fortune Journals

Research Article

ARCHIVES OF MICROBIOLOGY & IMMUNOLOGY

ISSN: 2572-9365

Use of Insecticide-Treated Mosquito Nets in Cameroon: A Cross-Sectional Study

Defo Tamgno Eric[*,1,2], Tiotsia Tsapi, Armand[2,3], Fossi Martin[1], Magne Tamoufe Gaelle[4], Ethgen Olivier[1], Nguefack-Tsague Georges[6]

Abstract

Background: Malaria remains a significant public health concern globally, particularly in the WHO African Region, where Cameroon is among the countries bearing a high burden of the disease. In Cameroon, malaria is highly endemic, with millions of cases and thousands of deaths recorded annually. Insecticide-treated mosquito nets (ITNs) are a crucial preventive measure against malaria, yet their ownership, utilization, and physical condition in Cameroon require evaluation.

Methods: A cross-sectional study was conducted in five regions of Cameroon, and data were collected through semi-open questionnaires from November 2020 to June 2022. The study assessed sociodemographic characteristics, ITN ownership and usage, and the physical integrity of ITNs. The proportionate hole index (pHI) was calculated to evaluate the ITN conditions. Malaria incidence was determined using rapid diagnostic tests (RDTs), and logistic regression analysis was performed to identify factors associated with ITN utilization.

Results: Among the 1719 participants, the sex distribution was balanced, with the majority aged 31 to 40 years. Awareness of malaria was high, with 100% familiarity with the disease. However, only 28.8% mentioned the use of ITN for prevention. The ITN possession rate was 66.55%, with 82% acquired through government-led campaigns. Only 65.91% of the ITN owners slept under one the previous night. Reasons for non-usage included heat (71.02%) and suffocation (24.90%). Physical integrity assessment revealed that only 34.97% of the ITNs were in good condition, emphasizing the need for proper maintenance.

The malaria incidence was 25.54%, with a significant association between ITN ownership and lower malaria positivity. Factors influencing ITN usage included region, sex, number of ITNs, pHI, and recent malaria experience.

Conclusion: This study underscores the importance of addressing barriers to consistent ITN usage and maintaining physical integrity. Health education programs should emphasize ITN effectiveness and proper care, particularly targeting regions with lower utilization rates. Additionally, interventions should consider sex, household characteristics, and recent malaria episodes when promoting ITN usage. By addressing these factors, Cameroon can enhance overall ITN utilization and contribute to reducing the burden of malaria on vulnerable populations.

Keywords: Malaria. Mosquito nets. Cameroon. This was a cross-sectional study

Affiliation:

[1]Department of Public Health, Epidemiology and Health Economics, University of Liege, Liege, Belgium.

[2]Faculty of Sciences and Technology, Evangelical University of Cameroon, Mbouo-Bandjoun, Cameroon.

[3]Department of Infectious Diseases, Microbiology, and Public Health, University of Rome "La Sapienza", Rome, Italy.

[4]Association HEADA Cameroon, Cameroon

[5]Department of Public Health, Faculty of Medicine and Biomedical Sciences, University of Yaoundé I, Cameroon

***Corresponding author:**
Defo Tamgno Eric, Department of Public Health, Tour de Pathologie 1 – Quartier Hôpital – B23, Avenue Hippocrate 13, 4000 Liege, Belgium.

Citation: Defo Tamgno Eric, Tiotsa Tsapi, Armand, Fossi Martin1, Magne Tamoufe Gaelle, Ethgen Olivier, Nguefack-Tsague Georges. Use of Insecticide-Treated Mosquito Nets in Cameroon: A Cross-Sectional Study. Archives of Microbiology and Immunology. 8 (2024): 452-459.

Received: August 21, 2024
Accepted: August 29, 2024
Published: October 16, 2024

Eric DT, et al., Arch Microbiol Immunology 2024
DOI:10.26502/ami.936500191

Keywords: Malaria. Mosquito nets. Cameroon. This was a cross-sectional study

Introduction

Malaria is a real public health issue. In 2021, there were an estimated 247 million cases of malaria worldwide (compared to 245 million cases in 2020), including 619,000 deaths (compared to 625,000 in 2020)(1). In the same year, the World Health Organization (WHO) African Region accounted for 95% of malaria cases and 96% of malaria-related deaths. Children under 5 represented approximately 80% of all malaria deaths in the region. This region bears a disproportionately high burden of the global malaria epidemic(1). The highest burden of malaria is carried by 11 countries, including Cameroon(2). In Cameroon, the entire population is exposed to malaria, making the disease highly endemic. According to the national surveillance report, Cameroon registers approximately 6 million cases of malaria annually, with health facilities recording approximately 4000 deaths, primarily occurring in children younger than 5 years of age(3). However, not all cases and deaths are recorded, and the WHO estimates that approximately 11,000 people die from malaria in Cameroon every year(3). Approximately 30% of outpatient visits to healthcare facilities are attributed to malaria, highlighting its significance as a prevalent disease in Cameroon(3). In 2021, the National Malaria Control Program (NMCP) of Cameroon reported 3,150,784 malaria cases and 3,863 deaths, constituting 30% of the reasons for consultation. This is an increase from 29 percent in 2019. Moreover, deaths in health facilities due to malaria increased from 14.3% in 2019 to 17.2% in 2020(4).

Malaria is caused by Plasmodium parasites and is transmitted to humans through the bites of infected female Anopheles mosquitoes(1). Using insecticide-treated nets (ITNs) is a preventive measure to prevent mosquito bites and has been proven to reduce the incidence of malaria, severe disease, and malaria-related deaths in endemic regions(5). For instance, in community-wide trials conducted in various African settings, ITNs demonstrated a reduction of child mortality under the age of 5 by approximately 20% from all causes(5). Additionally, it is estimated that 69% of the 663 million malaria cases prevented in sub-Saharan Africa between 2000 and 2015 can be attributed to the use of ITNs(6). Furthermore, when ITN usage is high, the protection provided by ITNs against malaria infection extends beyond the individual, providing indirect protection to the community(6).

For this reason, the Cameroonian government has organized four national campaigns of free long-lasting impregnated nets (LLIN) distribution since 2011, aiming to provide the majority of the population with this preventive strategy. In addition to these national campaigns, routine distributions are conducted, particularly targeting pregnant women who are free of LLINs during prenatal care visits (PCVs). However, according to the 2018 Demographic and Health Survey (DHS), only 59% of the de facto household population had access to an ITN, and only 54% of the household population had slept under an ITN the night before the interview(7). Three out of five (60%) children under 5 years of age and 61% of pregnant women aged 15-49 years had slept under an ITN(7). It is crucial to note the issue of the declining physical integrity of ITNs over time, leading to the presence of holes. The deterioration of physical integrity is a concern, as mosquitoes are more likely to enter LLINs with holes, exposing occupants to bites. Additionally, owners may stop using, discard, or repurpose nets with holes, rendering them ineffective at controlling malaria transmission(8). Therefore, the primary objective of this study was not only to assess the ownership and utilization of ITNs but also to evaluate the physical integrity of the ITNs in use.

Methods

To achieve our objective, we conducted a cross-sectional study with an analytical focus, employing a semi-open questionnaire. The study was carried out in five randomly selected health areas (Nsimeyong, Bépanda Omnisport, Ouro Kanadi, Ambam, and Fiala-Foréké) within five randomly selected health districts (Efoulan, Deido, Garoua 1, Ambam, and Dschang, respectively), representing five regions of Cameroon (Centre, Littoral, North, South, and West, respectively). Data collection occurred in two phases, from November 2020 to July 2021 and from December 2021 to June 2022. The structured questionnaire addressed the sociodemographic and economic characteristics of the respondents, as well as aspects related to the ownership and use of ITNs.

To evaluate the physical condition of the ITNs, we followed the guidelines published in 2011 by the World Health Organization Pesticide Evaluation Scheme (WHOPES)(9). These guidelines facilitate the assessment of the physical integrity of ITNs by quantifying the number of holes and calculating the proportionate hole index (pHI)(10). The initial step involved determining hole sizes based on their approximate diameter relative to the thumb (0.5–2 cm), fist (2–10 cm), head (10–25 cm), or larger than the head (≥ 25 cm). Holes with a diameter < 0.5 cm were excluded from the assessment, as the pHI method assumes that mosquitoes cannot pass through holes of this size(11). The subsequent step involved determining the pHI by assigning weights to each hole based on its size and then summing these values for each net, as per the following formula(9):

$$pHI = (n\ holes\ (a)) + (n\ holes\ (b) \times 23) + (n\ holes\ (c) \times 196) + (n\ holes\ (d) \times 578)$$

Eric DT, et al., Arch Microbiol Immunology 2024
DOI:10.26502/ami.936500191

where:

- n holes (a) = number of holes counted with diameter sizes between [0.5–2 cm]

- n holes (b) = number of holes counted with diameter sizes between [2–10 cm]

- n holes (c) = number of holes counted with diameter sizes between [10–25 cm]

- n holes (d) = number of holes counted with diameter ≥ 25 cm

The third step involved classifying ITN integrity based on the pHI into three categories: "good" ($0 \leq PHI \leq 64$; undamaged net with no reduction in efficacy), "acceptable" ($65 \leq PHI \leq 642$; efficacy reduced but still providing much greater protection than no net), and "too torn" ($PHI \geq 643$; net to be replaced, significantly reduced protection). (9,12).

During our research, we conducted malaria rapid diagnostic tests (RDTs) using the VIKIA Malaria Ag P.f/Pan test (Biomerieux, France) to determine the prevalence of malaria in our study population. Individuals with a positive result were referred to one of the nearest health facilities for management following national treatment guidelines. The sample included anyone who resided in one of the five health areas mentioned above during the study period, who was aged at least 18 years, and who provided informed consent.

The sample size calculation was performed using R software version 4.1.2. For this estimation, we utilized the population size of each health area, the 2019 malaria incidence according to the National Malaria Control Program (NMCP) (28 per 100 inhabitants), a confidence level of 95%, and a study precision of 0.05(13). We obtained different sample sizes for each health area, to which we added a margin of 10% to account for nonresponse rates. After calculation, we obtained a minimum sample size of 1,558 people for our study. Before analysis, the data were encoded in an Excel file version 2016 and exported to R software for analysis. Normally distributed quantitative variables are presented as the mean ± standard deviation, while nonnormally distributed variables are presented as the median (interquartile range). Frequencies and percentages (%) were used to describe qualitative variables. The factors associated with the ownership and use of ITNs were determined using binary logistic regression. P values less than 5% were considered to indicate statistical significance.

Results

Sociodemographic characteristics of the study population

In our study, we collected data from 1719 participants from various regions: 19.78% (340/1719) from the Centre Region, 21.12% (363/1719) from the Littoral Region, 18.56% (319/1719) from the North Region, 20.36% (350/1719) from the Ouest Region and 20.19% (347/1719) from the South Region. The study population exhibited gender parity (44.27% female. 55.73% male), predominantly falling within the age group of 31 to 40 years (44.68%). Educationally, 26.35% of the respondents had attained a university degree. Regarding income distribution, 21.87% had incomes below 100,000 XAF (152.49 Euro), 8.32% had incomes between 100,000 (152.49 Euro) and 200,000 XAF (304.98 Euro), 25.19% had incomes between 200,000 (304.98 Euro) and 300,000 XAF (457.47 Euro), and 44.62% had incomes above 300,000 XAF. Notably, 85.86% had no children under five years of age, and 95% had no pregnant women. The proximity to health facilities varied (≤2 km: 21%, 2–10 km: 40.20%, 10–20 km: 27.34%, >20 km: 11.46%). (Table 1)

Table 1: Sociodemographic variables

variables	modalities	Frequency (%)
Region	Centre	340 (19.78)
	Littoral	363 (21.12)
	North	319 (18.56)
	West	350 (20.36)
	South	347 (20.19)
Gender	Female	761 (44.27)
	Male	958 (55.73)
Age	21 to 30 years	486 (28.27)
	31 to 40 years	768 (44.68)
	41 to 50 years	166 (9.66)
	Over 50	299 (17.39)
Marital status	Single	530 (30.83)
	Cohabiting	168 (9.77)
	Divorced	256 (14.86)
	Married	417 (24.26)
	Widowed	348 (20.24)
Education level	Primary	284 (16.52)
	Secondary	361 (21)
	Higher No-university	621 (36.13)
	Higher education University	453 (26.35)
Income	Less than 100,000 XAF (150.97 EUR)	376 (21.87)
	Between 100,000 and 200,000 XAF (152.49-304.98 EUR)	143 (8.32)
	Between 200,000 and 300,000 XAF (304.98-457.47 EUR)	433 (25.19)
	Over 300,000 XAF (457.47 EUR)	767 (44.62)
Children under 5 years of age	Yes	243 (14.14)
	No	1476 (85.86)

Eric DT, et al., Arch Microbiol Immunology 2024
DOI:10.26502/ami.936500191

Presence of pregnant women	Yes	86 (5)
	No	1633 (95)
Distance to nearest health facility	Less than 2 km	361 (21)
	Between 2 and 10 km	691 (40.20)
	Between 10 and 20 km	470 (27.34)
	More than 20 km	197 (11.46)

Participants' knowledge of malaria

The study population exhibited a high awareness of malaria, with 100% reporting familiarity with the disease. Participants demonstrated a solid understanding of malaria's definition, identifying it primarily as a parasitic disease (91.86%). The recognized vector for malaria was correctly identified as a mosquito (100%). Knowledge about prevention methods varied, with 28.8% mentioning the use of insecticide-treated nets, 34.15% insecticide-treated nets, and 23.79% incense-treated nets. Knowledge levels were distributed, with 49.04% at a medium level and 50.96% at a good level. (Table 2).

Table 2: Malaria knowledge

Variables	Modalities	Frequency (%)
Having heard about malaria	Yes	1719 (100)
	No	0 (0)
Definition of malaria	parasitic disease	1579 (91.86)
	Contagious disease	140 (8.14)
	Hereditary disease	0 (0)
	Cancer	0 (0)
	Witchcraft	0 (0)
Malaria vector	Fly	0 (0)
	Mosquito	1719 (100)
	Bee	0 (0)
Time of day of the bite	Morning	0 (0)
	evening	1706 (99.24)
	between sunset and sunrise	13 (0.76)
Prevention methods	Insecticide-treated net	495 (28.8)
	PID	42 (2.44)
	Insecticide	587 (34.15)
	Incense	409 (23.79)
	Mosquito Net and Insecticide	186 (10.82)
Groups vulnerable to malaria	Children under 5	444 (25.83)
	Pregnant women	316 (18.38)
	Pregnant women and children under 5	959 (55.79)
	Elderly people	0(0)
	Other	0(0)
Level of knowledge about malaria	Low level	0(0)
	Medium level	843 (49.04)
	Good level	876 (50.96)

Insecticide-treated net ownership and use among the population

During our study, we observed that only 66.55% (1144/719) of the respondents possessed at least one insecticide-treated mosquito net. Among them, 82% (946/1144) had acquired it during previous free mosquito net distribution campaigns organized by the Cameroonian government. Notably, among individuals owning at least one mosquito net, only 65.91% (754/1144) had slept under a mosquito net the previous night. Among those who slept under a mosquito net, only 65.91% reported consistently sleeping under this protective measure. The most commonly cited reasons for not always using mosquito nets were heat (71.02%), suffocation (24.90%), and forgetfulness (4.08%). According to the proportionate hole index (pHI), only 34.97% of the respondents slept under a good-quality mosquito net the previous night, 40.73% under an acceptable-quality mosquito net, and 24.30% under a damaged mosquito net. (Table 3)

Table 3: Insecticide-treated net ownership and use

Variables	Modalities	Frequency (%)
Having at least one ITN in the household	Yes	1144 (66.55)
	No	575 (33.45)
Whether the respondent bought or received the ITN free of charge	Purchase	165 (14.42)
	Donation	946 (82.69)
	Donation and purchase	33 (2.88)
Where the ITN was purchased	Public market	36 (19.15)
	Pharmacy/Health facilities	81 (43.09)
	Street vendor	71 (37.77)
Whether the respondent uses the ITN	Yes	754 (65.91)
	No	390 (34.09)
Frequency of ITN use by the respondent	Always	519 (68.83)
	Sometimes	235 (31.17)
Why the respondent does not always use the ITN	Heat	174 (71.02)
	Choking	61 (24.90)
	Forget	10 (4.08)
pHI of ITN used by respondent	Damaged	278 (24.30)
	Acceptable	466 (40.73)
	Good	400 (34.97)

Malaria case history and prevalence

Among the participants, 81.15% (1395/1719) reported experiencing malaria in the 12 months before the survey, and 33.22% (571/1719) suffered from malaria in the month preceding the survey. According to the rapid diagnostic test (RDT) results, the prevalence of malaria was 25.54%. (Table 4)

Table 4: Malaria case history and prevalence

Variables	Modalities	Frequency (%)
Whether the respondent suffered from malaria in the 12 months preceding the survey	Yes	1395 (81.15)
	No	324 (18.85)
Whether the respondent suffered from malaria in the month preceding the survey	Yes	571 (33.22)
	No	1148 (66.78)
RDT results	Negative	1280 (74.46)
	Positive	439 (25.54)

The analysis of the RDT results about the possession of at least one ITN revealed a significant difference between those who had at least one ITN and those who did not. Indeed, among individuals who were positive for RDT, 69.5% did not have any ITN. This observation is also noted concerning the use of the ITN, where a higher positivity (80.9%) is observed in the group of those who do not use the ITN. (Table 5)

Table 5: Correlations between Malaria RDT Results and Ownership / Use of ITNs

		Having at least one mosquito net in the household		P.Value
		No	Yes	
RDT results	Negative	270 (21.1)	1010 (78.9)	<0.0001
	Positive	305 (69.5)	134 (30.5)	

		Whether the respondent uses the net		P.Value
		No	Yes	
RDT results	Negative	282 (27.9)	728 (72.1)	<0,0001
	Positive	108 (80.6)	28,6 (19.4)	

Factors associated with ITN use

The univariate binary logistic regression analysis revealed that six variables were significantly associated with the probability of using insecticide-treated bed nets (ITNs). These variables include region, gender, marital status, the number of ITNs in the household, the pHI of the ITN used by the respondent, and whether the respondent suffered from malaria in the month preceding the survey. The probability of using the ITN decreased for participants living in the North (OR=0.40; 95% CI=[0.26-0.62]), West (OR=0.48; 95% CI=[0.31-0.71]), and South (OR=0.57; 95% CI=[0.37-0.84]) regions compared to those in the Central region. It also decreased for males (OR=0.55; 95% CI=[0.44-0.71]) compared to females. This probability was greater for cohabitants (OR=1.75; 95% CI=[1.13-2.76]) than for singles, for those with at least 2 ITNs (OR=1.79; 95% CI=[0.85-4.23]), for those with undamaged ITNs (OR=2.34; 95% CI=[1.69-3.24]) than for those with damaged ITNs, and for those with malaria in the month preceding the survey (OR=1.23; 95% CI=[1.11-1.82]).

Multivariate analysis of significant univariate variables revealed that region, gender, the number of ITNs in the household, the pHI of the ITN, and whether the respondent suffered from malaria in the month preceding the survey were also significantly associated with the probability of using the ITN. The probability of using the ITN decreased for participants living in the North (OR=0.51; 95% CI=[0.33-0.80]), West (OR=0.53; 95% CI=[0.35-0.82]), and South (OR=0.54; 95% CI=[0.34-0.79]) regions compared to those in the Central region. It also decreased for males (OR=0.56; 95% CI=[0.43-0.73]) compared to females. This probability increased for those with at least 2 ITNs (OR=1.55; 95% CI=[1.28-3.12]), who were undamaged (OR=2.79; 95% CI=[1.97-3.98]) compared with those with a damaged ITN, and if the respondent suffered from malaria in the month preceding the survey (OR=1.32; 95% CI=[1.00-1.75]). An additional table file shows these results in more detail (see Additional file 1).

Discussion

Our study provides valuable insights into the possession and utilization of insecticide-treated mosquito nets (ITNs) among diverse populations in various regions of Cameroon. The demographic characteristics of our study participants reflected a balanced gender distribution, with a notable proportion falling within the age group of 31 to 40 years. This age distribution is crucial for understanding the targeted age groups for ITN interventions. Additionally, the educational and income profiles highlight the need for targeted interventions and health education programs to enhance ITN awareness among different socioeconomic strata. Our findings reveal a commendable level of awareness regarding malaria among the study population, with 100% reporting familiarity with the disease, 91% identifying it as a parasitic disease, and 100% recognizing mosquitoes as its vector. These results are similar to those of numerous studies(14,15). This can be explained by the fact that malaria is endemic in Cameroon, and the National Malaria Control Program of Cameroon has made significant efforts to raise awareness among the population, which has made patients more familiar with and more educated about the disease(14). This high awareness is a positive indicator of the success of

Eric DT, et al., Arch Microbiol Immunology 2024
DOI:10.26502/ami.936500191

health education initiatives in the country. However, it is important to note that only 28.8% of respondents mentioned using insecticide-treated nets (ITNs) as a preventive measure, compared to the use of insecticides (34.15%) and incense (23.79%). This indicates that efforts should be directed towards disseminating accurate information on the effectiveness of ITNs in preventing malaria, as demonstrated by several studies(10,16–19).

It is important to emphasize the pivotal role of ITNs in combating malaria. Our study revealed a mosquito net possession rate of 66.55%, with 82% of the ITN owners having obtained their nets through past government-led distribution campaigns, highlighting the impact of such initiatives. However, among those who owned ITNs, only 65.91% slept under one the previous night. These results are similar to those of Apinjoh et al. and Njumkeng et al. in their studies conducted in 2013 and 2014, respectively, where they demonstrated that the percentages of ITNs were 69.3% and 77.6%, respectively, in their study populations (20,21). However, regarding usage, they found percentages of 58.3% and 77.5%, respectively. The predominant reasons for not using the mosquito net in our study included heat (71.02%), suffocation (24.90%), and forgetfulness (4.08%) (20,21). Apinjoh et al. and Njumkeng et al. also identified these factors as reasons for the non-utilization of the mosquito net (20,21). It is important to note that the absence or even the non-use of insecticide-treated nets (ITNs) has consequences. Indeed, during our study, we observed that among individuals who tested positive for malaria, 69.5% did not own an ITN compared to those who did (30.5%). This observation was also noted among those who claimed to own the mosquito net. Specifically, this positivity was greater (80.9%) among those who did not use it than among those who did (28.6%). It should be noted that we obtained a malaria incidence of 25.54% in our study population. This prevalence is slightly lower than that recorded by the national malaria control program in 2021, which was 29.6% (22). This underlines the importance of addressing barriers to consistent ITN usage, such as discomfort due to heat and suffocation. Health education campaigns should focus on dispelling myths and addressing misconceptions that contribute to suboptimal ITN usage.

It is essential to highlight that simply owning or using a mosquito net is not enough to fully protect against malaria; the ITN must also be in good condition. In our study, regarding the proportionate hole index (pHI), only 34.97% of the participants slept under a good-quality mosquito net ($0 \leq PHI \leq 64$; undamaged net with no reduction in efficacy) the previous night, 40.73% under an acceptable-quality mosquito net ($65 \leq PHI \leq 642$; efficacy reduced but still providing much greater protection than no net), and 24.30% under a damaged mosquito net ($PHI \geq 643$; net to be replaced, significantly reduced protection). These results indicate that among the small proportion of individuals using mosquito nets, only 34% are in good condition. Furthermore, Shah et al., in their 2013 study, demonstrated that among ITN users, the incidence of malaria was significantly lower in users of ITNs with no holes (of any size) than in users of ITNs with≥1 hole (RR 0.82, 95% CI 0.69–0.98)(23). This result is consistent with ours, as it demonstrates that efforts should be directed towards not only distributing nets but also educating communities on the importance of proper net care and replacement. By addressing these issues, we can maximize the effectiveness of mosquito nets for malaria prevention and ultimately reduce the burden of this disease on vulnerable populations.

Regarding the factors associated with the non-utilization of ITNs, we observed that the region, gender, the number of ITNs in the household, the pHI of the ITN, and whether the respondent suffered from malaria in the month preceding the survey were also significantly associated with the probability of using the ITN. We noted that the probability of using the ITN varies depending on the region. It decreased significantly among respondents living in regions considered somewhat more urban (North region: OR=0.51; 95% CI=[0.33-0.80], West region: OR=0.53; 95% CI=[0.35-0.82], and South region: OR=0.54; 95% CI=[0.34-0.79]) compared to those in the Central region (which is more urban). We did not observe a significant difference between the Littoral region and the Central region, both of which are more urban. These results are consistent with numerous studies in the past that have shown greater use of ITNs in regions located in urban areas than in regions located in rural areas (24,25).

It also decreased for males (OR=0.56; 95% CI=[0.43-0.73]) compared to females. This result is similar to many studies that have demonstrated a lower use of the ITN among male individuals than among female individuals (24,26). This probability increased for those with at least 2 ITNs (OR=1.55; 95% CI=[1.28-3.12]) compared to those with only one mosquito net in the household. This means that the more mosquito nets there are in the household, the more likely the household members are to use them. Scott et al., in their study published in 2021 in Mozambique, made the same observation. Similarly, Babalola et al. published their study in 2022 (27,28). This probability increased for those with an undamaged ITN (OR=2.79; 95% CI=[1.97-3.98]) compared to those with a damaged ITN. This can be easily understood when we know that the more holes an ITN has, and depending on their size, the more mosquitoes it will let through. Finally, this probability increased for those who suffered from malaria in the month preceding the survey (OR=1.32; 95% CI=[1.00-1.75]). Through discussions with respondents, this could be explained by the fact that having recently experienced a malaria episode, they still have recent memories of the physical, moral, and social discomfort it

caused, and they try to prevent it further. The association between sociodemographic factors and ITN utilization, as revealed by our regression analyses, emphasizes the need for targeted interventions. Strategies should consider regional variations, gender disparities, and household characteristics, including the number and condition of ITNs. Tailored interventions for specific demographic groups, such as cohabitants and individuals with lower ITN accessibility, can enhance overall ITN usage.

Conclusion

In conclusion, our study on insecticide-treated mosquito nets (ITNs) in Cameroon revealed a commendable awareness of malaria among participants, yet gaps persist in understanding the efficacy of ITNs. Efforts should prioritize the dissemination of accurate information on ITN effectiveness and the dispelling of misconceptions. While past distribution campaigns have made strides in ITN possession, consistent usage remains a challenge and is often hindered by factors such as discomfort and misconceptions. Proper net care and replacement are crucial for maximizing effectiveness. Addressing barriers to usage through targeted health education campaigns is imperative. Additionally, sociodemographic factors influence ITN utilization, emphasizing the need for tailored interventions. Regional variations, gender disparities, and household characteristics should inform strategies to enhance overall ITN usage and reduce the burden of malaria on vulnerable populations. By prioritizing education, consistent usage, and targeted interventions, we can improve ITN effectiveness and contribute to malaria prevention efforts in Cameroon.

Abbreviations

CI: Confidence interval

DHS: Demographic and Health Survey

ITN: Insecticide-treated net

LLIN: Long-lasting insecticidal net

NMCP: National Malaria Control Program

pHI: Proportionate Hole Index

RDT: Rapid Diagnostic Test

WHO: World Health Organization

WHOPES: World Health Organization Pesticide Evaluation Scheme

Acknowledgments

We would like to express our gratitude to all the study participants for their cooperation. We would like to express our sincere gratitude to the local authorities for their authorization to conduct our research. without which this study would not have been possible.

Funding: The study did not receive funding.

Authors contributions

E.D.T. conceptualized the study, conducted the data analysis, and drafted the initial manuscript.

E.D.T, M.F, A.T.T & MTG contributed to the data collection and analysis and participated in the critical revision of the article for important intellectual content.

G.N.T, O.E & MF provided specific expertise on the methodology used, participated in interpreting the results, and contributed to the final writing of the article.

E.D.T, G.N.T & O.E oversaw the entire research process, contributed to substantial revision of the article for important intellectual content, and gave final approval of the version to be published.

Ethical declaration

Ethics approval: To conduct this study. We obtained the approval of the National Committee of Ethics Research for Human Health of Cameroon.

Reference number: 2020/02/1212/CE/CNERSH/SP

Consent to participate: All participants voluntarily contributed to this study and provided informed consent before their participation, ensuring ethical approval throughout the research process.

Consent for publication: Not applicable.

Conflict of interest: The authors declare that they have no conflicts of interest.

Availability of data and materials

All datasets on which the conclusions of the research rely are presented in this paper. However, the data are available from the corresponding author upon reasonable request.

References

1. World Health Organization. Malaria. 2022 (2023).
2. World Health Organization. World Malaria Report 2022. Geneva; (2022).
3. World Health Organization. Mobilizing communities to help prevent and control malaria in Cameroon (2022).
4. English news. Cameroon launches year-long anti-malaria campaign. 2022 (2023).
5. Centers for Disease and Control. How Can Malaria Cases and Deaths Be Reduced? - Insecticide-Treated Bed Nets. 4 January (2019).
6. Scott J, Kanyangarara M, Nhama A, Macete E, Moss WJ, Saute F. Factors associated with the use of the insecticide-

treated net for malaria prevention in Manica District, Mozambique: a community-based cross-sectional survey. Malar J. 1 déc 20 (2021): 1-9.

7. National Institute of Statistics (INS) and ICF. Cameroon Demographic and Health Survey 2018. Yaoundé, Cameroon et Rockville, Maryland, USA (2020).
8. Briet O, Koenker H, Norris L, Wiegand R, Vanden Eng J, Thackeray A, et al. Attrition, physical integrity and insecticidal activity of long-lasting insecticidal nets in sub-Saharan Africa and modeling of their impact on vectorial capacity. Malar J. 28 August 19 (2020): 1-15.
9. World Health Organization. Report of Fifteenth Working Group Meeting Control of Neglected Tropical Diseases WHO Pesticide Evaluation Scheme. Geneva (2012).
10. Minta AA, Landman KZ, Mwandama DA, Shah MP, Eng JLV, Sutcliffe JF, et al. The effect of holes in long-lasting insecticidal nets on malaria in Malawi: Results from a case-control study. Malar J. 2 oct 16 (2017): 1-10.
11. Vanden Eng JL, Mathanga DP, Landman K, Mwandama D, Minta AA, Shah M, et al. Assessing bed net damage: Comparisons of three measurement methods for estimating the size, shape, and distribution of holes on bed nets. Malar J 10 (2017): 1-13.
12. Boussougou-Sambe ST, Awono-Ambene P, Tasse GCT, Etang J, Binyang JA, Nouage LD, et al. Physical integrity and residual bioefficacy of used LLINs in three cities of the southwest region of Cameroon 4 years after the first national mass-distribution campaign. Malar J 17 (2017): 1-9.
13. National Malaria Control Program (NMCP). Epidemiological Situation - NMCP | Cameroon. 2020 [cited 7 April 2022].
14. [PDF] Malaria in West Cameroon: An Assessment of the Populations' Knowledge, Attitudes and Practices | Semantic Scholar. [cited 27 April 2024].
15. Status of malaria-related knowledge in school-going children in Cameroon | Semantic Scholar. [Cited 27 April 2024].
16. 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. déc 15 (2016): 172.
17. Taylor TE, Barlow R, Mathanga DP, Wilson ML, Campbell CH. reduction of childhood malaria by social marketing of insecticide-treated nets: a case-control study of effectiveness in Malawi. Am J Trop Med Hyg. 1 sept 73 (2005): 622-5.
18. Steinhardt LC, Jean YS, Impoinvil D, Mace KE, Wiegand R, Huber CS, et al. Effectiveness of insecticide-treated bednets in malaria prevention in Haiti: a case-control study. Lancet Glob Health. January 5 (2017): e96-103.
19. Krezanoski P. Delivering insecticide-treated nets for malaria prevention: innovative strategies. Res Rep Trop Med. Sept 7 (2016): 39-47.
20. Njumkeng C, Apinjoh TO, Anchang-Kimbi JK, Amin ET, Tanue EA, Njua-Yafi C, et al. Coverage and usage of insecticide-treated nets (ITNs) within households: associated factors and effect on the prevalence of malaria parasitemia in the Mount Cameroon area. BMC Public Health. déc 19 (2019): 1216.
21. Apinjoh TO, Anchang-Kimbi JK, Mugri RN, Tangoh DA, Nyingchu RV, Chi HF, et al. The Effect of Insecticide Treated Nets (ITNs) on Plasmodium falciparum Infection in Rural and Semi-Urban Communities in the Southwest Region of Cameroon. Culleton R, éditeur. PLOS ONE. 25 févr 10 (2015): e0116300.
22. National Malaria Control Program (NMCP). Epidemiological Situation - NMCP | Cameroon (2021).
23. Shah MP, Steinhardt LC, Mwandama D, Mzilahowa T, Gimnig JE, Bauleni A, et al. The effectiveness of older insecticide-treated bed nets (ITNs) to prevent malaria infection in an area of moderate pyrethroid resistance: results from a cohort study in Malawi. Malar J. 15 January 19 (2020): 24.
24. Tassembedo M, Coulibaly S, Ouedraogo B. Factors associated with the use of insecticide-treated nets: analysis of the 2018 Burkina Faso Malaria Indicator Survey. Malar J. 17 mai 20 (2021): 220.
25. Yeboah A. Comparative analysis of factors associated with insecticide-treated net utilization between rural and urban areas in Ghana: implication for malaria control and prevention.
26. Garley AE, Ivanovich E, Eckert E, Negroustoueva S, Ye Y. Gender differences in the use of insecticide-treated nets after a universal free distribution campaign in Kano State, Nigeria: postcampaign survey results. Malar J. 10 avr 12 (2013): 119.
27. Scott J, Kanyangarara M, Nhama A, Macete E, Moss WJ, Saute F. Factors associated with the use of insecticide-treated net for malaria prevention in Manica District, Mozambique: a community-based cross-sectional survey. Malar J. 27 avr 20 (2021): 200.
28. Babalola S, Kumoji K, Awantang GN, Oyenubi OA, Toso M, Tsang S, et al. Ideational factors associated with consistent use of insecticide-treated nets: a multicountry, multilevel analysis. Malar J. 6 déc 21 (2022): 374.