodes per year. This study investigated the annual household malaria episodes (AHMEs) in three health districts in Cameroon.

Methods: A community-based cross-sectional household survey using a multi-stage cluster design was conducted 2 – 3 years post campaign to assess long-lasting insecticide net (LLINs) ownership, utilisation and maintenance as well as demographic characteristics. Multinomial regression analysis was used to identify factors associated with household LLIN ownership, utilization and AHME.

Results: Household LLINs ownership, *de facto* population with universal utilisation and AHME were respectively, 92.5%, 16.0% and 83.4%; thus, 4 out of 25 household residents effectively used LLINs the previous night. AHME was significantly ($p < 0.05$) associated with age and gender (OR; 1.6, 95% C.I; 1.1 – 2.3) of household head, health district (OR; 2.8, 95% C.I; 1.1 – 7.2) and tiredness (OR; 2.6, 95% C.I; 1.0 – 6.3). LLINs ownership and insufficiency also significantly contributed AHME. The overall average cost for the treatment of malaria was 6,399.4±4,892.8Fcfa (11.1±8.5US$).

Conclusions: The proportion of households with at least one LLIN and those with at least one AHME were high. Findings are of concern given that average cost for the treatment of malaria represents a potentially high economic burden. The results outlined in this paper provide an important tool for the examination of the deficiencies in LLINs regular and universal utilisation.

Keywords

Annual household malaria episodes (AHME), Ownership, Universal coverage, Utilisation

INTRODUCTION

Studies have identified the factors influencing the ownership and utilisation of long-lasting insecticide nets (LLINs) [1-9] in and out of Cameroon. The utilisation rate of LLINs, especially amongst children less than five years old and pregnant women are widely low [2, 3, 10]. In malaria-endemic countries, malaria rates are still high, especially amongst the vulnerable population [11]. Malaria is a preventable and curable disease transmitted by the bites of female Anopheles mosquitoes [11, 12] and a serious global public health problem with an estimated 216 million cases in 91 countries in 2016 [12-15]. 90% of all worldwide estimated malaria cases and 91% of deaths in 2016 occurred in 15 African countries alone contributing 80% of all cases [11, 13]. The prevalence of malaria is 29% [16] and 15.0% in the North West and 46.1% in the South West Region amongst children under five in Cameroon [17].

The determinants of LLINs ownership, coverage, accessibility and utilisation are multiple and their contributions vary according to geographical location, sample size and season of study [1, 8, 18-20]. Indicators of LLINs ownership and utilisation involve differences between health districts/ localities, socio-demographic and economic statutes [10, 21, 22].

The effective utilisation of LLINs has been reported to be invariably associated with ownership [4, 23], although annual household malaria episodes (AHME) is not primarily related to LLINs ownership. It is thought that poor LLINs utilisation by mostly the vulnerable is mostly due to behavioural attitudes of the population [6, 7, 24], while the persistence of malaria is due in part to, underutilisation of LLINs, other preventive methods and negligence as well as vector resistance.

Studies in Cameroon and beyond have shown consistently that malaria is, and remains a public health problem [10, 15, 17]. Thus in this study, the question is, “In health districts with high malaria endemicity and high LLINs ownership, what is the proportion and determinants of AHME, 2 – 3 years after the mass distribution campaign (MDC)?”.

MATERIALS AND METHODS

Study area

The study was carried out in BHD, SHD and THD which constitute part of the most impoverished populations in Cameroon. These health districts are located in the North West and South West Regions of Cameroon. The characteristics of the study area have been described elsewhere [25].

Sampling design

This study is part of a prospective cross-sectional survey carried out in the THD in July and June 2017 and in Bamenda and Santa Health Districts in March to May 2018 [25].

Sample size determination

A minimum sample size of 385 for each health district was calculated with the assumption that 50% of households suffered at least one AHME in the past one year and with 95% confidence interval, with an acceptable margin of error for proportion being estimated to be 0.05 [26].

Recruitment procedures and measures

At enrolment, a structured questionnaire was used to record ownership of LLINs, utilisation of LLINs and socio-demographic characteristics as well as housing and AHMEs.

Outcome variables

The main LLIN outcome variables were;

1. **LLINs ownership indicators**: *LLINs ownership*: proportion of households with at least one LLIN, where the numerator comprises the number of households surveyed with at least one LLIN and the denominator, the total number of households surveyed [9]. *Coverage*: proportion of households with at least a LLIN for every two people, where the numerator comprises all households where the ratio between number of LLINs owned and the number of *de jure* members of that household, that is, usual members excluding visitors, is 0.5 or higher

and the denominator is the total number of sampled households. *Access to LLINs within the household*: proportion of population with access to LLINs (population that could sleep under a LLIN if each LLIN in the household were used by up to two people) and proportion of the *de facto* household population that slept under a LLIN last night. *De facto* household members are all people present in the household on night of the survey including visitors [27-29].

2. **LLIN utilisation indicators**: *Household universal utilisation*: proportion of population that slept under a LLIN the previous night [27-29]. *By the vulnerable population in the household*: proportion of children under five (or pregnant women) that slept under a LLIN the previous night [27]. *Regularly sleeping under bed nets*: household heads who reported habitually using nets on a daily basis [30]. *Household head slept under a LLIN last night*: proportion of households in which the household head slept under a LLIN last night, where the numerator comprises the number of households surveyed wherein the household head slept under a LLIN last night and the denominator, the total number of households surveyed.
3. **Annual household malaria episodes (AHME)**: proportion of households which experienced at least one malaria episode in the last one year, where the numerator comprises the number of households surveyed wherein at least one household member suffered a malaria attack and the denominator, the total number of households surveyed.
4. **Independent variables** considered for association with LLIN ownership, use and AHME were age, gender, marital status, education, occupation, health district, house type and household composition.

Statistical analysis

Data were analysed with IBM-SPSS Statistics 21.0 for windows (IBM-SPSS Corp., Chicago USA). The Chi square (χ^2) test was used to compare socio-demographic characteristics with the AHME and multivariate logistic regression to identify significant correlates of the main outcomes. The level of statistical significance was set at $p < 0.05$.

Ethics statement

The study, obtained approval from the Institutional Review Board of the Faculty of Health Sciences, University of Buea (Nº: 624-05). Administrative authorisation was obtained from the South West Regional Delegation of Public Health. Written informed consent was obtained from all participants and confidentiality was maintained at all steps of data collection.

RESULTS

Characteristics of study participants

A total of 1,251 household heads were surveyed, in the three health districts. The mean (±SD) age of study participants was 36.1 ±10.8, while the overall mean (±SD) household size was 4.7 ±2.1 members: 4.6 ±2.2 in BHD, 4.5 ±1.7 in SHD and 5.0 ±2.5 in THD. The overall mean AMHE was 2.2 ±1.7: 3.1 ±1.8 in BHD, 1.4 ±1.1 in SHD and 2.0 ±1.5 in THD. There was a significant association between AHME and house type as well as health district. Most (68.0%) households were headed by females, while majority (54.8 %) of the respondents were married. About 37.6% of the study participants had attained at least secondary education and only 9.3% had no formal education (NFE). The greater percentage (35.3%) of the respondents was realised to be doing unskilled labour. AHME was frequent (89.2%) in households with surrounding bushes/ farms or water pools (Table 1). Pregnant women were recorded in 93 (7.43%) of the households and children under the age of five in 766 (61.23%) of the households. Of the 5,870 individuals (*de facto* population) covered in the study, 4,908 (82.2%) spent the night in the 1,043 households which had suffered at least an AHME.

Table 1: Socio-demographic characteristics: by AHME

	Dependent variable:	**AHME**				
Independent variable	**Subclass**	**No**	**Yes**	***n* (%)**	***p* value**	**OR (95% C.I.)**
Age groups (in years)	20	13	17	30 (2.4)	**< 0.001**	0.2 (0.1 - 0.4)
	21 – 30	81	377	458 (36.6)	0.233	0.7 (0.4 - 1.2)
	31 – 40	54	308	362 (28.9)	0.620	0.9 (0.5 - 1.5)
	41 – 50	32	186	218 (17.4)	0.935	1.0 (0.6 - 1.8)
	51 – 60	28	155	183 (14.6)	Ref	1.0
	Mean age	34.9±11.4	36.4±10.6	36.1±10.8		
Gender	Females	135	716	851 (68.0)	0.057	1.4 (1.0 - 2.0)
	Males	73	327	400 (32.0)	Ref	1.0
Marital status	Unmarried	102	463	565 (45.2)	0.464	1.1 (0.8 - 1.6)
	Married	106	580	686 (54.8)	Ref	1.0
Education	NFE	13	103	116 (9.3)	0.476	1.3 (0.6 - 2.6)
	Primary	62	308	370 (29.6)	0.215	1.3 (0.8 - 2.1)
	Secondary	83	387	470 (37.6)	0.624	1.1 (0.7 - 1.7)
	Tertiary	50	245	295 (23.6)	Ref	1.0
Occupation	Unemployed	48	151	199 (15.9)	0.728	1.2 (0.5 - 2.5)
	Agricultural	18	173	191 (15.3)	0.337	0.7 (0.3 - 1.5)
	Household & domestic	6	49	55 (4.4)	0.283	1.8 (0.6 - 5.7)
	Unskilled	79	362	441 (35.3)	0.873	1.1 (0.5 - 2.2)
	State/ Parastatal	43	173	216 (17.3)	0.871	1.1 (0.5 - 2.3)
	Professional	14	135	149 (11.9)	Ref	1.0
House type	Caraboat	10	74	84 (6.7)	0.205	1.6 (0.8 - 3.4)
	Mixed	21	86	107 (8.6)	0.286	1.3 (0.8 - 2.3)
	Mud Block	35	221	256 (20.5)	**0.043**	1.6 (1.0 - 2.5)
	Cement Block	142	662	804 (64.3)	Ref	1.0
House size	1 - 3 bedrooms	190	951	1,141 (91.2)	0.801	1.1 (0.6 - 1.9)
	4 - 7 bedrooms	18	92	110 (8.8)	Ref	1.0
	Mean number of bedrooms	1.9±1.1	2.0±1.1	2.0±1.1		
Environmental factor	No	21	114	135 (10.8)	0.329	0.8 (0.4 - 1.3)
	Yes	187	929	1,116 (89.2)	Ref	1.0
Family size	1 – 4 members	103	519	622 (49.7)	0.620	1.1 (0.7 - 2.0)
	5 – 7 members	83	413	496 (39.6)	0.768	1.1 (0.6 - 1.9)
	≥ 8 members	22	111	133 (10.6)	Ref	1.0
	Mean family size	4.6±2.2	4.7±2.1	4.7±2.1		
Health District	Bamenda	29	419	448 (35.8)	**< 0.001**	4.5 (2.5 - 8.2)
	Santa	98	287	385 (30.8)	**0.014**	0.6 (0.4 - 0.9)
	Tiko	81	337	418 (33.4)	Ref	1.0
	Total	**208**	**1,043**	**1,251**		

OR = Odds Ratio; C.I. = Confidence Interval; Ref = Reference group; Boldface numbers indicate significant *p* values

Ownership and utilisation of LLINs

A total of 2,958 LLINs were enumerated in the three health districts, overall LLINs density of 2.4 ±1.4. LLINs ownership, coverage and accessibility were 92.5%, 66.7% and 69.1%

respectively. The utilisation rates were 14.6% for children less than five years old, 4.7% for expectant mothers and 16.0 % for entire households.

Table 2: Indicators of LLINs ownership/ utilisation and AHMEs

	Households						*De facto* population in households			
Indicator	***n* (%)**	**BHD**	**SHD**	**THD**	**χ^2**	***p* value**	***n* (%)**	**BHD**	**SHD**	**THD**
Ownership										
At least one LLIN	1,157 (92.5)	418	367	372	12.23	**0.002**	5,577 (95.0)	2,000	1,680	1,897
Coverage	836 (66.8)	387	214	235	120.46	**< 0.001**	3,913 (66.7)	1,893	937	1,083
Accessibility	865 (69.1)	374	214	277	77.97	**< 0.001**	4,058 (69.1)	1,825	937	1,296
Utilisation by										
Entire household	256 (20.5)	193	4	59	238.94	**< 0.001**	942 (16.0)	767	10	165
Children 0- 5 years	520 (41.6)	250	103	167	381.58	**< 0.001**	859 (14.6)	427	188	244
Expectant mothers	59 (4.7)	32	15	12	9.61	**0.008**	273 (4.7)	173	46	54
Regular utilisation	484 (38.7)	87	203	194	112.62	**< 0.001**	1,296 (22.1)	346	297	653
Household head last night	350 (28.0)	152	94	104	12.29	**0.002**	705 (12.0)	356	111	238
Installation	811 (64.8)	275	235	301	14.21	**0.001**	4,017 (68.4)	1,347	1,138	1,532
AHME	1,043 (83.4)	419	287	337	57.24	**< 0.001**	4,908 (83.6)	1,900	1,290	1,718
Mean AHME	2.2±1.7	3.1±1.8	1.4±1.1	2.0±1.5						

Boldface numbers indicate significant *p* values

Determinants of household ownership and utilisation of LLINs

To investigate the determinants of LLINs ownership, coverage as well as utilisation in the three health districts, multinomial logistic regression was performed allowing adjustments for possible confounders. Households in the SHD (OR; 3.7, 95% C.I; 1.9 – 7.5, p <0.001) were significantly associated with LLINs ownership (Table 3). A majority of households with at least one LLIN (36.1%; 418/1,157) were found in the BHD, while (32.2%; 372/1,157) were in the THD. The difference was statistically insignificant (p =0.243). Secondary educational status, occupational status and family size of 1 – 4 members were significantly (p >0.05) not associated with the ownership of at least one LLIN per household.

Being a household head in all the age groups except 31 – 40, female, primary and secondary education, BHD and SHD and with no environmental factor were significant determinants associated with the use of LLINs by all children 0 – 5 years old in the household (Table 3). It is worth noting that the majority of the households with heads in the age group 21 – 30 (35.4%; 184/520), females (68.7%; 357/520), secondary education (37.3%; 194/520) and BHD (48.1%; 250/520), had all children 0 – 5 years using LLINs compared with the other

groups. Similarly, there was a significant association between household heads in the 21 – 30 years age group, BHD, families with sizes 1 – 4 and 5 – 7 members in the household and the use of LLINs by the entire household.

Table 3: Multinomial logistic regression of socio-demographic determinants of LLINs ownership and use by all children < 5 and entire household

Dependent variable:	**Ownership of at least one LLIN**			**Used by children < 5 years old**			**Used by entire household**		
	***n* (%)**	***p* value**	**OR (95% C.I.)**	***n* (%)**	***p* value**	**OR (95% C.I.)**	***n* (%)**	***p* value**	**OR (95% C.I.)**
Independent variable	*n* = 1,157			*n* = 520			*n* = 256		
Age groups (in years)									
20				16 (3.1)	**0.048**	3.0 (1.0 - 8.6)	6 (2.3)	**0.197**	2.3 (0.7 - 7.8)
21 – 30				184 (35.4)	**0.021**	1.8 (1.1 - 3.0)	111 (43.4)	**0.003**	2.5 (1.4 - 4.7)
31 – 40				146 (28.1)	0.306	1.3 (0.8 - 2.2)	76 (29.7)	0.133	1.6 (0.9 - 3.0)
41 – 50				108 (20.8)	**0.003**	2.4 (1.3 - 4.2)	35 (13.7)	0.141	1.7 (0.8 - 3.4)
51 – 60				66 (12.7)	Ref	1.0	28 (10.9)	Ref	1.0
Gender									
Female	786 (67.9)	0.751	0.9 (0.6 - 1.5)	357 (68.7)	**0.008**	1.6 (1.1 - 2.3)	166 (64.8)	0.583	0.9 (0.6 - 1.3)
Male	371 (32.1)	Ref	1.0	163 (31.3)	Ref	1.0	90 (35.2)	Ref	1.0
Marital status									
Unmarried	512 (44.3)	0.082	0.6 (0.4 - 1.1)	176 (33.9)	**0.010**	0.6 (0.5 - 0.9)	98 (38.3)	**0.005**	0.6 (0.4 - 0.8)
Married	645 (55.7)	Ref	1.0	344 (66.2)	Ref	1.0	158 (61.7)	Ref	1.0
Education									
NFE	108 (9.3)	0.577	0.8 (0.3 - 2.0)	53 (10.2)	0.576	0.8 (0.4 - 1.6)	34 (13.3)	0.291	1.4 (0.7 - 2.7)
Primary	346 (29.9)	0.814	0.9 (0.4 - 2.0)	165 (31.7)	**0.002**	2.1 (1.3 - 3.4)	60 (23.4)	0.973	1.0 (0.6 - 1.7)
Secondary	421 (36.4)	**0.035**	0.5 (0.2 - 1.0)	194 (37.3)	**0.035**	1.6 (1.0 - 2.4)	95 (37.1)	0.749	1.1 (0.7 - 1.7)
Tertiary	282 (24.4)	Ref	1.0	108 (20.8)	Ref	1.0	67 (26.2)	Ref	1.0
Occupation									
Unemployed	182 (15.7)	**0.007**	0.1 (0.0 - 0.6)						
Agricultural	174 (15.0)	**0.011**	0.2 (0.1 - 0.7)						
Household & domestic	50 (4.3)	**0.035**	0.2 (0.0 - 0.9)						
Unskilled	408 (35.3)	**0.014**	0.2 (0.1 - 0.7)						
State/ Parastatal	197 (17.0)	**0.014**	0.2 (0.0 - 0.7)						
Professional	146 (12.6)	Ref	1.0						
Health District									
Bamenda	418 (36.1)	0.243	1.5 (0.8 - 3.1)	250 (48.1)	**< 0.001**	3.2 (1.9 - 5.3)	193 (75.4)	**< 0.001**	7.4 (4.2 - 13.0)
Santa	367 (31.7)	**< 0.001**	3.7 (1.9 - 7.5)	103 (19.8)	**< 0.001**	3.4 (2.0 - 5.9)	4 (1.6)	**< 0.001**	0.0 (0.0 - 0.1)
Tiko	372 (32.2)	Ref	1.0	167 (32.1)	Ref	1.0	59 (23.1)	Ref	1.0

House type									
Caraboat	77 (6.7)	0.357	1.5 (0.6 - 3.6)	37 (7.1)	0.518	0.8 (0.4 - 1.5)	16 (6.3)	0.92	1.0 (0.5 - 2.1)
Mixed	103 (8.9)	0.141	2.2 (0.8 - 6.5)	35 (6.7)	**0.013**	0.5 (0.3 - 0.9)	7 (2.7)	0.703	0.8 (0.3 - 2.1)
Mud Block	239 (20.7)	0.756	0.9 (0.5 - 1.7)	115 (22.1)	0.716	0.9 (0.6 - 1.4)	58 (22.7)	0.954	1.0 (0.6 - 1.6)
Cement Block	738 (63.8)	Ref	1.0	333 (64.1)	Ref	1.0	175 (68.4)	Ref	1.0
House size									
1 - 3 bedrooms	1,055 (91.2)	0.96	1.0 (0.5 - 2.3)						
4 - 7 bedrooms	102 (8.8)	Ref	1.0						
Family size									
1 – 4 members	551 (47.6)	**0.010**	0.3 (0.1 - 0.7)	113 (21.7)	**< 0.001**	0.0 (0.0 - 0.1)	175 (68.4)	**< 0.001**	12.4 (6.0 - 25.7)
5 – 7 members	478 (41.3)	0.912	0.9 (0.3 - 2.7)	315 (60.6)	**0.007**	0.4 (0.2 - 0.8)	70 (27.3)	**0.007**	2.7 (1.3 - 5.6)
≥ 8 members	128 (11.1)	Ref	1.0	92 (17.7)	Ref	1.0	11 (4.3)	Ref	1.0
Own LLINs									
No				2 (0.4)	**< 0.001**	0.0 (0.0 - 0.2)	1 (0.4)	**0.001**	0.0 (0.0 - 0.2)
Yes				518 (99.6)	Ref	1.0	255 (99.6)	Ref	1.0
Install LLINs beds									
No				124 (23.9)	**< 0.001**	0.5 (0.3 - 0.7)	58 (22.7)	**< 0.001**	0.4 (0.3 - 0.6)
Yes				396 (76.1)	Ref	1.0	198 (77.3)	Ref	1.0
Environmental factor									
No				64 (12.3)	**0.019**	1.9 (1.1 - 3.3)	46 (18.0)	0.916	1.0 (0.6 - 1.7)
Yes				456 (87.7)	Ref	1.0	210 (82.0)	Ref	1.0

OR = Odds Ratio; C.I. = Confidence Interval; Ref = Reference group; Boldface numbers indicate significant *p* values

Annual household malaria episodes with LLINs ownership/ utilisation indicators

A total of 4,908 (83.6%) of the 5,870 *de facto* individuals were sampled in the 1,043 (83.4%) of households with at least one AHME in the last one year (Table 2). In terms of ownership indicators; AHMEs were associated with household accessibility (AOR; 1.2, 95% C.I; 0.6 – 2.5) to LLINs. AHMEs were influenced by use of LLINs by expectant mothers (AOR; 1.0, 95% C.I; 0.5 – 2.3), use of LLINs last night be the household head (AOR; 1.1, 95% C.I; 0.8 – 1.6) and regular utilisation of LLINs by the household head (AOR; 1.7, 95% C.I; 1.3 – 2.4), of which regular LLINs utilisation was significant (Table 4).

Table 4: Multinomial logistic regression of LLINs ownership/ utilization indicators in association with AHME

		Dependent variable:	AHMEs				
			***n* (%)**	***p* value**	**OR (95% C.I.)**	***Ap* value**	**AOR (95% C.I.)**
S/N	**Independent variable**	**Subclass**	n = 1,043				
1.	At least One	No	70 (6.7)	**0.018**	0.5 (0.3 -0.9)	**0.017**	0.5 (0.3 - 0.9)
		Yes	973 (93.3)	Ref	1.0	Ref	1.0
2.	Coverage	No	335 (32.1)	0.625	0.8 (0.4 - 1.7)	0.601	0.8 (0.4 - 1.7)
		Yes	708 (67.9)	Ref	1.0	Ref	1.0
3.	Accessibility	No	312 (29.9)	0.602	1.2 (0.6 - 2.5)	0.566	1.2 (0.6 - 2.5)
		Yes	731 (70.1)	Ref	1.0	Ref	1.0
4.	Children 0 – 5 years	None	458 (43.9)	0.293	0.8 (0.6 - 1.2)	0.347	0.8 (0.6 - 1.2)
		No	135 (12.9)	**0.001**	0.5 (0.3 - 0.7)	**0.001**	0.5 (0.3 - 0.8)
		Yes	450 (43.1)	Ref	1.0	Ref	1.0
5.	Expectant mother	No	992 (95.1)	0.957	1.0 (0.5 - 2.2)	0.938	1.0 (0.5 -2.3)
		Yes	51 (4.9)	Ref	1.0	Ref	1.0
6.	Entire household	No	814 (78.0)	0.103	0.7 (0.4 - 1.1)	0.109	0.7 (0.4 - 1.1)
		Yes	229 (22.0)	Ref	1.0	Ref	1.0
7.	By house head last night	No	755 (72.4)	0.529	1.1 (0.8 - 1.6)	0.533	1.1 (0.8 - 1.6)
		Yes	288 (27.6)	Ref	1.0	Ref	1.0
8.	Regularly	No	660 (63.3)	**0.001**	1.7 (1.3 - 2.4)	**0.001**	1.7 (1.3 - 2.4)
		Yes	383 (36.7)	Ref	1.0	Ref	1.0

AOR = Adjusted Odds Ratio; C.I. = Confidence Interval; Ref = Reference group; Boldface numbers indicate significant *p* values

Determinants of annual household malaria episodes

AHME was associated to age of household head whereby households whose heads were 20 years old had the fewest AHMEs ($p = 0.003$) (Table 5). Multinomial analysis showed that the

gender of the household head significantly ($p = 0.017$) influenced AHME. Households in the BHD had a higher AHME ($p = 0.031$) than those in the Santa and Tiko health districts ($p > 0.05$).

Table 5: Determinants of AHMEs

	Dependent variable:		**AHME**	
Independent variable	**Subclass**	***n* (%)**	***p* value**	**OR (95% C.I.)**
Age groups (in years)	20	17 (1.6)	**0.003**	0.2 (0.1 - 0.6)
	21 – 30	377 (36.1)	0.332	0.8 (0.4 - 1.3)
	31 – 40	308 (29.5)	0.649	0.9 (0.5 - 1.5)
	41 – 50	186 (17.8)	0.846	1.1 (0.6 - 1.9)
	51 – 60	155 (14.9)	Ref	1.0
Gender	Female	716 (68.6)	**0.017**	1.6 (1.1 - 2.3)
	Male	400 (31.4)	Ref	1.0
Health District	Bamenda	419 (40.2)	**0.031**	2.8 (1.1 - 7.2)
	Santa	287 (27.5)	0.251	0.7 (0.3 - 1.4)
	Tiko	337 (32.3)	Ref	1.0
Own LLINs	No	70 (6.7)	**0.045**	0.5 (0.2 - 1.0)
	Yes	973 (93.3)	Ref	1.0
Household LLINs sufficiency	No	964 (92.4)	**0.002**	0.1 (0.0 - 0.5)
	Yes	79 (7.6)	Ref	1.0
Tiredness	No	975 (93.5)	**0.042**	2.6 (1.0 - 6.3)
	Yes	68 (6.5)	Ref	1.0

OR = Odds Ratio; C.I. = Confidence Interval; Ref = Reference group; Boldface numbers indicate significant *p* values

DISCUSSION

This study examined the possible causes of AHMEs in the Bamenda, Santa and Tiko Health Districts amidst high LLINs ownership, 2 – 3 years post nationwide free MDC. Overall, LLINs ownership was 92.5%, coverage was 66.8% (overall LLIN: Person ratio of 0.50) while the proportion of the *de facto* population with universal utilisation was 16.0%, that of children < 5 years was 14.6% and AHMEs was experienced in 1,043 (83.4%) of the 1,251 households sampled. The overall average cost for the treatment of malaria was 6,399.4±4,892.8Fcfa (11.1±8.5US$): 9,010.3±5,297.2Fcfa (15.6±9.2US$) in BHD, 4,039.6±3,314.8Fcfa (7.0±5.7US$) in SHD and 5,774.5±4,325.1Fcfa (10.0±7.5US$) in THD.

Determinants of household LLINs ownership and utilisation

LLINs ownership frequency is higher than 47 – 89.9% obtained elsewhere in Cameroon [3, 8, 10, 20], as well as 15.5 – 85% in Nigeria, Ethiopia and Myanmar [29, 31, 32] and in line with 93.5% in Madagascar [33]. It was however low compared to 98.8% in Uganda [34]. The high frequency of LLINs ownership in this study could be attributed to the 2011 and 2015 free MDC.

With respect to LLINs utilisation by the entire household, 16.0% of the *de facto* population in 20.5% of the households and 14.6% of all the children < 5 years in 41.6% of the households had at least used it the previous night. This low usage by the population is confirmed by other findings [31-33] for the entire household and [8, 33, 34] for all children < 5 years in the household. The very low levels of LLINs utilisation could be attributed to differences in the health districts, socio-demographic differences of the household heads, as well as the lack of sufficient space.

Annual household malaria episodes with LLINs ownership/ utilisation indicators

The average cost for the treatment of uncomplicated malaria in Cameroon is 2,940Fcfa (6US$) [35]. The 83.4% AHMEs realised in this study is high compared to 57.6 – 77% reported in Nigeria [31, 36] and 50.8% in Ghana [37]. Associations were obtained between AHMEs and health districts (the BHD) as well as tiredness of the household head. The high AHMEs in this study is in line with a WHO report which states that the burden of malaria in low income countries is still high [11].

The average direct cost for the treatment of uncomplicated malaria in this study was 6,399.4Fcfa (11.1US$). This is low compared to the 65.1 US$ reported elsewhere in Cameroon [38], the 12.6 – 308 US$ reported elsewhere in Africa [36, 39-41], as well as 461.4 – 2,020.7US$ in Slovak [42]. It was however in line with 11.8 US$ reported in Vietnam [43] and higher than

6US$ in Cameroon [35], 4.9 – 5.1US$ in Ghana and Ethiopia [44, 45]. The differences in the cost of the treatment of malaria might be due to, study designs, sample size and time of the study.

RECOMMENDATIONS

The Ministry of Health together with stakeholders should intensify education on the effective use of LLINs by all in the household, especially the vulnerable populations.

STRENGTHS AND LIMITATIONS OF THE STUDY

Strengths

The data used in this study was collected by trained surveyors, who had mastery of all the health areas in the study area. All the health district offices were consulted for the mapping of the health areas, quarters and census list of households used in the last MDC and Expanded Programme on Immunisation (EPI) campaigns. The quality of data collected was assured through the multistage sampling strategy to minimize bias and pretesting of questionnaires.

Limitations

This was a cross sectional community based study, carried out only in three health districts. Data was collected through self-reporting, with neither question on expenditure on malaria, nor one on diagnosis and type of malaria, rather, there was a question on the AHMEs.

In the calculation of the average expenditure on malaria, we did not distinguish simple from severe malaria.

CONCLUSIONS

In conclusion, the proportion of households with at least one LLIN and those with at least one AHME were high. The average cost for the treatment of malaria in the North and South West of Cameroon represent a potentially high economic burden, mainly to the Internally Displaced Persons and to the national economy as a whole. An implication is that increasing the universal

utilisation could contribute to poverty reduction. The Ministry of Health, national malaria program and other stakeholders need to identify mechanisms for ensuring that everybody has uninterrupted easy access to LLINs as well as regular utilisation.

ABBREVIATIONS: 95% C.I, 95% Confidence Interval; AHME, annual household malaria episodes; BHD, Bamenda Health District; LLINs, long-lasting insecticide nets; MDC, Mass distribution campaign; NFE, No Formal Education; OR, Odds Ratio; *p*, Significance value; SD, Standard Deviation; SHD, Santa Health District; THD, Tiko Health District; χ^2, Chi square

DECLARATIONS

Ethics approval and consent to participate

Ethical clearance was obtained from the IRB-FHS of the University of Buea.

Supporting information

S file. Extra tables (Microsoft Excel).

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Competing interests

The authors declare that they have no competing interests.

Authors contributions

CFN, NFPCA and NPF conceived and designed the study. CFN, NFPCA, MSF, CBM and JPK collected data and CFN analysed it. NFCT and TAN provided resources for the study. NFPCA, MSF, CBM and CFN critically reviewed literature and wrote the original draft. NPF and JPK supervised the study. All authors contributed to the write up, reviewed the final draft, read and approved the final manuscript.

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