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MALARIA PREVENTION IN THE BUEA HEALTH DISTRICT IN CAMEROON: FACTORS INFLUENCING MOSQUITO BED NET USE IN HOUSEHOLDS

Kamga[1*], FHL., Nde-Fon[2],P., Morfaw[2], C., Nsagha[2], NDS.

[1]Department of Medical Laboratory Sciences, Faculty of Health Sciences, University of Bamenda, Cameroon
[2]Department of Public Health and Hygiene, Faculty of Health Sciences, University of Buea, Cameroon
*Corresponding author: Henri Lucien Fouamno Kamga, Department of Medical Laboratory Sciences, Faculty of Health Sciences, University of Bamenda. Email: henrikamga2002@yahoo.fr

ABSTRACT
Background: Insecticide treated bed nets (ITNs), though proven to be effective in preventing malaria will have little impact unless people sleep under them. Several studies have shown that owned ITNs are usually not used and that ITN use is influenced by several factors that vary between communities.
Objective: To investigate the factors influencing the use of mosquito bed nets in households in the Buea Health District (BHD) in Cameroon.
Material and Methods: A cross-sectional study with two-stage cluster sampling included 420 households from 35 sites. Questionnaires adapted from the Malaria Indicator Survey were used. CSPro 4.1 and Epi info 3.5.3 were used to create database and analyze respectively.
Results: ITN ownership in the BHD was high (92.6%; 95% CI: 89.6%-94.9%) but ITN use was less than average (41.2%; 95% CI: 39.2%-43.3%). ITN use was least likely in the age group 5-15 years (P<0.01), in educated individuals (P<0.01) and in households with less than one ITN for two persons (P<0.01). White ITNs were less likely to be used (P<0.01). Conclusion: There is a gap between ITN ownership and use in the malaria holoendemic BHD and ITN use is associated with age of individual, level of education, colour of ITNs and household net density. Use of the highly owned ITNs could be increased by targeting the least protected 5-15 years age group and schooling individuals; by promoting school-based education on ITN use.
Keywords: Insecticide-treated nets, malaria, Buea Health District

PREVENTION DU PALUDISME DANS LE DISTRICT DE SANTE DE BUEA AU CAMEROUN: FACTEURS INFLUENÇANT L'UTILISATION DE LA MOUSTIQUAIRE DANS LES MENAGES

Kamga[1*], FHL., Nde-Fon[2],P., Morfaw[2], C., Nsagha[2], NDS.

[1]Departement des Sciences du Laboratoire Médical, Faculté des Sciences de la sante, Université de Bamenda, Cameroun
[2]Department de Santé Publique et d'Hygiène, Faculté des Sciences de la sante, Université de Buea, Cameroun
*Auteur pour Correspondance: Henri Lucien Fouamno Kamga. Departement des Sciences du Laboratoire Médical, Faculté des Sciences de la sante, Université de Bamenda, Cameroun. Email: henrikamga2002@yahoo.fr

Résumé
Contexte: Les moustiquaires, quoique ayant été prouvées efficaces dans la prévention de la transmission du paludisme auront encore peu d'impact sur la population, à moins qu'elles ne soient effectivement utilisées par celle-ci. Plusieurs études ont montré que les personnes possédant les moustiquaires n'en font d'habitude pas bon usage et que leur utilisation est influencée par plusieurs facteurs qui varient selon les communautés.
Objectif: Examiner les facteurs influençant l'utilisation des moustiquaires par les ménages dans le District de Santé de Buea (DSB) au Cameroun.
Matériel et Méthodes: il s'agissait d'une étude transversale avec un échantillonnage groupé en deux étapes comprenant 420 ménages choisis dans 35 sites différents. Les questionnaires adaptés de l'Enquête sur les Indicateurs du Paludisme ont été utilisés. Les logiciels CSPro 4.1 et Epi infos 3.5.3 ont été utilisés pour créer une base de données afin de l'analyser.
Résultats: Le pourcentage de personnes possédant les moustiquaires des dans le DSB était élevé (92.6 %; 95 % CI: 89.6 %-94.9 %) celui des personne en faisant effectivement usage étaient en dessous de la moyenne (41.2 %; 95 % CI: 39.2 %-43.3 %). L'utilisation des moustiquaires était moins probable dans la tranche d'âge 5-15 ans (P<0.01), chez les individus ayant un niveau alphabétisation élevé (P<0.01) et dans les ménages avec moins d'une moustiquaire pour deux personnes (P<0.01). Les moustiquaires de couleur blanche étaient moins susceptibles d'être utilisés que celles d'autres couleurs (P<0.01).
Conclusion: Il existe un réel fossé entre la possession des moustiquaires et leur utilisation effective dans le DSB qui est une zone holo-endémique de paludisme. L'utilisation des moustiquaires est associée à l'âge d'individu, le niveau d'éducation, la couleur d'ITN et la densité nette du ménage. L'utilisation des moustiquaires pourrait être augmentée en visant les individus de la tranche d'âge de 5-15 ans et en promouvant la sensibilisation sur l'utilisation des moustiquaires en milieu scolaire.
Mots clés: moustiquaire, paludisme, District de Santé de Buea

INTRODUCTION

Insecticide-treated bed nets (ITNs) have been proven as one of the most effective ways of reducing malaria morbidity and mortality, especially in children and pregnant women [1,2]. They have been shown in several randomized controlled trials in Africa to reduce cases of uncomplicated malaria by 50%, severe malaria by 45%, splenomegaly by 30% and mortality by 17% [3]. ITNs do not only protect those who sleep under, but in communities with a greater than 60 percent ITN use, those who do not sleep under are protected as well by massive killing and decrease in the survival of the anopheles vectors [2]. This implies that what is more important is increased ITN use throughout the entire community and not just by groups most at risk [4]. As suggested by theoretical models, there will be greater benefit in targeting the entire population for ITN use than there will be in targeting only the most vulnerable groups [5]. This is because an estimated 80 percent of human-to-mosquito transmission of *Plasmodium* occurs from human hosts older than 5 years of age [6]. Given that the most promising malaria vaccine to date is just about 50 percent effective [7], ITNs remain one of the most effective methods for malaria prevention. However, ITNs will only be effective in preventing malaria if they are used effectively, and attainment of the desired epidemiological impact is crucially dependent on such effective ITN use [8]. Effective ITN use can reduce malaria transmission by up to 90% [9].

Half of the world's population is at risk of malaria with 89% of the malaria burden on Africa [10]. The disease is the leading cause of illness and death in Cameroon, and accounts for 41% of outpatient consultations, 41% of morbidity in the general population, 49% and 56% of morbidity in pregnant women and children under five years respectively, 43% of deaths in all regions of the country and 14% and 54% of deaths in pregnant women and children under five years respectively [11]. All the ten regions of Cameroon are affected by malaria. The Buea Health District (BHD) is hyperendemic for malaria [12].

As reported in several studies, despite the proven effectiveness of ITNs in preventing malaria, a significant number of ITNs owned are not used [8,13-15]. There is therefore a significant disparity between ITN ownership and ITN use. This means that there are several determinants of or factors associated with the effective use of ITNs even by those who already own them. A particular socio-demographic factor may have different associations with ITN use, depending on the setting. For example, being male was directly associated with net use in Burkina Faso [16] and inversely associated with net use in six other African countries [17].

In several communities, some of these factors associated with ITN use have been identified to be: poor conception and knowledge of malaria [18], knowing that mosquitoes transmit malaria [19], Age [17,20], gender [16,17], level of education [19,21], occupation [21], socioeconomic status [19,22], conical shape of bed net [23], colour of net [19], having to pay for nets [19,23], sleeping with the mother [24], use of coils for mosquito control [19], and fewer nets in household [8,14,19]. In some communities, studies have shown that ITNs are being misused for other purposes like fishing [25].

There is relatively little data on the factors influencing ITN use in the Buea Health District. Recently, there is was nation-wide campaign to freely distribute ITNs to Cameroonians. It is hypothesized that achievement of the desired epidemiological impact of preventing malaria would dependent on effective ITN use. It is therefore necessary to know the local factors associated with ITN use. This study therefore sought to determine the ownership and use of ITNs and the factors associated with their use in the BHD.

MATERIAL AND METHODS

Study Design

This was an observational, cross-sectional descriptive study.

Study Area

This study was carried out in the Buea Health District (BHD). The BHD is located in the Fako Division of the South West Region of Cameroon. It is hyper endemic for malaria [12]. The BHD has a population of 133,092 inhabitants. It is divided into 7 health areas (HA) which are in turn divided into Communities. In the BHD, the percentage of children 0-5 years having received ITNs was 1.2 percent as of March 2010. The national target was 90 percent and the District target was 80 percent. In addition, the percentage of pregnant women having received ITNs was 53 percent as of March 2015. The national target for pregnant women was at least 90 percent and the District target 80 percent [26].

Study Population and Sampling

Sample size

The minimum required sample size was calculated using the formula for proportions as described by Eng [27], thus the study had to include at least 385 households using a prevalence of 50% [28]. It included 420 households in order to account for the cluster sampling technique used. Thus the study included 347 children aged 2 to 9 years.

Sampling technique

A two-stage cluster sampling design was used [28]. In the first stage, Probability Proportional to Size sampling (PPS) as described by Bennett et al. [29], Merg et al. [29], Milligan et al. [30] and Mc Ginn [31] was used to select 35 sites from the 66 communities that make up the 7 health areas in the BHD. The measure of size used was the population of each community [32]. The second stage involved listing and sampling of households within the selected communities [29]. Households in the BHD were listed during the recent nation-wide campaign to distribute ITNs. The household serial numbers were recorded per community. We obtained these numbers from the Health Centres of each Health

Area following authorization from the District Medical Officer. The sampling frame of households was therefore known for each community. In each selected community, 12 households were balloted from the sampling frame. The selected households were visited first to obtain consent, then secondly to obtain data. If no one was available in the household during the first visit, two more visits were carried out. If no one was available after 3 visits, the next randomly selected household was studied until at least 12 households were studied in that community [15,29,]. All individuals who spent the previous night in the pre-selected households were studied. However, there was just one respondent of the questionnaire for each household. The respondent of the questionnaire was any adult member of the household who was capable of providing information needed to fill in the questionnaire. A visitor who spent the previous night in the household, though included in the study did not qualify to be a respondent of the questionnaire [29].

Data collection and data quality control

A structured household questionnaire developed from the Malaria Indicator Survey (MIS) was used to conduct interviews in the households [29]. The questionnaire was divided into seven main parts namely Informed Consent Form, Identification, Household Listing, Ownership and Use of ITNs, Perceptions and Attitudes toward Malaria, and Interviewer Summary. To ensure good data quality the questionnaire was pre-tested in a selected sample before being used for the study. Moreover, all questionnaires were checked for errors and completeness in the field and inconsistencies verified with the respondent. Another factor that ensured good data quality was that callbacks were done for households in which no respondent was present during the first visit.

Ethical Considerations

Ethical clearance was obtained from the Institutional Review Board of the Faculty of Health Sciences of the University of Buea and administrative approval from the Regional Delegation of Public Health for the South West Region, Cameroon. Informed consent was sought from each household before their inclusion in the study. Moreover, for children aged between 2 to 9 years, guardian consent was sought and from those aged 7 to 9 years, assent consent was sought.

Data management and analysis

All questionnaires were checked for filling errors, correct coding and completeness All inconsistencies were verified with the respondents before leaving the households. Data were entered into CSPro 4.1 every day after returning from the field and counterchecked by double-entry. Logic, skip patterns and consistency checks were used during data entry to prevent entry errors. The data werw then exported from CSPro 4.1 to Epi Info 3.5.3 and analyzed. The research was self-weighted by virtue of probability proportional to size sampling (which weights the variables) carried out in the first stage of the cluster sample design [28,30]. All P-values were calculated using the Chi-square test.

RESULTS

A total of 2253 individuals were studied in 420 households. These households had 1110 Insecticide treated bed nets (ITNs). There were more females (54.1%) than males (45.9%). The majority (75.5%) of the participants had attained primary and secondary school and the least proportion had attained higher education. Those who had not had any formal education also made up a good proportion of the study participants (15.6%). More than half of the participants (55.3%) were older than 15 years. A small proportion (1.9%) of the participants was pregnant.

Out of the 1245 adults studied, 511 (41.0%) slept under an ITN (X^2= 23.47, 2d.f., P-value < 0.01). RR comparing children < 5 years to children 5-15 years = 1.43 (95% CI: 1.24-1.66), X^2 = 23.36, P-value < 0.01; RR comparing children < 5 years to adults = 1.24 (95% CI: 1.10-1.40), X^2=11.75, P-value < 0.01. Thus there is a statistically significant difference in ITN use between children aged less than five years, children aged 5-15 years and adults in the BHD.

TABLE 1 : INSECTICIDE TREATED BED NETS (ITNS) USE ACROSS INDIVIDUALS BY AGE GROUP

Age group in years	ITN use across individuals		otal number of individuals No (%)	RR	P-value
	Used No (%)	Not used No (%)			
< 5 years	199 (50.9)	192 (49.1)	(17.4)	1.00	
5-15 years	219 (35.5)	398 (64.5)	617 (27.4)	1.43	< 0.01
> 15 years (adults)	511 (41.0)	734 (59.0)	1245 (55.3)	1.24	< 0.01
otal number of individuals	929	1324	2253 (100.0)		

TABLE 2: ITN USE ACROSS INDIVIDUALS BY LEVEL OF EDUCATION

Level of education	ITN use across individuals		tal number of individuals No (%)	RR	P-value
	Used No (%)	Not used No (%)			
None	184 (52.3)	168 (47.7)	352 (15.6)	1.00	
Primary	362 (39.1)	563 (60.9)	925 (41.1)	1.34	< 0.01
Secondary	316 (40.8)	459 (59.2)	775 (34.4)	1.28	< 0.01
Tertiary (Higher)	66 (32.8)	135 (67.2)	201 (8.9)	1.59	< 0.01
Total number of individuals	928	1325	2253 (100.0)		

The use of ITN in individuals who had received no formal education was 52.3% while that in individuals who had attained primary education was 39.1% while that in individuals who had attained secondary education was 40.8% while that in those who had attained higher education was 32.8% (X^2= 25.31, d.f.=3, P-value < 0.01). RR comparing no education to primary education = 1.34 (95% CI: 1.18-1.52), X^2= 17.97, P-value < 0.01; RR comparing no education to secondary education = 1.28 (95% CI: 1.12-1.46), X^2= 12.95, P-value < 0.01; RR comparing no education to higher education= 1.59 (95% CI: 1.28-1.99), X^2= 19.48, P-value < 0.01. Thus there is a statistically significant difference in ITN use between non-educated, primary-educated, secondary-educated and higher-educated individuals in the BHD.

TABLE 3: ITN USE ACROSS NETS BY ITN COLOUR

ITN colour	ITN use across nets		Total number of nets No (%)	RR	P-value
	Nets used No (%)	Nets not used No (%)			
White	130 (30.9)	291 (69.1)	421 (37.9)	1.00	
Green	37 (52.9)	33 (47.1)	70 (6.3)	0.58	< 0.01
Blue	244 (39.4)	375 (60.6)	619 (55.8)	0.78	< 0.01
Total number of nets	411	699	1110 (100.0)		

TABLE 4: ITN USE ACROSS HOUSEHOLDS BY HOUSEHOLD NET DENSITY

Household net density	ITN use across households		al number of households No (%)	RR	P-value
	100% ITN Use No (%)	Less than 100% ITN Use No (%)			
≥ 1 ITN per person	19 (43.2)	25 (56.8)	44 (10.5)	1.00	
1 ITN for 2 persons	65 (34.4)	124 (65.6)	189 (45.0)	1.26	0.28
1 ITN for 3 persons	30 (26.3)	84 (73.7)	114 (27.1)	1.64	0.04
1 ITN for ≥ 4 persons	5 (6.8)	68 (93.2)	73 (17.4)	6.30	<0.01
Total number of households	119	301	420 (100.0)		

Of of the 421 white nets, 130 (30.9%) had at least one person sleep under; out of the 70 green nets studied, 37 (52.9%) had at least one person sleep under; out of the 619 blue nets studied, 244 (39.4%) had at least one person sleep under (X^2= 15.87, 2 d.f., P-value < 0.01). RR comparing white nets to green nets = 0.58 (95% CI: 0.45-0.76), X^2= 12.89, P-value < 0.01; RR comparing white nets to blue nets = 0.78 (95% CI: 0.66-0.93), X^2= 7.93, P-value < 0.01. Thus there is a statistically significant difference between the use of white, green and blue nets in the BHD.

Out of the 44 households with a household net density of ≥1 (one or more ITNs per person), 19 (43.2%) had a 100% ITN use; out of the 189 households with a household net density of 0.50-0.99 (one ITN for two persons), 65 (34.4%) had a 100% ITN use; out of the 114 households with a household net density of 0.33-0.49 (one ITN for three persons), 30 (26.3%) had a 100% ITN use; out of the 73 households with a household net density of 0.00-0.32 (one ITN for four or more persons), 5 (6.8%) had a 100% ITN use (X^2= 25.02, 3 d.f., P-value< 0.01). RR comparing households with net densities of ≥ 1 to those with net densities of 0.00-0.32 = 6.30 (95% CI: 2.53-15.68), X^2= 20.05, P-value< 0.01; RR comparing

households with net densities of ≥ 1 to those with net densities of 0.33-0.49 = 1.64 (95% CI: 1.04-2.59), X^2= 4.19, P-value= 0.04; RR comparing households with net densities of ≥ 1 to those with net densities of 0.50-0.99 = 1.26 (95% CI: 0.85-1.86), X^2= 1.19, P-value= 0.28. Thus there is a statistically significant difference in ITN use between households having one or more ITNs per person and households having one ITN for three or more persons in the BHD.

DISCUSSION

Data analysis revealed that 92.6 % of the households in the BHD have at least one ITN. This finding indicates that the ownership of ITNs by households in the BHD is high. This could owe to the recent nation-wide campaign to freely distribute ITNs. The ownership of ITNs by children less than five years and pregnant women in the BHD were respectively 1.2% and 53% [33]. These proportions are expected to have greatly increased following the nation-wide free distribution of ITNs to Cameroonian households.

The second objective was to determine the proportion of individuals in the BHD who slept under an ITN the previous night. Data analysis and interpretation revealed that 41.2% of the population in the BHD slept under an ITN. This finding indicates that less than half of the population of the BHD uses ITNs and ITN use in the BHD is less than the 60% target above which a meaningful impact on malaria transmission is expected [34]. It also shows that most people who own ITNs in the BHD do not use them. This finding of a gap between ITN ownership and use is consistent with findings in other studies elsewhere [8,13-15].

The main reported reason for not sleeping under an ITN in the BHD was rumour that ITNs killed people. It may be useful therefore to educate the population and reassure them that ITNs do not kill. They should also be reminded to expose the ITNs outside in a shaded place for at least 24 hours before starting to use [34].

In a study carried out in Cameroon before the nation-wide campaign to freely distribute ITNs [35], the reported problems experienced by families using ITNs were: difficulty in finding chemicals for retreatment, insufficient financial means to buy new bed nets to replace old ones, insufficient bed nets for all in the household and excessive heat when sleeping under net. In a study in Ethiopia [27], the main reported reasons for not using owned ITNs was the perception that ITN had lost its effectiveness or needed retreatment. In another study in the Democratic Republic of Congo [36], the main reason for not using ITNs was heat/discomfort within a bed net. These varied reasons for non-use of ITNs in different communities further confirm the need for studying local environmental and socio-cultural factors influencing ITN use, so that proper cost effective measures can be taken to improve use.

Children under five years were significantly more likely to sleep under an ITN than children aged 5-15 years and adults. Children aged 5-15 years were significantly least likely to sleep under an ITN. These findings indicate that there is an association between ITN use and age of individual in the BHD and children less than 5 years are more likely to sleep under an ITN while children aged 5-15 years are least likely to sleep under an ITN. The association of bed net use with age has also been found in other African studies [17,19,20,37]. The greater ITN use in children less than five years could owe to two reasons: Firstly, they form one of the groups at greater risk of malaria and have been targeted for a long time now (before campaigns targeting the whole community) for ITN distribution at Infant Welfare Clinics. They are therefore more used to ITNs and probably more likely to sleep under [19]. Secondly, as previously reported by Mugisha and Arinaitwe [24], children who shared a bed with their mothers are 21 times more likely to sleep under an ITN; they are more likely to share a bed with their parents whereas older children are more likely to sleep on separate beds or on the floor [20].

In a study carried out in six African countries, Baume and Marin [33] showed the children 5-14 years were least likely to use ITNs. In another study by Noor et al. [20], children 5-19 were least likely to use ITNs. In this BHD study, the age group least likely to use ITNs was 5-15. The relatively lower protection against malaria in children above 5 years and in adolescents has great implications. These children above five years constitute the most important reservoir for malaria with more than 80% of human to mosquito transmission of *Plasmodium* occurring from humans above 5 years [21]. The protection of these children above 5 years by ITNs therefore needs to be scaled up, probably by school based education as suggested by Noor et al. [20]. This finding is contrary to Ndjinga and Minakawa [37] who reported that children aged 5-15 years were more likely to use bed nets than other age groups in the Democratic Republic of Congo. They attributed the increase ITN use in this age group to education on disease prevention and sanitation carried out in primary and secondary schools and further emphasized the importance of education in schools on ITN use especially in the age group 5-15. Although children less than five years constituted the age group with the highest ITN use in the BHD, they had only 50.9% ITN use. This is less than the 60% target set for this age group at the African Summit on Roll Back Malaria held in Abuja, Nigeria, on April 25, 2000 [36]. Therefore, increasing ITN use by the least protected 5-15 year age group should be coupled to improving use in the more protected but more at risk less than five years age group.

Another finding in the present study is that individuals in the BHD who had received no formal education were significantly more likely to use ITNs than individuals who had gone to school while individuals who had attained higher education were least likely to use ITNs. These findings indicate that there is an association between ITN

use and level of education in the BHD. This does not support the findings from previous reports carried out in Africa [18,19,21,36). These studies found that households whose heads or caregivers were more educated were more likely to use ITNs. Our finding may be explained by the fact that individuals who have attained higher education are exposed to health ideals which enhance promotion of their social health, they are more likely to get good and clean houses in areas with fewer mosquitoes whereas those with no formal education are more likely to get mosquito prone houses. The pain and nuisance caused by these mosquitoes to the people with no formal education may then push them more to seek mosquito preventive measures than their more educated counterparts.

The present study also revealed that white ITNs were significantly least likely to be used compared to green and blue ITNs. Green ITNs, though fewest in number, were significantly more likely to be used, showing the association between ITN use and ITN colour. These findings are consistent with findings in Ghana by Baume and Franca-Koh [19]. A possible reason for these findings is that coloured ITNs do not easily show dirt when dirty as compared to white ITNs and that coloured nets may be considered decorative and attractive [19]. People are therefore more likely to use coloured ITNs. For effective and consistent use of ITNs to be achieved, the choices of the local population must be considered. It may therefore be useful to distribute coloured (especially green) ITNs in subsequent ITN distribution campaigns so that maximum use is achieved.

Households with more ITNs per person were significantly more likely to have a 100% ITN use. However, the difference in ITN use between households with one or more ITNs per person and those with one ITN for two persons was not significant. These findings indicate that there is an association between ITN use and household net density in the BHD and although household ITN use is likely to increase with more nets in the household, there is likely to be no further increase in use above a net density of 0.5 (more than one ITN for two persons). In previous studies of households in many Sub-Saharan African countries [8], bed net use by children under five years and pregnant women was found to increase with increase household net ownership. The reason for this was that in households with few bed nets, the few nets were more likely to be used by the household heads and adults but not children under five and pregnant women. So as the number of household bed nets increased, access to nets for children and pregnant women also increased. In another study in Ghana, using bed nets as the unit of analysis, Baume and Franca-Koh [19] found that a bed net was more likely to be used if there were fewer bed nets in the house. The former studies differed from Baume and Franca-Koh's study in that they used children under five years and pregnant women as their unit of analysis.

The present study used all the household members as well as the ITN as the units of analysis. The findings of this BHD study could be explained by both findings from the two sets of studies above [19,38]. As household net ownership increases, dependent groups like children and pregnant women tend to also have access to ITNs, increasing household ITN use to 100%. This explains the increase in households with a 100% ITN use with an increase in household net density. However, above a net density of 0.5 (more than one ITN for two persons), the extra ITNs are more likely to be kept unused because there is no room to hang them or saved as a reserve net for those already hanging [35]. This explains why there is likely to be no further increase in household ITN use when household net density is above 0.5. The implications of these findings are that it may be useful to distribute more ITNs to households with less than one ITN for two people, with the goal of achieving at least one ITN for two persons. On the other hand, it may not be useful adding more nets to the households already having one or more ITNs for two people.

This study did not find any significant association between ITN use and gender, pregnancy, use of other methods than ITNs for malaria prevention, respondent's perception of malaria as a serious problem, knowledge by respondent that mosquitoes transmit malaria and the respondent's perception on the effectiveness of ITNs in preventing malaria in the BHD.

There are some limitations to this study. A few households in the BHD were not numbered during the household listing that was done to distribute vouchers for ITNs in the BHD. However, this household listing was the best available sampling frame given that there is no better numbering of households in the BHD. Potential inflation in the reported ownership and use of bed nets was suspected. To prevent this, ITNs were directly observed in as many households as possible and noted if they were hanging. It was assumed in this study that the respondent's knowledge, perception of ITN efficacy and perception of malaria as a serious problem applied equally to all household members.

Conclusion: This study investigated the factors influencing the use of mosquito bed nets in the BHD. It was intended to determine any gap between ITN ownership and use as well as determine any factors associated with ITN use, so that ITN use could be improved. This was in relation to the relatively little data in the BHD and in Cameroon on the factors associated with ITN use. The study established that the ownership of ITNs in the BHD is high (92.6%; 95% CI: 89.6%-94.9%) but the use is less than the 60% target at which a meaningful impact on malaria transmission is expected (41.2%; 95% CI: 39.2%-43.3%). The main reported reason for non-use is fear that ITNs kill. It also established that ITN use is significantly least likely in the age group 5-15 years, in educated individuals and in households with less than one ITN for two persons. Moreover green and blue ITNs

are significantly more likely to be used compared to white ones. Furthermore the study established that malaria has gone from being hyperendemic to being holoendemic (splenic index= 81.6%, AES= 4.12) in the BHD. In view of these findings we conclude that there is a gap between ITN ownership and use in the malaria holoendemic BHD and ITN use is associated with age of individual, level of education, colour of ITNs and household net density.

The highly owned ITNs in the malaria holoendemic BHD would be a major tool in reducing malaria transmission provided the less than average use is improved. Improving use would imply targeting the least protected age group of 5-15 years and the school going individuals of the health district using school-based education on ITN use. It would also imply ensuring that every household in the BHD has at least one ITN for two persons while considering the persons' colour preference.

Competing interests: The authors declare that they have no competing interests

Authors' contributions: KFHL and PNF conceived the study and participated in its design and implementation and drafted of the final manuscript. NPF participated in the design and implementation of the study. CM implemented the study. All authors read and approved the final manuscript

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