International Journal of Mosquito Research

ISSN: **2348-5906**
CODEN: **IJMRK2**
IJMR 2019; 6(4): 26-30

Received: 09-05-2019
Accepted: 13-06-2019

Pam DD
Department of Zoology, University of Jos, P.M.B. 2084, Jos, Nigeria

Neslea AM
Department of Zoology, University of Jos, P.M.B. 2084, Jos, Nigeria

Lapang M
Department of Zoology, University of Jos, P.M.B. 2084, Jos, Nigeria

Njila HL
Department of Science Laboratory Technology, University of Jos, P.M.B. 2084, Jos, Nigeria

Ombugadu A
Department of Zoology, Faculty of Science, P.M.B. 146, Federal University Lafia, Nasarawa State, Nigeria

Akindigh TM
Department of Zoology, University of Jos, P.M.B. 2084, Jos, Nigeria

Correspondence
Pam DD
Department of Zoology, University of Jos, P.M.B. 2084, Jos, Nigeria

Human nighttime outdoor activities in a rural community of north-central Nigeria: Implications for residual malaria transmission

Pam DD, Neslea AM, Lapang M, Njila HL, Ombugadu A and Akindigh TM

Abstract
Introduction: Residual transmission can limit control efforts to tackle the scourge of malaria in rural settings where nighttime activities are mostly outdoor. This cross-sectional study determined the risk of night-time activities for malaria transmission in a Nigerian community
Methods: We administered a structured questionnaire to collect data from three communities in Dokan Tofa district while outdoor catches of mosquitoes were carried out to determine the presence of malaria vectors and ascertain sporozoite rates.
Results: January-March was the most likely period of the year for inhabitants to sleep outside. Tengzet community was the most likely to have inhabitants sleeping outside during the first quarter of the year. A sporozoite rate of 10.3% was observed with *Anopheles gambiae* s.l as the most abundant anopheline species encountered.
Conclusion: As climate change worsens, its' toll on human activities at night will prevent the interruption of transmission and endanger the outcomes of control interventions.

Keywords: Night-time, climate change, outdoor, residual transmission, sporozoite rate

1. Introduction
Malaria is still considered one of the most important public health challenges facing the world today. The current estimate of cases was put conservatively at 219 million for 2017 alone by the World Health Organization with an associated mortality of 435 000 people [1]. The African region remains the hardest hit region of the world with the largest burden of the disease at 92% of the world's cases and 93% of malaria associated deaths[1]. Children who are five years or below and pregnant women continue to be the most susceptible groups at risk [2, 3]. Amid the grim statistics for Africa, Nigeria ranks highest as the top contributor of cases to the malaria situation, accounting for 25% of the current world figures and sadly 52% of the burden to Africa [1]. In spite of the present control efforts, malaria transmission continues to exist at appreciable levels [4]. To achieve the global targets for control and elimination of the malaria scourge, the mainstay of efforts has been to reduce man-mosquito contact using long lasting insecticide treated nets (LLINs) and /or Indoor Residual sprays (IRS) [5, 6]. This combination of distributing LLINs en masse along with Indoor Residual Spraying has shown promise in reducing malaria [7, 8]. However, the usefulness of LLINs with or without combination with Indoor Residual spraying as an effective strategy for control is limited by the achievement of coverage and utilization of at least ≥ 80% [6]. It is therefore not uncommon to find that even in areas where the use of LLINs and IRS is engaged widely, malaria transmission continues to persist [9]. This is an indication that transmission takes place away from places where people enjoy the protection provided by LLINs or other control measures [10]. Such transmission, known as residual malaria, results from both human and vector behaviors that promote contact outside the safe haven of LLINs and other protections against mosquito bites [11]. People may remain outdoors at night for reasons that may be occupational, social or weather related [12, 13]. In addition to many countries not attaining at least ≥ 80% coverage, those mosquito species adapted to feeding and resting outdoors remain unaffected by the insecticides in LLINs or IRS.

Malaria control programs are consequently faced with the challenge of creating innovative approaches and strategies that will not only target indoor resting populations but also confer a measure of protection for humans who may remain outdoors. It is important to look at the predisposing factors that encourage continuous transmission away from the protection provided by LLINs. Such factors may vary in details from one location to another [12].

Residual malaria transmission presents a significant challenge to every attempt to arrest the menace of malaria particularly in Nigeria where the coverage of LLINs and other interventions are yet to reach levels enough to break transmission. It is against this background that we designed this cross-sectional investigation to study night-time behaviour of the residents from Dokan Tofa, a rural district in Plateau State, North-central Nigeria and the implications of such behaviour to malaria control efforts in Nigeria.

2. Materials and Methods

2.1 Study area

The study area in Dokan Tofa district is one of the four administrative districts found in Shendam Local Government Area of Plateau State, North-central Nigeria. The headquarters of the town is located between latitude 8˚33” N and 9.5˚ 33” E and longitude 8° 33” N and 9° 32” E. This area is recognized as lowland due to its low altitude. Average annual temperature is 27.8˚C with average precipitation of 160cm. Rainfall is highest in September with an average of 239cm. We selected three communities from the district namely: Tengzet, Shinkwan, and Kopgalwa which are primarily agrarian communities.

2.2 Mosquito collection and dissections

Outdoor catches for mosquitos was performed between June and August 2016 using modified CDC light traps. These catches were made between the period of 6pm-6am using mouth aspirators with the aid of a flashlight. The collected mosquitoes were then transferred to a field laboratory where species identifications were carried out.

Mosquito identification was sorted out on an Olympus entomological dissecting microscope using morphological identification keys described by Service for Maxillary palps, wing spots, leg shape, and abdomen [14].

The salivary glands of identified vectors were dissected for sporozoites using the methods described by WHO [15]. The sporozoite rate was calculated using the formula,

Sporozoite rate = Number of mosquitoes with sporozoites / Number examined x 100% [15].

2.3 Questionnaire administration

Structured interviewer and self-administered questionnaires were used by trained interviewers from the communities for the collection of data on behavior and attitudes of the community members.

2.4 Ethical consideration

Ethical clearance for this study was obtained from the Health Research Ethics Committee (HREC) of the Plateau State Specialist Hospital, Jos with Reg No: NHREC/09/23/2010b.

2.5 Statistical analysis

Statistical analysis was performed using SPSS version 21 to determine proportions and descriptive statistics. We performed a chi-square distribution test to determine the association for categorical variables. We also utilized an unpaired t-test to determine the difference between means of ages of participants and made decisions for statistical significance at an alpha level of 5%.

3. Results

3.1 Socio-demographic characteristics of study participants

A total of 329 participants were interviewed for this survey from three communities in the Doka Tofa district. The number of participants interviewed from Shinkwan community were 107 (32.5%), from Tengzet 112 (34.0%) were interviewed and from Kopgalwa 110 (33.4%) were interviewed. Of this number, 185 (56.2%) were male while 144 (43.8%) were female. The mean age of the participants interviewed for this study was 31.6±14.7 years. The average age of male participants which was 30.6±15.4 years was not significantly different than the age for female participants, 32.7±13.3 years (p=0.205). Participants who were married accounted for 155(47.1%) of respondents, 148(45.0%) were single, 10(3.0%) were divorced and 16(4.9%) were widowed. (Table 1). Married people were more likely to be associated with social drinking outside with friends at night while single people were significantly associated with watching TV and playing outdoors (p<0.0001).

The proportion of participants who had a secondary education was the highest for respondents in this study, making up 144(43.8%) of participants, 70(21.3%) had a tertiary education, 57(17.3%) had a primary education while 58(17.6%) had no formal education (Table 1). The educational background of a respondent was significantly associated with the sort of night-time activity engaged in before retiring to bed (p<0.0001). Respondents who were in secondary school were more likely to simply play outside while respondents with no formal education were more likely to spend their time at night drinking with friends

Of the total respondents to our survey, 133(40.4%) were students, 74(22.5%) were farmers, 64(19.5%) were small business traders, 18(5.5%) were housewives while 39(11.9%) were civil servants (Table 1).

3.2 Night-time activities

One hundred and twelve participants (34.0%) indicated that they spend their time at night outdoors watching TV, 131(39.8%) spend time just sitting outside the in the compound, 30(9.1%) play outside while 55(16.7%) spend the time drinking with friends.

There was a significant association between gender and staying outdoor beyond 9 pm as males were more likely to be out later than 9 pm than females (p=0.023). No significant association was observed between staying outdoors late and occupation (p=0.209). We also observed a significant association between age group and nighttime activity (p= 0.029). Inhabitants between the ages of 21-31 years showed the most likelihood for staying out late while engaged in nighttime activities.

3.3 Out-door sleeping

A total of 209(64.5%) of respondents indicated that they slept outdoors while 117(35.5%) indicated that they sleep indoors (Figure 1). For those who indicated they slept outside at night,

100(30.4%) said they slept until morning while 227(69.0%) said they slept until it gets cold. There was no association between any of the three sites and sleeping in the open (p=0.15).
There was an association between the quarter of the year and sleeping outside in the open with the first quarter of the year between January-March being the most likely period of the year for inhabitants to sleep outside (p=0.006). Of the three communities, inhabitants of Tengzet were 2.2 times the most likely to outside during the first quarter of the year (95% CI, 1.2-4.1) (p=0.011).

3.4 Adopted prevention strategies

Of the respondents interviewed during this study, 171(52.0%) said they used insecticide-treated nets as protection from contact with mosquitoes while sleeping indoors, 73(22.2%) indicated that they used insecticides, 59(17.9%) said they simply covered themselves with a blanket or other forms of covers while 25(7.6%) did not use any protection against mosquitoes. For inhabitants who responded to our study and slept outside, 188(57.1%) said they covered themselves with a blanket while 54(16.4%) said they used bed nets outside while sleeping (Figure 2). There were 73(22.2%) respondents who said they used a mosquito coils as a repellent while sleeping outdoors, 11(3.3%) did not engage any form of protection from mosquito bites (Figure 3).
For inhabitants engaged in night-time activities before retiring for the night, 112(34.0%) simply tried to protect themselves from bites by warding off the mosquitoes, 149(45.3%) used protective covering while staying out at night, 25(7.6%) used repellents, 32(9.7%) said they did not worry themselves about the bites while 8(2.4%) said they did not feel the bites.

3.5 Outdoor mosquito catches

A total of 49 anopheline mosquitoes were caught during the outdoor catches from the three districts. Of the *Anopheles* species caught in this study, 31(63.3%) were *Anopheles gambiae s. l*, 8(16.3%) were *A. funestus while* 10(20.4%) were *A. coustani*. The results of dissecting the mosquitoes for infective sporozoites revealed a sporozoite rate of 5(10.3%) (Table 2). The highest number of mosquitoes with infective sporozoites was 3(12.0%) from Tengzet village, while 1(8.3%) were found in Shinkwan and 1(10.0%) from Kopgalwa village (Table 3). The highest number of anophelines, 25(51.0%) were found in Tengzet village while 12(24.5%) were caught in Shinkwan and 12(24.5%) were caught from Kopgalwa village (Table 3).

4. Discussion

The high proportion of people involved in nighttime activities as a form of social interaction from the three communities studied and the presence of anopheline vectors with infective stage presents an enormous concern for malaria control. As pointed out by the work of a study by Moshi and colleagues [13], night-time human activities not only increase the possibility of exposure to malaria but also compounds the challenge of disease transmission. The implications of exposure to malaria vectors that do not conform to the conventional thought that previously dominated vector control efforts i.e. malaria vectors are anthropophagic and endophagic, challenge the creativity of control managers to innovate strategies that can be used on outdoor mosquito populations in a manner that strengthen and support indoor interventions [10]. Moreover, while nighttime activities present human behaviour that has the potential to influence the outcome of vector-related interventions, sleeping outdoors at night is a habit that will weigh down expected results for deployed interventions. Our results also show the inadequacy of malaria prevention practices utilized by those who sleep outdoors. Nearly two-thirds of participants in our study simply “cover themselves” with blankets or ordinary sheets which have no protective capabilities against mosquitos that may exhibit other feeding pattern with respect to their host preferences and resting behaviour. The receptiveness of humans to personal protection can have a huge impact on the intensity of malaria transmission when correlated to the feeding preferences of vectors [16, 17]. Protective interventions cannot provide protection if they are not deployed for use by the members of a community. Despite upscaling LLIN coverage in Nigeria [18, 19], increased ownership of this tool is yet to result in significant reduction in malaria cases in some areas [20].
A significant observation of our study is the association of outdoor sleeping to the first quarter of the year particularly in Tengzet. We observed that weather conditions as a result of climatic changes were a major reason for opting to sleep outside at night in our study site. While a case for the cause and effect relationship between climate change and the distribution of malaria is difficult, there is no doubt that it has made a significant contribution to the current distributions [21]. Climate change is increasingly making the African highlands apposite for malaria transmission and this is projected to continue well into the 2080s at the current rate of shifts in climatic conditions [22]. As transmission rates for malaria increase due to the influence of significant alterations in the earth’s climatic condition, it should be an imperative in designing control interventions to take into account the effects of climate change on rainfall and temperature as important variables that can determine vector distribution and abundance.
It will also be essential to formulate control strategies for communities based on empirical data so that areas that the relationship for increasing inherent risk for residual transmission can be prioritized for deployment of resources. The study by Monroe and colleagues highlighted the role of yearly seasonality in influencing the use of LLINs and the likelihood that the discomfort experienced during such seasons may encourage behaviour that limit the usefulness of interventions [12]. The use of repellents that can be applied topically represents an intervention strategy that may find widespread outdoor application when used in tandem with existing intervention. It is also important to consider how male community members can be encouraged to limit exposure to mosquitos when engaged in nighttime activities since they were the most likely to engage in outdoor activities at night.
When deployment of control interventions is considered for this area in North-central Nigeria, the educational level of the inhabitants can be leveraged as a choke point to improve community sensitization. The benefits of protection both indoors and outdoors can be included in messages that are emphasized to improve intervention outcomes.

5. Conclusion

The act of staying outdoors at night for such reasons as avoiding heat inside rooms creates human-mosquito contact away from rooms where indoor interventions such as indoor residual sprays and long-lasting insecticidal mosquito nets provide protection against mosquito bites. Such human behaviour is sure to maintain residual transmission of malaria. Although residual transmission is traditionally considered when high coverage for LLINs and IRS vector inventions have been achieved, our study demonstrates that there is the distinct risk presented by human activities that endanger the effectiveness of such interventions even in areas yet to achieve significant coverage sufficient to suppress vector populations and interrupt transmission significantly. The situation is likely to get worse as climate change brings about conditions that will increase in mosquito breeding and people to cool off outdoors during hot nights. There is urgent need to improve the utilization of control interventions and understand how to modify the behaviour of humans that may jeopardize the effects of the current measures for control at our disposal.

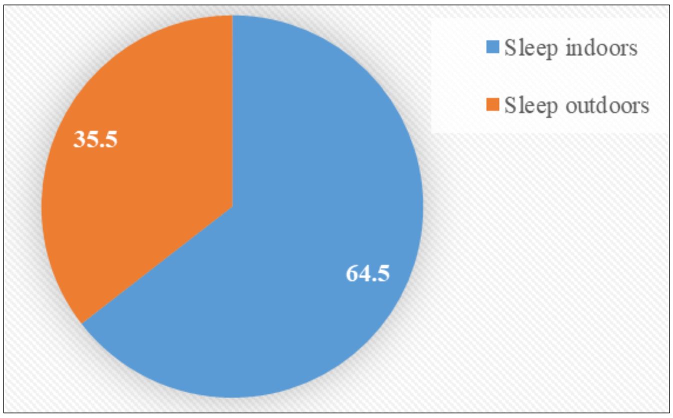

Fig 1: Proportion of participants who sleep indoors or outdoors

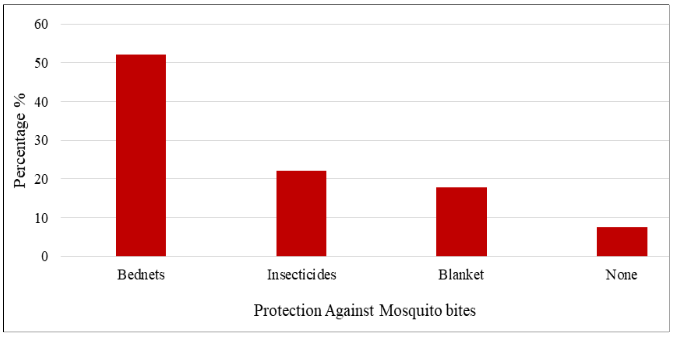

Fig 2: Prefered method of protection against mosquito bites

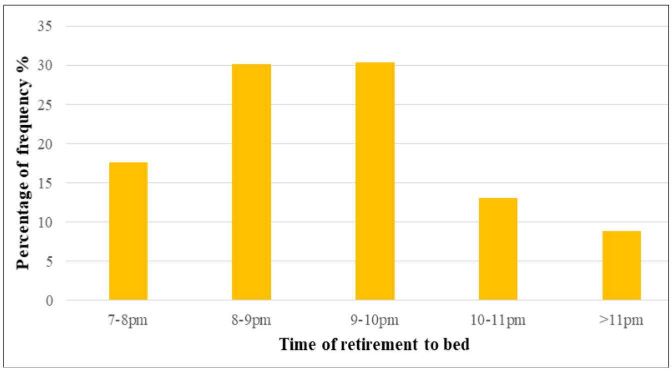

Fig 3: Time of retirement to bed at Night

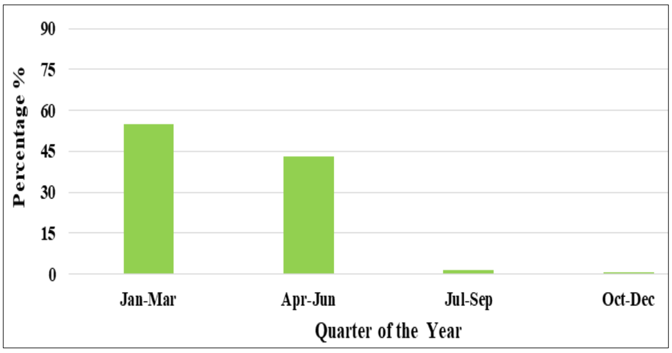

Fig 1: Proportion of inhabitants sleeping outside by quarters of the year

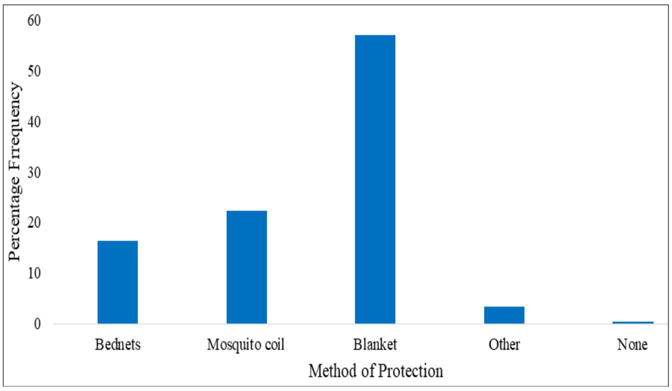

Fig 4: Prefered protection when sleeping outside at night

Table 1: Socio-demographic characteristics of interviewed participants, n=329

Variable	n (%)
Sex	
Male	185(56.2)
Female	144(43.8)
Study Community	
Tengzet	112(34.1)
Shinkwan	107(32.5)
Kopgalwa	110(33.4)
Marital Status	
Married	155(47.1)
Single	148(45.0)
Divorced	10(3.0)
Widowed	16(4.9)
Educational Status	
Primary	57(17.3)
Secondary	144(43.8)
Tertiary	70(21.3)
No Formal Education	58(17.6)
Occupation	
Student	134(40.7)
Farmer	74(22.5)
Trader	64(19.5)
Housewife	18(5.5)
Civil Servants	39(11.9)

Table 2: Sporozoite rates of dissected *Anopheles* species

	Not Infective	**Infective**	**Total Dissected**
***Anopheles* Species**	**N (%)**	**N (%)**	**N (%)**
A. gambiae	26(89.7)	3(10.3)	29(100.0)
A. funestus	6(75.0)	2(25.0)	8(100.0)
A. coustani	10(100.0)	0(0.0)	10(0.0)
Total	42(89.4)	5(10.6)	47(100.0)

Table 3: Sporozoite rates from mosquitoes dissected from the three villages

Village	Not Infective N (%)	Infective N (%)	Total No Dissected N (%)
Tengzet	22(88.0)	8(12.0)	25(100.0)
Shinkwan	11(91.7)	1(8.3)	12(100.0)
Kopgalwa	9(90.0)	1(10.0)	10(100.0)
Total	42(89.4)	5(10.6)	47(100.0)

References

1. World Health Organization. World Malaria Report. Geneva: WHO, Global Malaria Programme, 2018.
2. Kweka EJ, Mazigo HD, Munga S, Magesa SM, Mboero LEG. Challenges to malaria control and success stories in Africa. Global Health Perspectives. 2013; 1:71-80.
3. Nkumama IN, O'Meara WP, Osier FHA. Changes in Malaria Epidemiology in Africa and new challenges for elimination. Trends in Parasitology. 2017; 33(2):128-40.
4. Mwesigwa J, Achan J, Di Tanna GL, Affara M, Jawara M, Worwui A *et al*. Residual malaria transmission dynamics varies across the Gambia despite high coverage of control interventions. PLOSONE. 2017; 12(11):e0187059. https://doi.org/10.1371/journalpone.0187059
5. Karunamoorthi K. Vector control: a cornerstone in the malaria elimination campaign. Clinical Microbiology and Infection. 2011; 17:1608-16.
6. Pinder M, Jawara M, Jarju LBS *et al*. Efficacy of indoor residual spraying with dichlorophenyltrichloroethane against malaria in Gambian communities with high usage of long-lasting insecticidal mosquito nets: a cluster-randomized controlled trial. Lancet. 2015; 385:1436-46.
7. Lengeler C. Insecticide-treated bed nets, and curtains for preventing malaria. Cochrane Database of Systematic Reviews. 2004; 2:CD0003632009.
8. Pluess B, Tanscer FC, Lengeler C, Sharp BL. Indoor residual spraying for preventing malaria. Cochrane Database of Systematic Reviews. 2010; 4:CD006657.
9. Mwesigwa J, Okebe J, Affara M, Di Tanna GL, Nwakanma D, Janha O *et al*. On-going malaria transmission in The Gambia despite high coverage of control interventions: a nationwide cross-sectional survey. Malaria Journal. 2015; 14:314. https://doi.org/10.1 186/s12936-015-0829-6 PMID: 26268225.
10. Killeen GF. Characterizing, controlling and eliminating residual malaria transmission. Malaria Journal. 2014; 13:330.
11. Durnez L, Coosemans M. Residual Transmission of Malaria: An old Issue for New Approaches. In Anopheles Mosquitoes-New insights into Malaria Vectors, 2013.
12. Monroe A, Asamoah O, Lam Y, Koenker H, Psychas P, Lynch M *et al*. Outdoor-sleeping and other night-time activities in Northern Ghana: Implications for residual transmission and malaria prevention. Malaria Journal. 2015; 14:35. DOI 10.1186/s12936-015-0543-4.
13. Moshi IR, Ngowo H, Dillip A, Msellemu D, Madumla EP, Okumu FO *et al*. community perceptions on outdoor malaria transmission in Kilombero Valley, South Tanzania. Malaria Journal. 2017; 16:274. DOI 10.1186/s12936-017-1924-7
14. Service MW. Medical Entomology for Students. 5th Edition. Cambridge, Cambridge Press, 2013.
15. World Health Organization. Malaria Entomology and Vector Control. WHO. Geneva, 2013.
16. Aju-Ameh CO, Awolola ST, Mwansat GS, Mafuyai HB. Malaria-related knowledge attitude and practices (MKAP) in fourteen communities in Benue State North-Central Nigeria: Evidence for the success of focal malaria control intervention programmes. International Journal of Mosquito Research. 2016; 3(5):11-16.
17. Killeen GF, Kiware SS, Okumu FO, Sinka ME, Moyes CL, Massey NC *et al*. Going beyond personal protection against mosquito bites to eliminate malaria transmission: population suppression of malaria vectors that exploit both human and animal blood. BMJ Global Health. 2017; 2: e000198. DOI: 10.1136/bmjgh-2016-000198.
18. Aderibigbe SA, Olatona FA, Sogunro O, Alawode G, Babatunde OA, Onipe AI *et al*. Ownership and utilization of long-lasting insecticide-treated nets following free distribution campaign in South-West Nigeria. Pan African Medical Journal. 2014; 17:263. Doi:10.11604/pamj.2014.17.263.3927.
19. Onwuka JU, Akinyemi JO, Ajayi IO. Household ownership and use of insecticide-treated bednets among school children in Ibadan, Oyo State, Nigeria. Malaria World Journal. 2016; 7(9):1-5.
20. Saleh JEA, Saddiq A, Uchenna AA. LLIN Ownership, utilization and Malaria Prevalence: An outlook at the 2015 Nigeria Malaria Indicator Survey. Open Access Library Journal. 2018; 5:e4280. https://doi.org/10.4236/oalib.1104280.
21. Ngarakana-Gwasira ET, Bhunu CP, Masocha M, Mashonjowa E. Assessing the Role of Climate Change in Malaria Transmission in Africa. Malaria Research and Treatment. 2016; ID 7104291, 7 pages. Doi:10.1155/2016/7104291.
22. Caminade C, Kovats S, Rocklov J, Tompkins AM, Morse AP, Colon-Gonzalez FJ *et al*. Impact of Climate Change on Global Malaria Distribution. Proct. Natl Acad Sci USA. 2014; 111(9):3286-3291.