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Effects of environmental, living space and climate variability on the utilization of impregnated bed nets in west Cameroon: A community based survey for policy implementation

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Abstract
Background: Despite the fact that Long Lasting Impregnated Mosquito Net (LLIN) represents one of the most effective tools in fighting malaria, its use remains limited. Our study aimed at determining how environmental, household characteristics and climate affect bed net use.
Methodology: A cross sectional descriptive and analytic study was carried out from January to April 2014 in Mifi health district. Data collected were collected in households during a face to face interview with standard household questionnaires, entered and analyzed using Epi Info software version 3.5.3. Graphics and tables were obtained using MS Excel and Word.
Results: Of the 317 participants interviewed, average age was 33.23 years (SD = 10.80) and female sex predominant (85.2%). Most participants had attended secondary education 53.6% (n= 170), married marital status was most represented (58.1%; n= 185).75.4% (n=239) of households had at least 1 LLIN and average district coverage estimated to 1 LLIN for 3.3 persons. 78% of occupants in households with at least one LLIN had slept under the night before the survey. The presence of a ceiling in a house reduced net usage by 2.5% (p = 0.67) compared to house lacking ceiling. Standing waters around the compound increased net utilization rate to 16.6% (p = 0.03), whereas the presence of a covered well decreased the rate by 1.4% (p = 0.86). The dry season was identified as the period during which 86.8% (n= 239) of respondents sleep less under a net. Heat (57.60% n = 138/239), increased choking (2.5%), reduction in vector breeding sites (39.90%; n = 95) were cited as main reasons.
Conclusion: Although classified as zone of continuous transmission, our findings indicate that bed net usage by our study population depends on environmental, household characteristics and climate. There is therefore an urgent need to develop strategic communication and sensitization campaigns coupled to environmental management to help scale up and optimize malaria burden reduction.

Keywords: Determinants, characteristics, bed net, Malaria, West Cameroon

1. Introduction

Malaria, an infectious disease caused by a parasite of the genus *Plasmodium* continues to be major public health problem with close to 50% of the world population at risk [1]. 300 – 500 million new cases are recorded annually with about 1.5 to 2.7 million deaths among which 1 million children under 5 [2]. About 90% of malaria cases occur in sub-Saharan Africa; pregnant women and children under 5 years old being the most concerned [3].

Malaria is does not only hinder health progress of affected countries, but also slows down annual economic growth up to 1.3% in some African countries. In addition, reduction in productivity due to malaria results to an estimated 12 billion US dollars losses per year [4].

In Cameroon, all the inhabitants are exposed to Malaria. Data reveal that 40 – 45% of medical consultations, 46% of all hospital admissions, 30% to 35% of deaths in adults, 40% of morbidity in children under 5, 11% of morbidity among pregnant women and 17.55% of all deaths in health facilities are attributable to malaria. Of all malaria deaths, the proportion of children under 5 years is estimated to 62%. The disease alone consumes 40% of the household budg *et al.* located to health [5]. The implementation of effective and sustainable control strategies therefore appear primordial to reduce the health and economic burdens

caused by the disease. The approach relies on two main interventions: Prevention and Management.

Management is done with anti-malarial drugs administered according to the national protocol of malaria management. Prevention on the other side consist to of administrating of intermittent preventive treatment (IPT) to pregnant women as from the second term of pregnancy and most importantly reduction of human-vector contact through the use of Long Lasting Impregnated Mosquito Net (LLINs) [5]. By reducing the vector density, correct utilization of LLINs by majority of the target population confer total protection to the community including those who do not make use [6, 7].

Reducing malaria burden demands particular attention to the vulnerable groups. This has resulted in millions of free or highly subsidized ITNs and long-lasting insecticide treated nets (LLINs) being distributed in the last decade, resulting in substantial increases in ITN ownership in many malaria-endemic countries [8-10]. However, despite the fact those LLINs to remain one of the most effective tools in the fight against malaria, incidence of use does not follow rates of use which are often lower than rates of ownership [10, 11].

Previous studies have explored this apparent “gap” between net ownership and use. Potential determinants of ITN use in addition to knowledge/perception of malaria and LLINs, physical characteristics of bed nets, family size/composition and sleeping arrangements include: dwelling construction, environmental and climatic factors [12 - 17].Thus, this study aimed at identifying, environmental and climate related factors that could impact on the use of LLINs; to produce data for developing and implementing evidence base policies and strategies to effectively tackle malaria.

2. Methodology

2.1. Study design and population

A cross sectional descriptive and analytic study was conducted from January to April 2014 in Mifi health district, Western Cameroon. Mifi subdivision is known to be the capital of this region. Predominantly urban, the district had an estimated population of 266988 dwelling in 12 health areas. The vegetation is less dense and the climate is equatorial type characterized by a quite long raining season (9 months) and a dry season which all combines yielding a favorable environment for diverse kinds of activities [5]. The population of this district is cosmopolitan, practicing agriculture as main activity and income source. However, other informal occupations such as small scale commerce and craft are practiced by indigenous inhabitants [18].

2.2 Data collection

To obtain a representative sample, health areas were grouped into rural and urban and randomly selected proportionally to the number in each category. Three urban and four rural health areas were sampled and included in the study. The number of households to be interviewed in each health was determined taking into account the total population of the area. Once at the center of the health area, the streets to be considered for investigation were selected by tossing a coin. Households were selected from both sides of the streets following a "zig-zag" movement. At household level, purpose of the study was explained to the participants and the household head or representative invited to participate by signing the informed consent form. Data were recorded on a standard pretested questionnaire during a face to face interview with the participants. Questions were related to the availability of Impregnated Benet, usage in relation to climate. The observational phase consisted of assessing and taking notes on household and environmental characteristics (presence of open well, house with ceiling, etc.).

2.3 Statistical analysis

Following data collection, questionnaires with missing or inconsistent data were eliminated and therefore not considered during data analysis. Data entry and analysis were performed using EPI Info analysis software version 3.5.3 (CDC, Atlanta, GA, USA). Microsoft Office Word and Excel were used to obtain graphics and tables. First phase of analysis (descriptive) helped obtain a general tendency and compare the frequency of the different variables. With a *p-value* set at 5%, the next phase of analysis focused on highlighting the relationship between the dependent variable (net usage) and explanatory factors (dwelling, climate and environmental characteristics) using linear regression.

3. Results

Overall, 325 participants were approached during the study, 317 consented and answered the questionnaire (97.5% response rate). From the Table I, it appears that Djeleng health area is most represented because its population is the highest; while Batoukop is the least represented. Any person (male or female) having reached the age of majority according to the Cameroonian legislation (21 years old) identified as household head or representative was interviewed once the free consent obtained.

Table I: Distribution of households according to health areas.

Health Area	Health Area Category	Population (2014)	Planned number of households to be sampled	Number of households sampled
Badiembou	Rural	11150	25	25
Djeleng	Urban	47036	105	105
Batoukop	Rural	7065	16	20
Afas	Urban	19447	43	43
Tocket	Rural	7539	17	22
Tyo	Urban	35828	80	80
Wouong	Rural	7765	17	22
Total	---	135830	302	317

3.1. Socio-demographic characteristics

Of all participants, female sex was predominant giving a female/male ratio of 6/1. The average age of participants was 33.23 years (SD= 10.80) with lower value 21 years and maximum 70 years. On average, 5.68 (that is ≈ 6) persons live in each household. Data reveal there exist some difference (p= 0.94) between the urban (5.67) and rural (5.69) zones. Regarding marriage which is a sensitive aspect,

no question was asked in view of differentiating the type of marriage (traditional, religious, state); to reduce the risk of biasing the interview. The Mifi health district being characterized by the presence of farms and plantations; 15.3% (n= 49) of respondents practice subsistence agriculture as main source of income. 82% (n= 260) of all participants were family mothers, 72.3% of men (n= 34) were families heads (Table II).

Table II: Social and demographic characteristics of the study population.

Variables (N= 317)	Frequency	Percentage (%)
Gender		
Male	47	14.8
Female	270	85.2
Educational level		
None	27	8. 5
Primary	94	29.8
Secondary	170	53.6
University	26	8.1
Participants Marital status		
Single	44	14.0
Cohabitation	54	17.1
Married	184	58.1
Separated	6	1.8
Divorced	3	0.9
Widow	26	8.1
Professional Occupation		
Trader	45	14.2
Farmer	49	15.5
Government worker	11	3.5
Dress maker	32	10.1
House wife	109	34.4
Barber/Hair maker	10	3.2
Other	61	19.2

3.2 Household, environmental characteristics of study population

Table III below shows that 67.4% (n = 213) of households had a ceiling. The presence of stagnant water (lake, pond, marsh, etc.) around houses was observed in 87% of cases and open well were present in 51% (n= 161) of compounds.

Table III: Household and environmental characteristics of study population.

Characteristics (N= 317)	Frequency	Percentage (%)
Presence of Ceiling		
Yes	213	67.4
No	103	32.6
House surrounded by stagnant water		
Yes	87	27.5
No	230	72.5
Presence of open well in the compound		
Yes	161	51
No	156	49

3.3 Bed net coverage

For residents of households to use LLINs in fighting against malaria, it is basic that they first possess this tool. Amongst the 239 households having at least 1 LLIN, 64.0% (n= 153) were located in urban health areas while the remaining 36.0% (n= 86) were found in rural communities. Data from our survey reveal average district coverage of 1 LLIN for 3.3 persons. Value for this indicator was non-significantly greater (p= 0.35) in rural (3.53) compared to urban (3.15) settings. Table IV and V give an overview of bed nets coverage.

Table IV: Bed net coverage per zone

Zone	Average Number of LLINs for 10 households.	SSD	*P-value*
Health District	18		17
Urban Health Areas Rural Health Areas	17 19	18 15	0 .35

Table V: Long lasting impregnated mosquito net possession.

Possession of at least one LLIN in the household	Frequency	Percentage (%)
Yes	239	75.4
No	78	24.6
Total	317	100

Note: LLIN= Long Lasting Impregnated Net.

3.4 Household, environmental characteristics and the use of LLINS association

To determine existing relationship among the variables, binary logistic regression was used. Findings indicate that the presence of a ceiling in a house reduces LLINS usage by 2.5% (p= 0.67) when compared to a house lacking ceiling. The presence of stagnant water around the compound which are breeding sites for mosquitoes appear to increase the utilization rate of LLIN by 16.6% (p= 0.03). On the other side, the presence of a covered well impacted negatively on LLINs usage by decreasing the rate by 1.4% (p= 0.86) (Table VI).

Table VI: Association between bet net usage and household and environmental characteristics.

Characteristics	Modalities	RR	*p-value*
Presence of Ceiling	No®	1	0.67
	Yes	-0.025	
Presence of stagnant water around the house	No®	1	0.03
	Yes	0.166	
Presence of open well in the compound	No®	1	0.86
	Yes	0.014	

Note: ®= reference category; RR= Relative risk (non-adjusted).

3.5 Climatic variations and LLINS use association

Results from our survey suggest there is a link between the use of LLIN and the season of the year. According to half of the 239 households (49.8%), residents make use of LLINs depending on the season. The dry season was identified as the period during some people sleep less under LLINs. Several reasons were cited to justify the non-use of LLINs during the dry season. The major reason mentioned by 57.60% (n= 138) of participants was related to high temperatures during this period coupled to the feeling that bed nets reduces airflow therefore increasing heat sensation. In addition, some respondents (2.5%; n= 6) said sleeping under LLINS during hot season provoked choking. According to 39.9% (n= 95) of household representatives surveyed, mosquito breeding sites (stagnant waters) decreased during the dry season thus resulting in a reduction in the number of mosquitoes justifying why they will not make use of LLINs.

Moreover, added to the reasons already mentioned, negligence which is not associated to climate was highlighted as one of the reasons for non-use of LLINs in 2.1% (n = 5) of houses. A small proportion of the participants 0.8% (n=2) reported that the LLINs were at the origin of cough.

4. Discussion

This paper outlines environmental, climatic factors and households characteristics associated to bed net use in an endemic context. For LLINs to be effective in reducing malaria burden, Roll back malaria and World Bank mention that coverage and usage rate by the population must equal at least 80% [4, 19].

During feeding, the female *Anopheles* injects saliva in its host which includes a combination of antihemostatic and anti- inflammatory enzymes that disrupt the clotting process and inhibit the pain reaction; it is also silent on flight, so that the victim is unaware of the bite [20, 21]. This has been a source of confusion as the various species of mosquitoes are found cohabitating in the tropics and most people associate noise made by *Culex* and *Aedes* to the malaria vector and hence use nets up on perception of this noises described as nuisance and often intense during sleeping hours, coupled to itching bites [22]. Mosquito nets protective mechanism is by reduction of human-vector and hence frequency of the nuisance bites [23 - 25]. In addition to serving esthetic purposes, ceiling in a house also helps reduce mosquito influx and density leading to decreased amount of noise and given that population mistakenly associate silence to the absence of malaria causing mosquito, there is a negative association between the use of nets and presence of a ceiling in a household. This observation is in accordance with other findings which indicate that the use of alternative methods such as intra domiciliary pulverization, the presence of nets on the windows and the ceiling decreased the use of ITN [26].

Anopheles mosquitoes require standing waters to breed preferably clean unpolluted sunny sources [27]. Open wells and stagnant waters therefore constitute excellent milieus for the anopheles to lay its eggs and for full development to take place [27]. As such environmental hygiene including draining stagnant waters and eliminating potential water retaining containers around the compound; providing covers for wells may significantly contribute in reducing vector density by interrupting the reproductive cycle. With a reduction inbreeding sites, adult mosquito density and associated discomfort tends to diminish, hence impacting negatively on bed net usage [28, 29].

Soil texture and climate can affect the mosquito breeding cycle. Zones located where the ground have a water retention capacity (clay) tend to be surrounded by stagnant waters that are suitable for the development of mosquito larvae. Climate on the other side determines the availability of water and the required temperature for the growth and development of mosquitoes [30, 31]. Mifi Health District is found in West Cameroon, which is classified as a zone of continuous transmission, as this takes place throughout the year [5]. This implies variation in *Anopheles* mosquitoes with season is less significant and therefore the use of the LLINs as protective measure should not be climate dependent. Our findings indicate otherwise, 49.8% of our respondents mentioned that LLINs use in the household was determined by the season; this attitude has been reported in some studies [32 - 34]. This is an indicator that populations lack of informations on malaria transmission cycle and there is some preference of comfort and not protection.

As demonstrated by recent studies, the dry season or hot months of the year appears as the period of the year during which bed net utilization falls down [35]. Many reasons have been brought up to justify this behavior and there seems to be some relationships between them. Dry periods are characterized by a decrease in mosquito breeding sites, hence reduction in number and density. The outcome is a down fall in the quantity of nuisance bites and a declining rate of LLINS use. More than half (57.60%) of the respondents who made use of LLINs according to climate confessed increased heat sensation as a result of the bed net, this has also being indicated in a study on bed net use and associated factors in a rice farming conducted in central of Kenya [17]. Similarly, research carried out by Jane *et al.*, showed that LLINS were used to fight against cool, consequently less used during hot seasons [35].

5. Conclusion

An effective coverage and correct/intensive usage Impregnated Bed nets are essential for a successful fight against malaria. However, usage of this tool is mostly as a protective tool against nuisance mosquito bites and for temperature regulations; and not against malaria. Designing evidence based policies that focus on communication for behavioral change to raise awareness and favor the use of LLINs; sensitizing and informing the population on malaria transmission cycle coupled to sanitation campaigns represents cornerstones for optimizing current strategies targeting the ambitious goal of controlling and eliminating malaria.

6. Limits of the Study

Data collection was done only during the dry season; and as such may impact on the usage rate calculated. Also, although the sample size was determined based on scientific approach P- values obtained were not significant for most; this could due to the fact that the sample size was not large enough.

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