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The Impact of Human and Socio-cultural behavior on Outdoor malaria transmission in a rural community of Nigeria: The Nyumagbagh Experience

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Abstract: Malaria has remained a global puzzle particularly for sub-Saharan countries despite all effort to control the disease. Increase in outdoor feeding and resting of malaria vectors in most African settings where people spend significant time outside at night have allowed vectors to avoid interventions and consequently limit the effectiveness of those known control measures. A tripod design which includes a quantitative component (health facility and entomological surveillance), qualitative component (Household interviews) and non-peri-domestic (community interview) were carried out concurrently to identify the impact of human behaviours, socio-cultural practices and their significance to the exposure and existing outdoor malaria transmission in Nyumangbah. Data from the observations and entomological data were entered into MS Excel and analysized using SPSS version 21. Predominant outdoor activities in the community vary at the three selected spots but drinking of alcohol, meetings, charging of phones and sales of farm products frequently occurred. Of the *Anopheles* mosquitoes (n=33) collected, *An. gambiae* sl were more in number (n=15) followed by *An funestus* (n=11), *An.coustani* (n=6) and *An. moucheti* (n=1). More mosquitoes (n=51) were collected from the farm house and Hut house (n=39) than Block house (n=19). Members of the *An. gambiae* complex were identified as *An.gambiae* ss using PCR. Of the fifty-nine (100%) persons interviewed for the incidence of malaria, fourteen (24%) persons reported to have been diagnosed and treated malaria once while twenty-nine (49%) and Nine (15%) persons reported to have been diagnosed and treated of the illness twice and thrice respectively over the past 12 months. Of the three hundred and ninety-eight (398) persons that presented with fever and were tested for *Plasmodium* with RDT kit only two hundred and sixty-five (265) were positive for *plasmodium falciparium* of which 86 of them were under five while 179 were above five years. Of the fifty households observed, only 82% of them have at least one bed-net while 64% actually slept inside the treated net a day before with their nets still hanging. The socio-cultural activities of both individuals and the community at large has been seen encouraging the persistent risk exposure to infected malaria vectors. Improvement on housing pattern, literacy level, occupation, electricity, knowledge of malaria and proper diagnosis of malaria for the rural dwellers will be an emerging assistance to the existing malaria control measures.

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Introduction

Malaria has remained a global puzzle particularly for sub-Saharan countries despite all effort to control the disease. The intensity of malaria transmission is exceptionally high in Africa, largely because of abundance of breeding habitats and high vectorial capacity of the major vector species (3). The efficacy of current control strategies has slowed in recent years and, more worryingly, for the first time in a decade, malaria incidence is on the rise (1).

The free distribution of Long-lasting insecticide treated nets (LLINs) that retain insecticidal activity for 3-5 years for the control of malaria contributed greatly to the reduction of malaria prevalence in rural communities (2, 4). However, progress in malaria control is beginning to level off, with no significant changes in the number of malaria cases or deaths

between 2015 and 2017 (10). While achieving and sustaining high levels of coverage of LLINs is essential, in many context malaria can persist even once these targets have been achieved. Increase in outdoor vector feeding and resting in settings where people spend significant time outside at night may allow vectors to avoid interventions and consequently limit their effectiveness (15). *Anopheles* mosquitoes biting humans when they are unprotected outdoors is the most obvious of these behaviours (5). While the malaria vector behavior has naturally existed in relation to exophagic and exophilic transmitters, heritably modified behaviours have also been seen by widespread use of LLINs and IRS. This behaviour has resulted in vector populations that can be described as behaviourally resistant in the reality (6).

Socio-cultural practices at both individual and community level that contributes to outdoor malaria transmission risks need to be well understood for identification and allocation of appropriate intervention to prevent mosquito bites and in turn control malaria. Indeed, the timing of human activities and sleeping behaviors in particular has a strong modulating effect upon human-mosquito contact and the effectiveness of LLINs as it provides personal protection against bites in specific time and space (16). While behavioural factors are important for individual and household level protection, a range of social and cultural factors are implicated in outdoor mosquito biting and malaria transmission in African communities. This study aimed to identify and explore the impact of human behaviours, socio-cultural practices and the significance of their contributions to exposure and existing outdoor malaria transmission in Nyumangbah, Vandekya Local Government Area of Benue State, Nigeria.

Methodology

Study Area

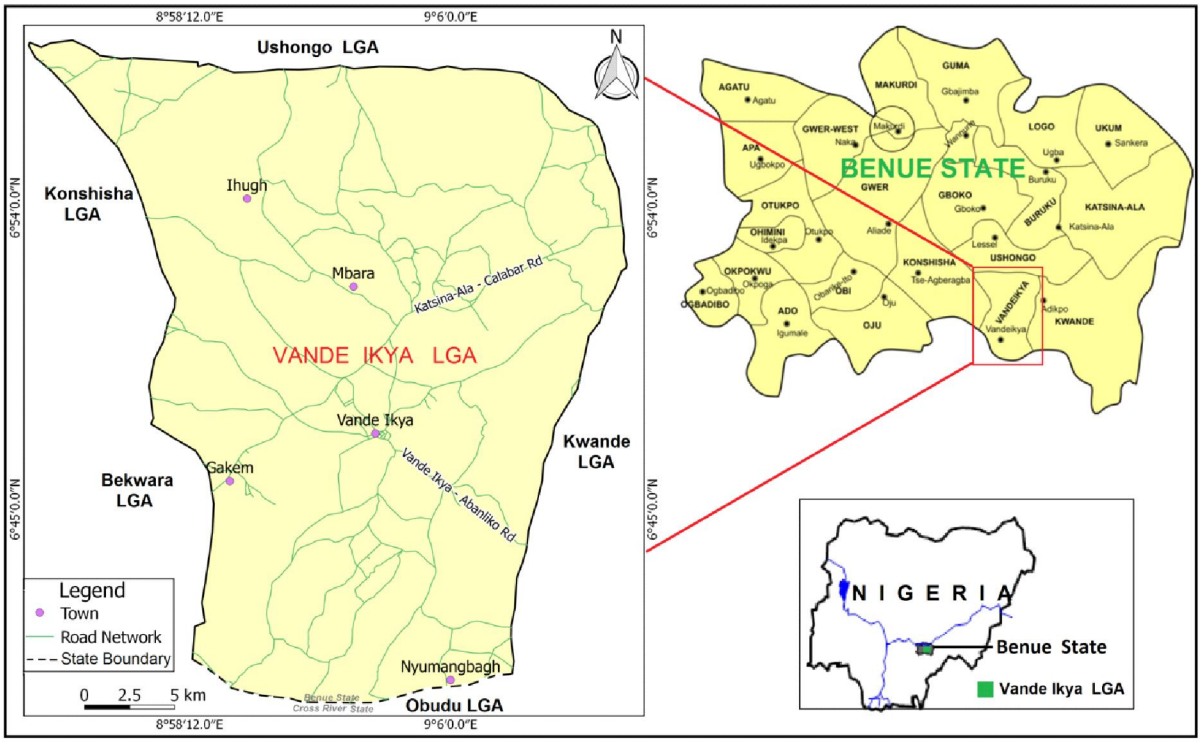

Figure1: Vande Ikya LGA, Benue State showing Nyumangbagh Community

The study was conducted in Nyumagbagh (lat 6^0659'N and long 9^009859'E), Vandeikya LGA of Benue State in North- Central Nigeria as seen in (Figure 1) below. Vandeikya LGA has a projected population of 316,600 (60) with a landmass of 183,939 square meters (0.7sq miles). Vandeikya is in the South Eastern part of Benue State and shares boundaries with Obudu and Bekwara in Cross River State to the East, Ushongo to the North and Konshisha LGA to the West. The indigenous community is the Tiv people who speak the Tiv language. Vandeikya Local Government area is dominated by undulating terrain with much of the area being below 183 m (600 ft) above the sea level. Over 80% of the population are directly engaged in the peasant farming of virtually all major food crops, with concentration on rice, sweet potatoes, cassava, sorghum, citrus, spices, pepper, groundnut and bambara nuts. The housing

pattern are mainly Block and Huts houses. The Block and Huts households are mainly cited at the central and clustered area of Nyumangbah while the farm houses were cited some distance around the clustered settlement.

Ethical considerations

Meetings with the Local Government Head, Head of Health Department, community leaders and community members in the study sites were held and the aim and procedures of the study were explained. Consent was obtained from heads of households to observe the natural behaviour of inhabitants and mosquito collections. Participants of in-depth interviews also provided written informed consents. Additionally, consent was obtained from officer in charge of the Primary health Centre Ichighi to observe the hospital records.

The study design which includes a quantitative component (health facility and entomological surveillance), qualitative component (Household interviews) and non-peri-domestic interview were carried out concurrently. For purposes of the study, non-peri-domestic settings were settings where people tended to gather away from the observed houses especially in the evenings for example; bars, movie kiosks and cultural or religious gatherings (e.g. weddings and prayer events). The in-depth interviews explored people's perceptions on malaria transmission risk.

The houses selected has an average number of 4 persons per household which majorly includes the father, mother and two children or grandparents as most of their household members resides in Makurdi or Obudu and visits home especially for important festivities. Age distribution varies as most of the respondents were from ages 31and above followed by individuals in ages 16 and 30.

Data collections

A tripod stand design as seen in the study of (7) was used to identify the factors associated with the behavior of the people in relation to outdoor malaria transmission in Nyumangbah.

Qualitative and quantitative data collection on Human behaviour

A Structured questionnaire for members of 50 households was carried out in a quiet, private space, inside or close to the respondent's home. Each questionnaire lasted between 5-9 minutes. The questionnaire which is basically for the household interview contained the following; number of people in the household, number of children under five, presence of LLINs, time of sleep and the activities keeping persons outdoor before sleeping. Three selected known spots in the community where people gather in the evening were sampled for the behaviour of people in the community. These spots included bars and kiosks where people drink and watch football games, market-square and phone charging spot. Community leaders were asked to inform the survey team of any night-time gatherings in their communities, after which health workers from the community conducted the observations and assisted in translations from Tiv language to English language. Consent was obtained from the community leader and only the places that had consent were observed. The questionnaire for behaviour of the people in the community has the following content; knowledge of malaria, name of any activity that keeps individual outdoor and when last suffered malaria.

Quantitative data collection for incidence of malaria

Hospital records were observed from PHC Ikpoikpo for malaria incidence. A retrospective observation starting from August, 2017 to September, 2018 of monthly incidence of malaria in the community health centre, PHC Ikpoikpo Nyumangbagh. The laboratory diagnosis was all with Rapid Diagnostic Test kits.

Qualitative and quantitative data collection of malaria vectors in the study area

Three types of houses (block house, hut (yotuho) and farm house) were selected for the entomological survey. CDC light traps were set in 3 households (Indoor and Outdoor) out of the fifty (50) households selected for the interview from 18 00hr to 6.00hr. The collections from the CDC light traps were sorted and identified morphologically. The wings or legs of all mosquitoes morphologically identified as *An. gambiae* s.l. were used for DNA extraction at the Molecular Lab of National Arbovirus and Vectors Research Centre. The mosquitoes were differentiated to species level using PCR which was performed with universal and species-specific primers for the *An. gambiae* s.l. Molecular identification of *An. gambiae* species complex is based on the species-specific nucleotide sequences in the ribosomal DNA (rDNA) intergenic spacers (IGS) following the procedure of Scott et al., (1993). Five sets of primers designed from the DNA sequences of the IGS region of An. gambiae s.l. rDNA were used in PCR for the member species identification. The sequence details of the primers are abbreviated, UN primer anneals to the same position on the rDNA sequences of all five species, GA anneals specifically to *An. gambiae* sensu stricto ME anneals to both *An. merus* and *An.melas*, AR to *An. arabiensis* and QD to *An. quadriannulatus*.

DNA extraction from *An. gambiae* complex

The legs and the wings of each mosquito was placed in a clean 1.5ml Eppendorf tubes and appropriately labeled. Extraction of the DNA was done using Zymo Research kit and the manufacturers'

protocol for nucleic acid extraction was followed strictly. The extracted DNA was kept at -20oC.

PCR protocol for *An. gambiae* complex detection.

The primers for the four sub-species of *Anopheles gambiae s.l* was mixed with 14µl of commercially prepared master mix (from Inqaba biotec West Africa) in a clean 0.2ml PCR tube. PCR water was used to make up the reaction volume to 30µl.

The PCR condition for amplification was programmed as Initial denaturation @94^{o}C for 30 sec, Denaturation @ 94^{o}C for 60 sec, Annealing @68^{o}C for 30 sec, Elongation @72^{o}C for 30 sec, for a total of 40 cycles, final Elongation @72^{o}C for 5mins. The PCR product (Amplicons) was run on 2% Agarose gel for one hour at 120V in an electrophoretic machine to separate the DNA bands. The separated bands were visualized using Dark Reader trans-illuminator.

Data Analysis

Data from the observations and entomological data were entered into MS Excel and analysized using SPSS version 21. Calculation of net access was done by calculating proportion of households owning at least one bed-net. Net use was calculated as a proportion of people sleeping under bed nets as established during the household observation. The number of potential net users in a household was computed by multiplying the number of nets in the household by two (assuming a maximum of two people per net), then dividing by the total number of household members. All statistical analyses were performed at 5% significance

Result

Three hundred and twenty-nine (n=329) persons from the fifty (n=50) households selected for the survey were interviewed and the selected households were divided into (Block house, Huts and Farm House) based on the structure of the houses.

From the questionnaire, hundred percent (100%) of responders (n=146) in the block house retire to their bedroom by 10pm while (75%) of the responders (n=98) that stays in the huts responded they retire to their bedrooms by 10:30pm and 11pm for the majority (88.5%) of the farmers that were observed in farm houses. Educational background of the respondents shows that 34% of the respondents have no formal education while only 7% have education to tertiary level and resides in block houses.

Table 1: Household Investigation and Characteristics of the study participants in Nyumagbagh, Vandekyia L.G.A Benue State

Household characteristics	Number of people	df	X^2	P-value	Mean±SD
Block House					
Male	67	1	0.99	0.321	73.49±6.00
Female	79				
Age					
0-5 years	17				
6-15 years	29	3	37.78	0.000	45.95±19.97
16-30 years	33				
31 and above	67				
Educational status					
Non-formal	34				
Primary	40	3	9.78	0.021	38.95±8.97
Secondary	49				
Tertiary	23				
Hut					
Male	49	1	8.31	0.004	69.66±16.03
Female	82				
Age					
0-5 years	11				
6-15 years	33	3	31.05	0.000	40.51±14.59
16-30 years	56				
31 and above	31				
Educational status	51	2	2.260	0.323	44.42±5.77

Non-formal					
Primary	43				
Secondary	37				
Tertiary	0				
Farm House					
Male	33	1	3.77	0.052	27.88±6.81
Female	19				
Age					
0-5 years	11				
6-15 years	2	3	18.00	0.000	17.50±5.73
16-30 years	23				
31 and above	16				
Educational status					
Non-formal	28				
Primary	18	2	14.000	0.001	22.00±7.45
Secondary	6				
Tertiary	0				

*** Statistically significant at P ≥ 0.05**

Predominant Outdoor Activities in Nyumangbah

Most of the household heads listed out some activities like folk tales, charging of phones, marriages, burials, market days and Agricultural practices as the key determinant to their time of sleep. These activities listed do occur frequently. Other activities observed in the course of questionnaire included gatherings in bars, kiosks and other informal settings. Viewing centre and bars were mostly populated by males while both males and females participated in all other activities like charging of phones, burials and wedding ceremonies. Activities related to funerals and parties were mostly outdoors, and many lasted all night. People were found mostly in the inter-community market which many communities like Dagba, Tsar, Obochichi in Obudu LGA of Cross River State come to sell their farm produce. The women selling their farm products mostly they carry their children along.

Table 2: Predominant Socio-cultural activities keeping the people outdoors in Nyumangbah

Activities	Respondents	df	X^2	P-value	Mean±SD	df	X^2	P-value (Overall)
Bars and Kiosks								
Charging of phone	15							
Marriages	13							
Burials	11							
Watching Football	9	5	15.14	0.01	19.56±9.16			
Drinking alcohol	33							
Market	13							
Planting/Harvesting	9							
Meetings	23							
Total	126					2	1.56	0.46
Phone charging spot								
Charging of phone	14							
Marriages	8							
Burials	19							
Watching Football	17	7	30.44	0.000	16.58±4.35			
Drinking alcohol	22							
Market	18							
Planting/Harvesting	12							

Meetings	15					
Total	125					
Market						
Charging of phone	4					
Marriages	18					
Burials	22					
Watching Football	10	7	30.44	0.000	17.36±8.08	
Drinking alcohol	19					
Market	34					
Planting/Harvesting	24					
Meetings	12					
Total	143					

*** Statistically significant at P >0.05**

Densities of host-seeking malaria mosquitoes indoors and outdoors

A total of one hundred and nine (n=109) mosquitoes were caught from the three houses sampled indoor and outdoor with CDC light traps. Of the collected mosquito species, *Culex* species comprised of 46.8% while 30.3%, 17.4% and 5.5% were for *Anopheles*, *Mansonia* and *Aedes* species respectively. CDC light traps indoor collected 31.2% (n=34) mosquitoes while the CDC light traps outdoor collected 68.8% (n=75) mosquitoes. Of the *Anopheles* mosquitoes (n=33) collected, *An.gambiae* sl were more in number (n=15), followed by *An funestus* (n=11), *An.coustani* (n=6) and *An. moucheti* (n=1). Of the *Anopheles* collected indoor using CDC light traps, *An.gambiae* sl were (n=9) while, *An.funestus* were collected more (n=8) outdoor than indoor (n=3), *An coustani* and *An mouchetti* were collected outdoors. More (n=51) collections were from the farm house and (n=39) Hut house than Block house (n=19). Members of the *An. gambiae* complex were identified as *An.gambiae* ss using PCR.

Table 3: Mosquito species collected in Nyumangbah

	Indoor			Outdoor			TOTAL
	Block	Hut	Farm House	Block	Hut	Farm House	
Mosquito species							
Cx.quenquefasciatus	6	9	8	5	9	14	51
An.gambiae sl	1	6	3	0	3	2	15
An.funestus	0	0	3	2	1	5	11
An.coustani	0	0	0	0	1	5	6
An. mouchetti	0	1	0	0	0	0	1
Mansonia uniformis	0	1	5	4	0	1	11
Mansonia africana	1	2	0	0	2	3	8
Aedes albopictus	0	0	0	2	1	1	4
Aedes aegypti	0	0	0	0	1	1	2
Total	**8**	**19**	**19**	**13**	**18**	**32**	**109**

Table 4: Behavioral preference of *Anopheles* species collected in Nyumangbah

Activities	**Number of mosquitoes**	**df**	**X^2**	**P-value**	**Mean±SD**	**df**	**X^2**	**P-value (Overall)**
Indoor								
Block	1							
Hut	7	2	4.43	0.109	15.65±1.52			
Farm house	6							
Total	**14**							
						1	0.29	0.590
Outdoor								
Block	2							
Hut	3	2	10.71	0.005	9.24±4.42			
Farm house	12							
Total	**17**							

Anopheles sp								
An. gambiae	15							
An. funestus	11							
An. coustani	6	3	13.42	0.004	11.61±3.86			
An. mouchetti	1							
Total	**33**							

*** Statistically significant at P> 0.05**

Knowledge of malaria and monthly malaria diagnosis

Participants responded that these activities listed above are the major ones that left people prone to malaria-transmitting mosquitoes despite widespread availability of bed nets. Of the fifty-nine (100%) persons interviewed for the incidence of malaria over the past 12 months, twenty-nine (49%) persons reported to have been diagnosed and treated malaria twice over the past 12 months while fourteen (24%) persons reported to have been diagnosed and treated of the illness once. Nine (15%) reported to have been diagnosed and treated of the illness thrice while the remaining seven (11%) said they have not suffered from malaria for the period in question. Majority of the people interviewed mentioned mostly the month of July, August, and December as the month they were diagnosed of malaria in the health facility as people that practiced self-medication were excluded.

Table 4: Monthly frequency of malaria parasitemia amongst the residents of Nyumangbah

Activities	**Number of people**	**Df**	X^2	**P-value**	**Mean±SD**	**df**	X^2	**P-value (Overall)**
Diagnosed Thrice								
January	1							
February	0							
March	1							
April	0	1	2.78	0.096	1.22±0.44			
May	1							
June	2							
July	0							
August	1							
September	1							
October	1							
November	0							
December	1							
Total	**9**							
Diagnosed twice						2	12.50	0.002
January	1							
February	1							
March	2							
April	1							
May	2	4	2.80	0.575	3.28±1.67			
June	2							
July	3							
August	6							
September	3							
October	3							
November	1							
December	4							
Total	**29**							
Diagnosed once								
January	1	2	3.571	0.168	2.00±0.68			

February	0
March	2
April	0
May	0
June	2
July	2
August	1
September	0
October	2
November	1
December	3
Total	**14**

Health Facility Data

A retrospective data from August,2017 through September, 2018 were collected from the Primary health facility Ikpoikpo. From the facility record, 398 persons presented with fever and were tested for *Plasmodium* with RDT kit. Two hundred and sixty-five (n=265) were positive for *plasmodium falciparium* of which (n=86) of them were under five while (n=179) were above five.

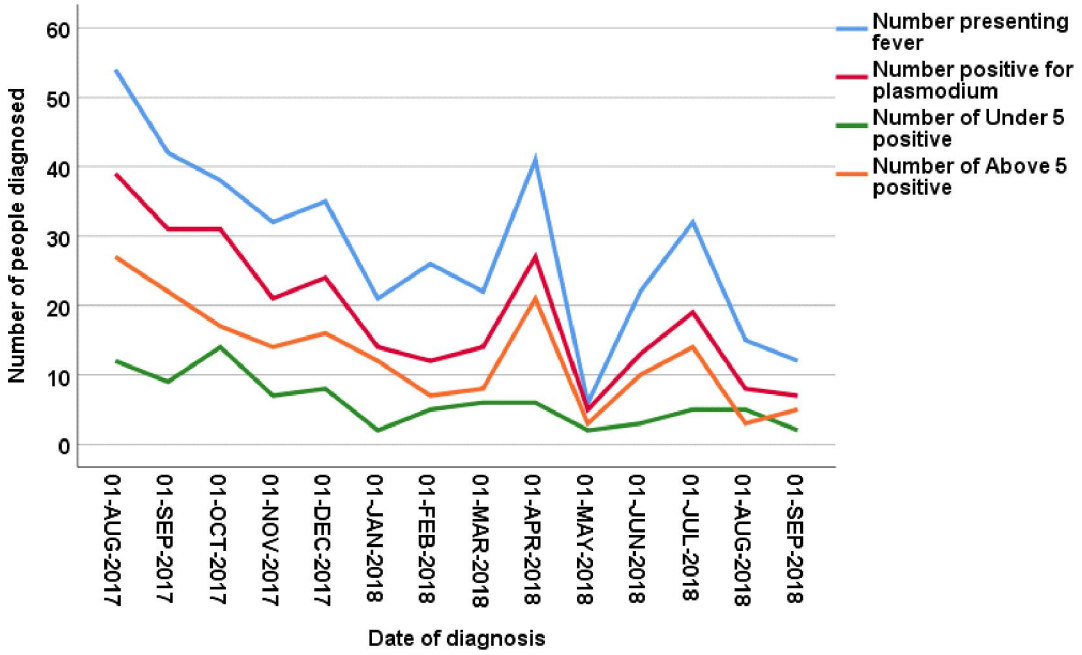

Figure 2: Health facility Data on malaria incidence in Nyumangbah from August 2017-September 2018

Net ownership, access and use Usage

Of the fifty households observed with the average number of (4, 3 and 2) for Block, Huts and farm house respectively, 82% of them have at least one bed-net while 64% actually slept inside the treated net a day before with their nets still hanging.

Table 5: Net ownership and usage in Nyumangbah

Ownership and Usage of Mosquito net in Nyumangbah

	Households with Nets	**df**	X^2	**P-value**	**Mean±SD**
Number of					
Block House	20	2	7.37	0.025	16.12±4.83
Huts (Yotouho)	15				
Farm House	6				
Total	**41**				

Number of					
Block House	18	2	9.25	0.01	13.75±5.22
Huts (Yotouho)	10				
Farm House	4				
Total	**32**				

*** Statistically significant at P> 0.05**

Discussion

The findings in the study reveal how socio-cultural behaviour influences the risk of exposure to malaria in the local communities of Nigeria. It was also observed in the study of (22) in some communities of Sub Saharan Africa.

It was observed in the study that individuals living in the block houses mostly retire to their sleeping rooms on time (22:00hrs) as compared to those in the huts (22:30hrs) and farm houses (23:00). Most of the respondents admitted they have not seen electric light aside from generator set since they were born so they prefer staying outdoor for some while to receive "*fresh air*" as indoors were very hot. Some prefer to rest a while outdoor especially the farmers amongst them while the children and the women engage in household chores and folklore. The few well to do among them living in the block houses power their small generators as (9) suggested that the arrival of electric lighting in the last few decades have changed behaviors of people over time. Studies in southern Nigeria by (11) and (12), indicate that *An. gambiae* s.s seeks host outdoors as we observed in this study that some peri domestic (inside and directly outside of the home) activities were seen as factors why some people tend to stay outdoors thereby increasing the transmission risk. Early biting of *Anopheles gambiae* sl has been seen to commence outdoor from 6pm (23), 7pm (13) and 9pm (14) in Akwa-ibom, Nasarawa, Bauchi, Ebonyi and Sokoto states of Nigeria. From the household questionnaire, it is apparent that the earliest the households retire to sleep was 10pm in Block houses in which biting and transmission of the parasites to the individuals while they are still outdoor is very possible.

The graduation of housing type in sub-Saharan Africa from traditional huts with thatched-roof to cement houses with metal-roof is likely to have profound reduction in the transmission of malaria. More mosquitoes were collected from the Hut house (n =51) and farm house (n= 37) than Block house (n= 21). This represents a highly statistically significant difference (P<0.002) between them in this regard. This affirms the findings of Lindsay *et al.,* (2003) that poorly constructed houses allow easy entrance of mosquito vectors and increases chance of transmission among family members. Although some respondents from this study still prefer the hut houses with thatched roof as they claim the block house seem hotter than the huts thereby making the later airier to sleep in. This is corroborated by the findings of (24). The farm houses surveyed were occupied by farmers and the numbers of *Anopheles* mosquitoes were also high, suggesting that the effect of occupation on malaria incidence can also be direct as seen in the study of (25). The finding in this study like staying temporary in farm shelters has a likelihood of increasing contact of individuals with malaria mosquitoes thereby increasing the risk of infection with *Plasmodium* as this is in line with the findings of (26).

Educational status could affect the ability to understand written or verbal information about symptoms, treatment, and transmission mechanisms of malaria. Literacy in turn could affect the income level, the knowledge of malaria, the practice of individuals to get treated for malaria as seen in the study of (27). From the respondents in the study, it was observed that those with higher education provides better housing for their wards and malaria prevention measures. Study conducted by (28) showed an association between educational status and health seeking in terms of terms of protecting one's self from mosquito bite (bed net ownership and use). The study reveals that more educated people (those who attained university level of education) mostly live in the block houses compared to those that attained lower educational level (P<0.021).

Alcohol consumption in the Bars and kiosks and selling of farm produce in the Central market, Ichigh were the major exposure activity that predisposes the people to *Anopheles* mosquito bites. These same outdoor activities were also observed in the studies of (29, 32, 22) and (30). There is a significant difference in the number of persons taking part in different activities in bars and kiosk (P = 0.01), with alcohol consumption accounting for the highest number of people (26%). The importance of alcohol consumption is accentuated by the fact that it also accounted for the significant difference (P=0.000) seen in the number of people involved in other activities in Phone charging spots (17.6%). People stay for long periods of time taking alcohol outdoors while charging their phones in these phone charging

spots. This finding is in line with that of (33) who reported that drinking alcohol was perceived to increase risk behaviour such as staying outdoors late into the night. This trend is consistent with reports in many countries seeking the elimination of malaria, where adult males who stay late outdoors drinking represent a rising proportion of malaria cases (34) and (35).

As an agrarian community, farm produce abounds all through the year and with lack of mechanized storage facilities, the products tend to be wasted. To avoid wastage and loss, most of the community members bring their products to sell in the markets and majority of the sellers are women with babies. Thus, selling of farm produce at the market is another high impact activity with respect to potential malaria transmission, accounting for 23.8% of people engaged in different activities in the market, with a high significant difference existing between the number of persons involved in the different activities.

Analyses with PCR revealed that all the *An.gambiae species* morphologically identified as *An. gambiae sl* were A*n. gambiae* s.s. This species largely accounted for the significant difference in number ($P< 0.004$) between all the *Anopheles species* collected. This finding collaborates with the finding of (36) in a near-by community. *Anopheles funestus* group, *An coustani* and *An.mouchetti* were also abundance in the collection and has been implicated to transmit malaria parasite (37).

LLINs have proven effective against endophilic vectors such as *An. gambiae s.s., An. arabiensis,* and *An. funestus* as seen in the study of Oyewole *et al* (2007), (38) and (39). In this study, there is no significant difference ($P>0.05$) between the number of *Anopheles gambiae s.s* collected indoors and outdoors while *An.funestus* was collected more outdoors than indoors ($P<0.000$). *An. gambiae* s.s as seen in this study typically exhibited both endophagic and endophilic behaviours as in the study of (40) and (41), though some level of exophily was also observed.

The pattern of biting activity by the different species of malaria vectors tended to coincide with human sleeping patterns. For instance, *Anopheles funestus* was collected mostly outdoors as people were carrying out activities outdoors and this is in line with the studies of (42).

Expectations were that *An.gambiae* s.s would be collected more outdoors due to the excito-repellence activity of the insecticide (Pyrethroid) in the LLINs as opined by (43) but it was not so. The result in this study points that either the malaria vectors were resistant to the insecticide used for the LLINs given in year 2016 or the community members did not properly adhere to the usage. The reason been that there was a marked increase in the number of malaria cases among the children both under five and above five in the months of August 2017 to October 2017 which was months after LLINs distribution. The Dawa net distributed in the community have $50mg/m^2$ of deltamethrin (a pyrethroid) as chemical component although resistance to deltamethrin has been elucidated by (44). Furthermore, Pyrethroid resistance affecting both *Anopheles gambiae ss* and *Anopheles coluzzii* has been widely reported in Nigeria (18, 19, 45, 17 and 44).

The burden of malaria has been known to be greater in children less than five years compared to those above five (WHO 2014), although several studies (47, 48) have found out that the trend is tilted towards significantly higher risk of malaria among subjects above five years. The age-related prevalence in this study from the health facility shows that the prevalence was higher among subjects above five years (Fig. 2). This finding agrees with the studies of (49), (50) who presented clearly that other age-groups also have great malaria burden. The higher positive results obtained among these age groups might be due to their occupational and socio-cultural settings. These groups expose themselves either as a result of their work, handling school home-work and chores are more likely to be subjected to mosquito bites compared to the under-fives who mostly stay indoors. This is in agreement with (51) who opined that human behavior is influenced by cultural, social and economic factors which directly or indirectly affect health outcomes, including the risk for infectious diseases like malaria.

On the impact of weather variables on malaria prevalence, this study showed that the incidence of malaria tends to be on increase during the beginning of rainy season (March – April 2018) and towards the ending of rainy season (August 2017 –October 2017). Seasonally, the months of March and April 2018 recorded another peak for the under-five while the months of June and July, 2018 were peak months for the children above five. All the peak months in malaria transmission were in the rainy season which suggests that the season presents favorable environmental conditions that enhance mosquito breeding, survival and biting rates. This finding is in line with the study of (51) and (52) in Gambia where malaria transmission occurred in the rainy seasons among children above five years.

The high number of people presenting with fever in Figure (4) showed that all fevers are not malaria related as the number of people presenting with temperature 37^0 C and above were higher than the number diagnosed with malaria as this is in line with the study of (54). The implication of this finding is that proper diagnosis of malaria in patients with fever

remains the key especially in sub Saharan Africa where malaria is endemic.

Significantly more people (P<0.02) were diagnosed twice of malaria in the community than people diagnosed once or thrice and this agrees with the findings of (55) which reported that some people suffer more than one episode of malaria in the sub-Saharan Africa. Although multiple malaria episodes may be the result of increased malaria exposure due to individual and community social behavior and or the available primary malaria vectors. Recurrent malaria episodes may be due to recrudescence, relapses, or new infections as the study did not differentiate the causes of these recurrent episodes because RDT was the only means of malaria diagnosis. The strategy of early diagnosis with microscopy as to determine the *plasmodium* species and treatment, combined with vector control which is already on ground and human behavioural change, will bring a drastic reduction of malaria incidence in this community as this was the same measures applied on the Thai-Myanmar border (56) and Carrara *et al*.,2013).

The study revealed that 82% of the households own at least one net while 64% of them used the net a night before the survey. Findings from (57) in Ekiti and (58) in Rivers state all observed this same pattern of more net ownership than usage as seen in this study. The findings of (59) in the adjoining local government areas revealed eighty-six (86%) net utilization which is above the 80% national target LLINs utilization, although the socio-cultural behavior of the population sampled were not studied. several studies have been conducted on ITN ownership and use, only a few of them had concentrated on identifying factors associated with the use particularly in the rural communities which are often characterized by socio-economic features that are different from that of urban communities. Socio-cultural activities within the community and households were identified in this study as altering the normal sleeping pattern and making the use of insecticide treated net non-effective. The routine of drinking, doing late night chores, charging of phones, meetings, selling of farm products late into the night, night burials and weddings outdoors increases the risk of exposure to mosquito bites and malaria transmissions. This finding is in line with that of (22, 29 and 33), (30) and Alaii et al 2003.

Conclusion

The break in dominance of malaria especially in this settlement is based on clear understanding of the human behaviour in that locality and the knowledge of malaria. The socio-cultural activities of both individuals and the community at large has been seen encouraging the persistent risk exposure to infected malaria vectors. This suggests that complementary interventions like full protective wears, repellents and aerial fumigation for outdoor malaria vectors should be of high priority. Improvement on housing pattern, literacy level, occupation, electricity, knowledge of malaria and proper diagnosis of malaria for the rural dwellers will be an emerging assistance to the existing malaria control measures.

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