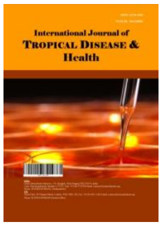


International Journal of TROPICAL DISEASE & Health

41(20): 1-10, 2020; Article no.IJTDH.62488
ISSN: 2278–1005, NLM ID: 101632866

Reduction of Malaria by Insecticide-Treated Mosquito Nets in Potiskum, Yobe State, Nigeria

Audu Ali[1], Aminu Y. Bala[2], Elijah S. Okwuonu[3*], Chinemerem H. Orakwelu[3] and Ifeanyi O. Aguzie[3]

[1]Department of Biological Science, Yobe State University, Yobe State, Damaturu, Nigeria.
[2]Department of Biological Sciences, Zoology Unit, Usmanu Danfodiyo University, Sokoto, Nigeria.
[3]Department of Zoology and Environmental Biology, University of Nigeria, Nsukka, Enugu, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Authors AA and AYB designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors ESO, CHO and IOA did the follow-up statistical analyses of the study, managed the literature searches, and edited and wrote the final draft. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJTDH/2020/v41i2030388
Editor(s):
(1) Dr. Cihad Dundar, Ondokuz Mayıs University, Turkey.
(2) Dr. Payala Vijayalakshmi, Gitam University, India.
Reviewers:
(1) Patricia Ghann, Jiangsu University, China.
(2) Dilek Aslan, Hacettepe University, Turkey.
Complete Peer review History: http://www.sdiarticle4.com/review-history/62488

Original Research Article

Received 28 September 2020
Accepted 03 December 2020
Published 17 December 2020

ABSTRACT

Aims: The study was conducted to assess prevalence of malaria pre- and post-distribution of insecticide treated nets (ITNs) in Potiskum Local Government Area, Yobe State, Nigeria.
Study Design: Retrospective and cross-sectional.
Place of Study: Potiskum Local Government Area, Yobe State, Nigeria.
Materials and Methods: Prevalence of malaria infection in ten political wards pre-distribution of ITNs was investigated using secondary data sources from Roll Back Malaria and Integrated Disease Surveillance and Response offices. Thin and thick blood smears used to evaluate malaria prevalence post-distribution of ITNs were prepared from blood samples of 520 patients seeking medical attention from the General Hospital, Potiskum. Questionnaires were also handed out to the same set of patients.
Results: Prevalence of malaria infection pre- and post-distribution of ITNs in the study area was 57.9% and 22.9% respectively. Respondents to the questionnaire (n = 216) had mosquito nets, of

**Corresponding author: Email: elijah.okwuonu@unn.edu.ng;*

whom 85% owned long-lasting ITNs and the remaining, conventional nets, but 35% used ITNs in their homes and 63% of those owning ITNs received them free-of-charge from local health centers.
Conclusion: If the impact of ITNs as an effective malaria vector control measure must be sustained, there should be a corresponding awareness program, which should be aimed at encouraging proper and constant use of ITNs.

Keywords: Insecticide treated net; malaria control; malaria prevention; mosquito control.

1. INTRODUCTION

Malaria, a vector-borne parasitic disease of public health importance in tropical and subtropical regions of the world, is caused by *Plasmodium* protozoon and transmitted to humans through bites of an infected female mosquito of the genus *Anopheles* [1]. The disease is characterized by malaise, cyclical bouts of fever, headache, and nausea, which if untreated can result in anemia, kidney failure, coma, and/or death [2]. Humans, serve as host to five species of malaria parasites, namely, *P. falciparum*, *P. knowelsi* (recently identified), *P. malariae, P. ovale,* and *P. vivax,* among which *P. falciparum* is the most common (in certain countries) and most virulent [1].

Malaria is endemic in about 87 countries with more than half of the world population at risk [3]. Approximately 200 million cases of malaria occurred in 2017 and 435,000 people were estimated to have died of the disease in the same period [3]. More than 90% of malaria burden occurs in sub-Saharan Africa, where severe malaria disease and death occur mainly among children in rural areas, who have little access to health services and protection against mosquito bites [1,4-6], and among pregnant women [1].

About 465 species of *Anopheles* mosquitoes are distributed globally, but approximately 70 of these species have the capacity to transmit human malaria parasites [7]. The changing patterns of malaria parasite infections call for a need to supplement and strengthen malaria control activities with preventive efforts, such as insecticide treated net (ITNs), identified to have significant impact in reducing morbidity and mortality particularly among children under five years of age and pregnant women [8]. An insecticide treated net (ITN) is one that repels, disables and/or kills mosquitoes that come in contact with the insecticide on the netting material. There are two categories of ITNs, namely, conventional treated nets and long lasting insecticide-treated nets (LLIN). A conventional treated net is treated by dipping in a WHO recommended insecticide and should be re-treated after three washes or at least once a year [9]. LLIN is made with materials that have insecticide incorporated within or bound around the fiber and retains its effectiveness for at least 22 washes (under laboratory condition) and three years under field condition without re-treatment [9]. The proportion of children sleeping under ITNs in sub-Saharan Africa has increased from 2% to 39% in the past ten years, owing to external and domestic internal aid. This has dramatically brought down the number of malaria deaths between 25% and 50% in many countries, such as Ethiopia, Namibia, Senegal, Swaziland, and Zambia [10]. While the development of new control tools is essential, it is equally recognized that most morbidity and mortality associated with malaria can be reduced, provided existing tools are made accessible and are used effectively. It was estimated that six lives could be saved for every 1,000 children protected under bed nets, translating to approximately 336,000 malaria deaths averted if every child slept under ITNs [11].

Malaria is also a major public health problem in Nigeria [12]. Efforts are being made by government and non-governmental organizations to control the disease, especially through distribution of ITNs [13]. Effective application of ITNs for malaria control comprises three main components, namely, bed net ownership, regular and correct re-treatment of bed nets and consistency of use and re-treatment. The rationale is that it does not matter how efficacious an intervention is, if compliance with its use is low, its effectiveness will be poor.

Hence, this study evaluated the impact of ITNs on malaria transmission in Potiskum Local Government Area (LGA), Yobe State, Nigeria. It is also focused on awareness and attitude of the population towards malaria and ITNs. The status of malaria pre-distribution and post-distribution of ITNs in the LGA was based on secondary and primary data and used to address two key questions: (i) whether there was a reduction in malaria prevalence post-distribution of ITNs, and

(ii) the knowledge, attitude and practice of the people towards malaria and ITNs.

2. MATERIALS AND METHODS

2.1 Study Area

Potiskum LGA, Yobe State, Nigeria has its headquarters in Potiskum Town. It covers an area of 2,671 km^2 with population of 236,247 [14]. The LGA (latitude 11°42'50.08" N and longitude 11°04'51.89" E) lies in the south western part of the state, sharing common boundaries with Fika LGA to the south, Fune LGA to the east and Nangere LGA to the north-west. Potiskum has an annual rainfall of 25-35 mm, with a rainy season from June to late September and a dry season from November to February. The average maximum and minimum temperature is 38.8°C and 20.4°C respectively according to the Nigeria Meteorological Unit Potiskum, 2012 (See also Eludoyin et al. [15]). Administratively, Potiskum LGA has 10 political wards: Bari-Bari, Bolewa ‘A’, Bolewa ‘B’, Danchua, Dogo-Nini, Dogo-Tebo, Hausawa Asibiti, Mamudo, Ngojin and Yarimaran (Fig. 1). All wards are <10 km distant from the local government headquarter (Roll Back Malaria Office, Potiskum, [16]).

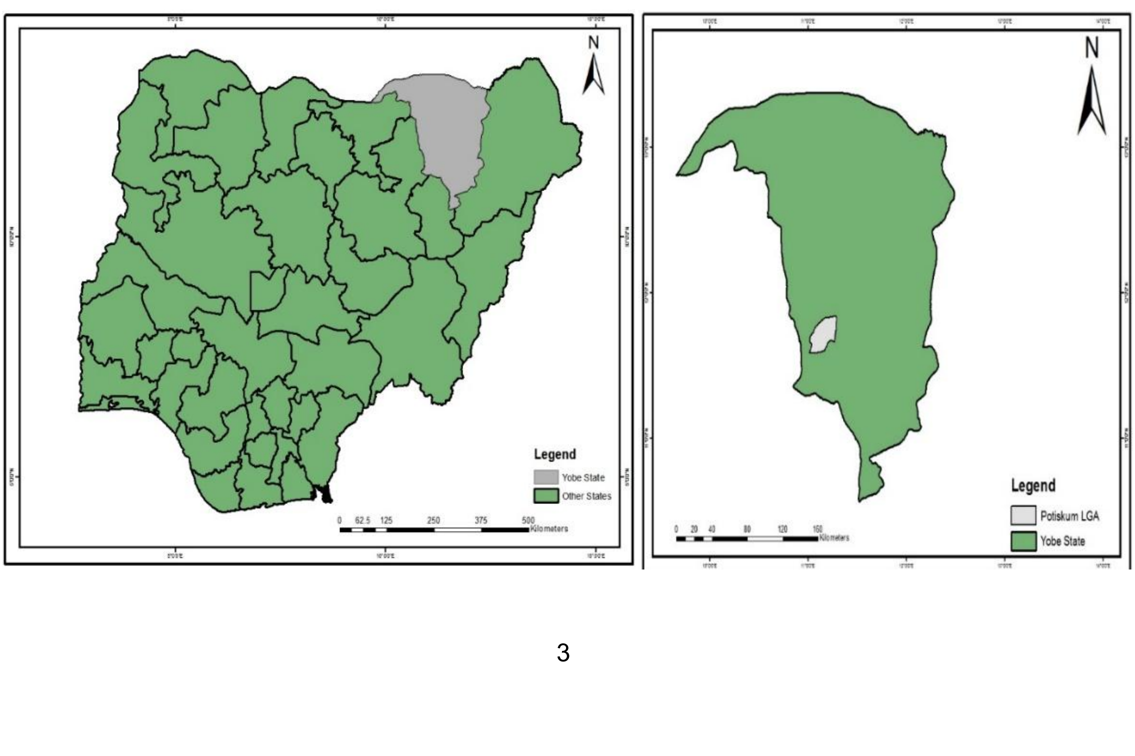
2.2 Sampling Procedures, Duration and Microscopy

In order to establish the prevalence of malaria pre-distribution of ITNs, secondary data on malaria prevalence was collected from the Integrated Disease Surveillance System Response office covering January 2010 to December 2011. ITNs were distributed in 2011. The records of distributed ITNs were collected from Roll Back Malaria office in Potiskum town. Malaria prevalence post-distribution of ITNs in the study area was established from blood samples collected weekly from 10 randomly selected patients attending the hospitals in all the political wards for a period of 52 weeks (January 2012 - December 2012). Thick and thin blood smears were prepared on the same slide, stained according to Cheesbrough [17] and viewed under the microscope, 100x magnification [18]. All slides were re-examined by an independent microscopist to ensure quality control [17]. A slide is considered negative for malaria parasites after viewing at least 100 microscopic fields of both thick and thin smears [17].

The study was compliant to the Declaration of Helsinki [19]. Participation in the study was completely voluntary.

2.3 Questionnaire

Questionnaires (n = 530) were distributed to the same group of patients attending the hospitals to ascertain their level of knowledge, attitude and practice towards ITNs. The questionnaire was close-ended and administered in English language and interpreted in the local languages when the need arose. The questionnaire was interviewer-based, and children who could not respond to the questions were represented by their parent(s) or legal guardian(s).



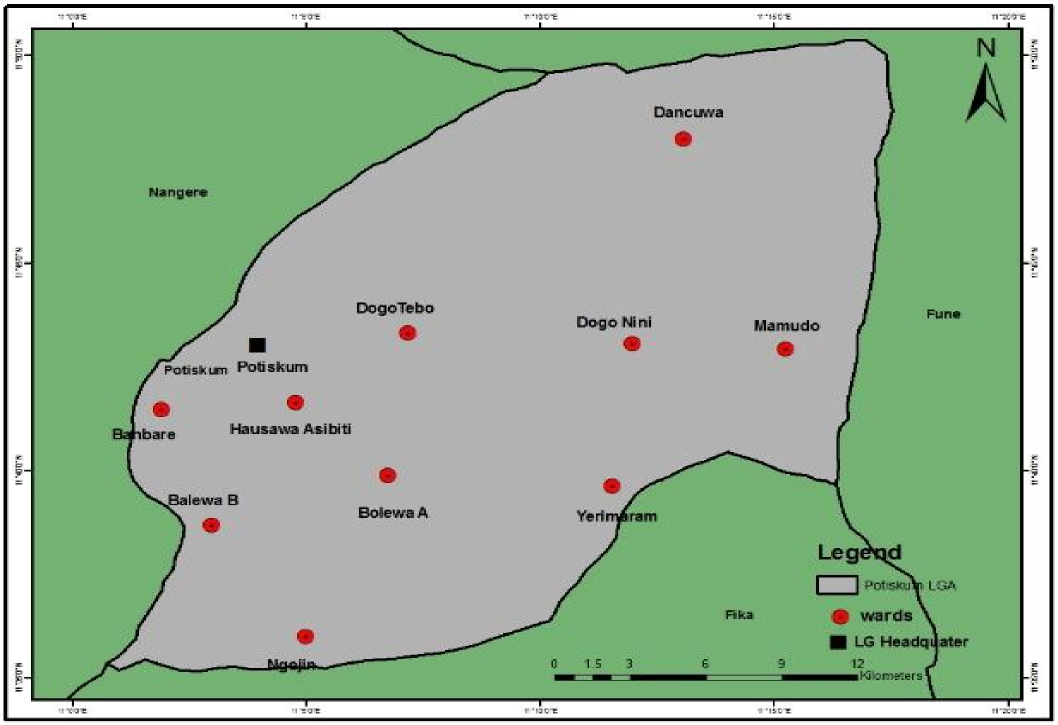


Fig. 1. Maps of the study area in Nigeria. LG, Local Government; LGA, Local Government Area

2.4 Statistical Analysis

Data was analyzed using SPSS® version 20.0 (IBM Corporation, Armonk, USA). Chi-square or Fisher Exact test was used to compare prevalence of malaria and questionnaire responses. Level of significance was set at $p \leq 0.05$.

3. RESULTS

3.1 Malaria Prevalence Pre- and Post-Distribution of ITNs

Records (n = 6,240) were examined from 2010 to 2011, of which 3,612 (57.9%) individuals were malaria-positive (Table 1). Malaria prevalence in the ten political wards was 43.5-69.1%, highest in Dogo-Nini ward and lowest in Yerimaram ward (χ^2 = 117.0, *p*-value < 0.001). Malaria prevalence was significantly higher in males (67.8%) than females (46.0%) (χ^2 = 302.1, *p*-value < 0.001). Age was a significant determinant of malaria prevalence (χ^2 = 672.6, *p*-value < 0.001), with prevalence higher in the age groups <1-4 years (76.7%) and 5-9 years (65.5%).

Patients (n = 520) from the 10 political wards were examined in 2012, of whom 119 (22.9%) were infected with malaria parasite (Table 1). Patients from Mamudo ward recorded the highest number of malaria cases, 23 (39.7%), while the lowest occurred in Yerimaram ward, 6 (13.3%) (χ^2 = 26.8, *p*-value = 0.002). Peaks of malaria prevalence in 2012 were similar to that of the Integrated Disease Surveillance System Response office records of 2010-2011. The age groups <1-4 years and 5-9 years had relatively higher prevalence (41.4 and 25.2% respectively). In general, malaria prevalence tended to significantly decline with increasing age (χ^2 = 49.3, *p*-value < 0.001).

Malaria prevalence in the study area was higher pre- than post-distribution of ITNs than for each of the months from January to December (2012) (Fig. 2). Overall malaria prevalence is significantly higher pre-distribution compared to post-distribution of ITNs (χ^2 = 31.4, df = 11, *p*-value < 0.001). The month of peak malaria prevalence was October, and lowest in August and September both before and after ITNs distribution.

Table 1. Malaria infection among out-patients of ten political wards in Potiskum Local Government Area, Yobe State, Nigeria (2010 - 2012)

	2010-2011(before ITNs distribution)[a]		2012 (after ITNs distribution)[b]	
	Number of patients	Number of infected patients (%)	Number of participating patients	Number of infected patients (%)
Political ward				
Bare-Bari	604	348 (57.6)	48	14 (29)
Bolewa 'A'	644	378 (58.7)	56	10 (18)
Bolewa 'B'	648	401 (61.9)	59	9 (15)
Danchuwa	600	322 (53.7)	47	8 (17)
Dogo-Nini	654	452 (69.1)	60	18 (30)
Dogo-Tebo	610	362 (59.3)	51	14 (27)
Hausawa	616	368 (59.7)	49	14 (29)
Mamudo	652	412 (63.2)	58	23 (40)
Ngojin	605	305 (50.4)	47	3 (6)
Yerimaram	607	264 (43.5)	45	6 (13)
Sex				
Male	3,390	2,300 (67.9)	280	70 (25)
Female	2,850	1,312 (46.0)	240	49 (20)
Age (years)				
<1-4	1,562	1,198 (76.7)	145	60 (41)
5-9	1371	898 (65.5)	123	31 (25)
10-14	1338	740 (55.3)	73	11 (15)
15-19	613	345 (56.3)	51	5 (10)
20-24	342	139 (40.6)	38	4 (10)
25-29	291	98 (33.7)	32	3 (9)
30-34	283	90 (31.8)	24	2 (8)
35-39	272	69 (20.8)	20	2 (10)
≥40	168	35 (57.9)	14	1 (7)
Total	6,240	3,612 (57.9)	520	119 (22.9)

[a]From the integrated disease surveillance system response office. [b]Thick and thin blood smears. ITNs, insecticide treated mosquito nets

3.2 Respondents' Knowledge, Attitude and Practice towards Malaria and Insecticide Treated Nets

Age range of the respondents (n = 519) to the questionnaire was <1 to >40 years (Table 2). The majority of the respondents, 424 (81.7%), were in the affirmative regarding knowledge of malaria, while 95 (18.3%) had no knowledge of malaria (Table 3). One hundred and ninety-one (36.8%) respondents reported one symptom of malaria (fever), followed by 183 (35.3%) three signs/symptoms (fever, headache and vomiting) and 76 (14.6%) and 69 (13.3%) two symptoms (fever and chill or fever and headache respectively). An evaluation of the measures taken to protect family members from malaria, 375 (72.3%) used spraying of insecticide, proper disposal of refuse and good drainage pattern as a protective measure, while 144 (27.7%) ignored the environmental problems. A further assessment of the measures taken by the respondents to prevent mosquito bites revealed 183 (35.3%) respondents slept under ITNs, 143 (27.6%) used mosquito coils and 117 (22.5%) spray insecticides, 46 (8.9%) cleared the surrounding environment, and 30 (5.7%) used all the above mentioned preventive measures. Only 342 (65.9%) respondents knew of ITNs and 184 (85.2%) had LLINs, while 32 (14.8%) used conventional nets. Among respondents who used ITNs 155 (84.7%) acknowledged ITNs had helped reduce malaria incidence while 28 (15.3) reported no change in malaria incidence.

Table 2. Demographic of respondents to questionnaire distributed to participating out-patients of ten political wards in Potiskum Local Government Area, Yobe State, Nigeria (2012)

Characteristic	Number (%) (n = 519)
Age group (years)	
0-4	130 (25.1)
5-9	84 (16.2)
10-14	80 (15.1)
15-19	73 (14.1)
20-24	50 (10.0)
25-29	47 (9.1)
30-34	22 (4.2)
35-39	18 (3.5)
≥40	15 (3.0)
Sex	
Male	282 (54.3)
Female	237 (45.7)
Ethnic group	
Kare-Kare	170 (32.8)
Ngizim	107 (20.6)
Bolewa	85 (16.4)
Others	113 (21.8)
Marital status	
Married	44 (8.5)
Single	196 (37.8)
Separated	20 (3.9)
Widow	7 (1.3)
Education	
Informal	141 (27.2)
Quranic	166 (32.0)
Pre-nursery	93 (17.9)
Nursery	26 (5.0)
Primary	93 (17.9)
Secondary	20 (3.9)
Tertiary	18 (3.5)

4. DISCUSSION

This study shows some 50% decrease of malaria prevalence in Potiskum Local Government Area, Yobe State from 2010 (pre-distribution of ITNs) and 2012 (post-distribution of ITNs). This could point to a success in vector control through use of ITNs targeted to prevent human-vector contact, hence cutting the transmission chain as similarly noted by Lengeler [20]. On the other hand, Okonko et al. [21] observed no significant difference in the malaria incidence pre-distribution (80.7%) and post-distribution (79.0%) of ITNs. The impact of ITNs on malaria prevalence is known to be determined by a number of factors such as level of people awareness to the importance of the use of ITNs [22], availability and proper use of ITNs [22,23], and prevailing climatic conditions [24]. The responses gathered from the respondents on the knowledge, acceptability and usage of ITNs highlighted the importance of awareness to the success of ITNs as a control measure for malaria.

The higher rate of malaria in males compared to females, both pre- and post-ITNs distributions, could be associated with exposure of males to places such as bushes and farms where mosquitoes are known to hide and breed. This result agrees with that of Adeleke [25] who reported males (73.8%) were slightly more infected than females 163 (69.4%). A contrary observation was made by Daboer et al. [26] where females had higher malaria prevalence (46.6%) than males (29.9%).

Table 3. Knowledge, attitude and practice of respondents to questionnaire distributed to participating out-patients of ten political wards in Potiskum Local Government Area, Yobe State, Nigeria (2012)

Category	Response	Number (%) (n = 519)
Knowledge		
Malaria knowledge	Yes	424 (81.7)
Sign and symptom	Fever	191 (36.8)
	Fever + chill	76 (14.6)
	Fever + headache	69 (13.3)
	Fever + headache + vomiting	183 (35.3)
Cause	Living near stagnant water	181 (34.9)
	Mosquito bite	295 (56.8)
	Sun heat	43 (8.3)
Site of malaria parasites in body fluid	Blood	89 (17.1)
	Do not know	430 (82.9)
Knowledge of ITNs	Yes	342 (65.9)
Knowledge of ITN types	One	175 (33.7)
	Two	269 (51.8)
	Four	75 (14.5)
Attitude and practice		
Malaria treatment practiced	Traditional	56 (10.8)
	Orthodox	148 (28.5)
	Use of drugs	117 (22.5)
	All of the above	198 (38.2)
Treatment-seeking behavior	Go to pharmacy	154 (29.7)
	See doctor	257 (49.5)
	Self-prescription	108 (20.8)
Protective measures against malaria	Spray insecticide, proper disposal of refuse and good drainage	375 (72.3)
	Ignoring environmental problems	144 (27.7)
	Cleaning environment	46 (8.9)
	Spray insecticide	117 (22.5)
	Sleep under net	183 (35.3)
	Use mosquito coil	143 (27.6)
	All of the above	30 (5.8)
Enforcement of sanitation measures by community leader	Yes	228 (43.9)
	No	291 (56.1)
Type of ITN owned by household	LLN	184 (85.2)
	Conventional	32 (14.8)
Source of ITN	Bought from market	81 (37.4)
	Given free by hospital	135 (62.6)
Used ITN all year round	Yes	356 (68.6)
	No	163 (31.4)
If no, when?	Rainy season	129 (24.9)
	Dry season	34 (6.6)
Number of family members sleeping under ITN	None	55 (10.6)
	All	271 (52.2)
	Others	193 (37.2)
Changes noticed in family since ITN use	Decline in malaria cases	155 (84.7)
	No change in malaria cases	28 (15.3)
Problems in using ITN	Yes	157 (30.3)
	No	362 (69.7)

ITN, insecticide=treated mosquito net; LLN, long lasting ITN

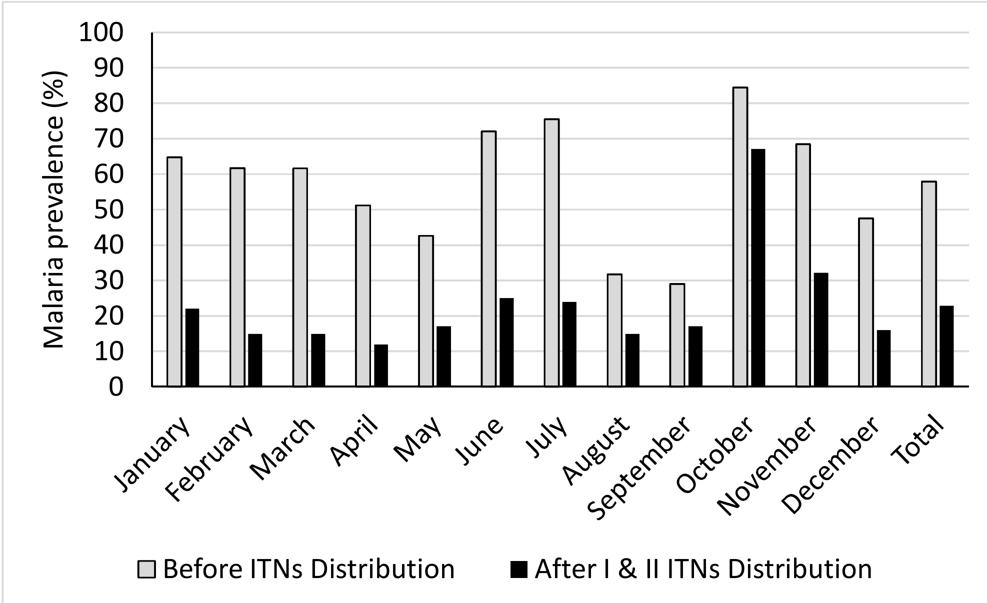


Fig. 2. Mean monthly malaria prevalence in Potiskum Local Government Area, Yobe State, Nigeria (2010-2012). I and II distribution of insecticide-treated nets (ITNs) occurred in 2011 and 2012 respectively. *χ^2 = 31.412, df = 11, p-value < 0.001; chi-square and p-value derived from comparison of monthly difference in malaria prevalence (%) before ITNs and after I and II ITNs distribution

The <1-4-year age group was the most vulnerable group to malaria. This is explained by their lack of acquired immunity to the disease. This finding is similar to those of Rogier and Trape [27] in Kaduna, Inabo and Umaru [28] in Zaria, and Ekeh and Teclire [29] in Abia.

A relatively high percent respondents recognized mosquito as the vector of malaria and ITN as an important preventive measure. These results were higher than in a similar study of Michelle et al. [30], where a relatively low percent respondents, 35% and 17% respectively, recognized mosquito as the vector of malaria and ITN as an important preventive measure. However, the relatively high number of our respondents regarding knowledge of the source of malaria did not translate into the same measure of ITN usage. This disconnect might be due to such factors as unavailability, lack of acceptance and lack of will to use ITN [31].

5. CONCLUSION

Overall, the reduction in malaria prevalence post-distribution of ITNs suggests ITNs use holds high potential in reducing human-mosquito contact thereby breaking the malaria transmission chain. In view of the findings of this research work, the following recommendations are suggested: (i) increasing availability of ITNs and intensifying awareness programs aimed at improving acceptability and proper usage of ITNs to sustain reduction in vector-human contact, and (ii) conducting further studies on the impact of ITNs as a potential preventive measure be encouraged and intensified in other parts of Nigeria.

The authors wish to acknowledge some limitations of the study. It is difficult to conclude that the reduction in malaria prevalence post-distribution of ITNs as observed in this study was due entirely to ITNs ownership and use. Other factors such as increased awareness, introduction of other complementary control measures, and changing climatic condition may have contributed to the observed reduction in malaria morbidity. These factors were not taking into consideration in the design of this study.

CONSENT

As per international standard or university standard written patient consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

It is not applicable.

ACKNOWLEDGEMENTS

The authors are grateful to the Integrated Disease Surveillance System Response office and the Roll Back Malaria office, both in Potiskum. The authors are equally grateful to all study participants.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Aguzie ION. Pregnancy-associated Malaria, Challenges and Prospects in Sub-Saharan Africa. *Clinics in Mother and Child Health,* 2018;15(1):1000282. DOI:10.4172/20907214.1000282
2. Ousmane BT, *Banao T*O, Adamu T, Abubakar U, Ladan MJ, Bala AY, Mu'Awiyya UL. The Prevalence of malaria in pregnant women in Maradi Metropolis, Niger Republic. Nigerian J Parasitol. 2010; 31(1):31-34.
3. World Health Organization. Malaria. (Accessed 2019 July 31). Available:https://www.who.int/news-room/fact-sheets/detail/malaria
4. Green LW, Kreuter MW. Health promotion planning: An educational and ecological approach, 3rd Ed. Mountain View California, USA; 1999.
5. Snow RW, Craig M, Deichman U, Marsh K. Estimating mortality, morbidity and disability due to malaria among Africa's non-Pregnant population. Bulletin of the World Health Organization. 1999;77:624–664.
6. World Health Organization. Malaria control in WHO Africa Region. Turning resources in to results. Annual Reports, 2003. World Health Organization, Geneva; 2003.
7. Service MW, Townson H. The anopheles vector. In: HM Gilles, DA Warrell (editors), Essential Malariology, Fourth edition. Arnold, London. 2002;59-84.
8. Lengeler C. Insecticide-treated bed nets and curtains for preventing malaria. Cochrane Database Syst Rev. 2004; CD000363; 2004.
9. World Health Organization. Guidelines for laboratory and field testing of long-lasting insecticidal mosquito nets. Geneva, World Health Organization; 2005. (WHO/CDS/WHOPES/GCDPP/2005.11).
10. UNDP. The Millenium development goals report, New: United Nation. WHO; 2012.
11. Lengeler C. Insecticide treated bed nets and curtains for preventing malaria. Cochrane Database of Systematic Reviews, 20040 (2): CD000363 (update of Cochradne Databases of systematic Reviews) 20004 (2); CD 000363; 2005.
12. Jimoh A, Sofola O, Petu A, Okorosobo T. Quantifying the economic burden of malaria in Nigeria using the willingness to pay approach. Cost Effectiveness and Resource Allocation. 2007;5:6–14.
13. US president's malaria initiative. Malaria Operational Plan FY; 2019.
14. National population commission of Nigeria (NPC). Facts and Figures, Potiskum Branch; 2006. Available:www.population.gov.ng/Factsand Figures2006; 2010.
15. Eludoyin OM, Adelekan IO, Webster R, Eludoyin AO. Air temperature, relative humidity, climate reorganization and thermal comfort of Nigeria. International Journal of Climatology. 2013;34:2000–2018.
16. Roll Back Malaria. Potential for progress. Roll Back Malaria. Available:http://www.rbm.who.int (Accessed January, 2012).
17. Cheesbrough M. District laboratory practice in tropical countries, Part 1. Cambridge: Cambridge University Press. 2006;239-258.
18. WHO. Guidelines for the treatment of malaria, second edition; 2010. Available:http:/www.who.int/malaria/publications/atoz/9689241547925/index.html (Accessed June 2011)
19. World Medical Association. World Medical Association Declaration of Helsinki, ethical principles for medical research involving human subjects. Bulletin of the World Health Organization. 2001;79(4):373–374.
20. Lengeler C. Insecticide-treated bed nets and curtains for preventing malaria. Cochrane Database Syst Rev. 2009; CD000363-2.
21. Okonko IO, Soleye FA, Amusan TA, Ogun AA, Udeze AO, Ejembi J, Faleye TOC. Prevalence of malaria Plasmodium in

Abeokuta, Nigeria. Malaysian Journal of Microbiology. 2009;5(2):113–118.
22. Rehman AM, Coleman M, Schwabe C, et al. How much does malaria vector control quality matter: The epidemiological impact of holed nets and inadequate indoor residual spraying. PLoS One. 2011;6: e19205.
DOI: 10.1371/journal.pone.0019205
23. Aguzie ION, Ivoke N, Onyishi GC, Okoye IC. Antenatal Practices Ineffective at Prevention of *Plasmodium falciparum* Malaria during Pregnancy in a Sub-Saharan Africa Region, Nigeria. Tropical Medicine and Infectious Diseases. 2017; 2:15.
DOI: 10.3390/tropicalmed2020015
24. Biadgilign S, Reda A, Kedir H. Determinants of ownership and utilization of insecticide-treated bed nets for malaria control in Eastern Ethiopia. J Trop Med; 2012.
DOI:10.1155/2012/235015
25. Adeleke SI. Malaria parasitaemia and its correlation with age in children diagnosed at Aminu Kano Teaching Hospital, Kano, Nigeria. International J Pure Applied Sci Tech. 2007;1(2): 39-42.
26. Daboer JC, Chingle MP, Ogbonna C. Malaria parasitaemia and house hold use of insecticide treated bed nets: A cross sectional survey of under five in Jos, Nigeria. Nigerian Med J. 2010;51(1):1-5.
27. Rogier C, Trape JF. Study of premonition development in holo- and mesoendemic malaria area in Dielmo and Ndiop (Senegal): Preliminary results, 1990-1994. Med Trop. 1995;55:71-76.
28. Inabo HI, Umaru BZ. Studies on the incidence as asymptomatic *Plasmodium* infection among apparently healthy subjects in orphanages in Kaduna and Zaria: Bayero J Pure and Applied Sci. 2011;4(2):83–88.
29. Ekeh EL, Teclire NN. Prevalence of Malaria parasitaemia and Association factor in febrile under five year children in P. H. C. Centres in Jos, North Central Nigeria. Nigeria Postgraduate Med J. 2008;15(2):65- 69.
30. Michelle R, Mahamadou S, Sharon P, Willi M, Julie P, Ogobara D. Use of ITN following a malaria education interview in Pirion, Mali: A control trial with systematic allocation of households. Malar J. 2005; 4:35.
31. D'Alessandro U, Olaleye B, McGuire W, Langerock P, Bennett S, Aikins M, Thomson M, Cham M, Greenwood BM. Mortality and morbidity from malaria in Gambian children after introduction of an impregnated bednet programme. Lancet. 1995;346:462-467.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/62488