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

The Nyumagbagh Experience

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Abstract: 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. This study therefore looks at the socio-cultural behavior of humans and their  
impact on malaria transmission in Nyumangbah Benue State. The study has a cross-sectional and tripod stand design  
that spans through households (in block house, huts and farm house), non-peri-domestic settings and health  
facilities. Direct observations, questionnaire based interview and Health Facility records were used concurrently for  
data collection. Data obtained from this study was entered into MS Excel and analyzed using SPSS version 25 at 5%  
significance level. Ownership of LLINs was highest, 40.0% among occupants of Block house and least, 12.0%  
among occupants of farm house (P < 0.05). Usage of LLINs was highest, 36.0% among occupants of Block house  
and least, 8.0% among occupants of farm house (P < 0.05). Average sleeping time of 22.00hrs, 22.30hrs and  
23.00hrs were recorded for households in block house, huts and farm house respectively. The most reported late  
outdoor activity was alcohol drinking with 49.3% occurrence while the least reported activity was charging of  
phones with 22.0% occurrence (P > 0.05). Anopheles mosquitoes (15 An. gambiae s. s., 11 An. funestus, 6 An.  
coustani and 1 An. moucheti) constituted 30.3% of overall mosquito collections. Members of the An. gambiae  
complex were identified as An.gambiae ss using PCR. From the Health Facility record, malaria prevalence of  
66.0% was observed. Frequency of malaria occurrence in a year was 17.3%, 55.8% and 26.9% for one, two and  
three malaria episodes respectively (P < 0.05). This study has shown that persistent malaria parasite transmission,  
possibly due to ineffective use of LLINs can be attributed to the socio-cultural activities of both individuals and  
community members at large.

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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 (White  
et al, 2011). 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 (Dhiman, 2019).

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 (Kulkarni et al., 2010; Egbuche et al,  
2013). 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 year 2017 (WHO, 2018). 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 (Durnez and Cooseman,  
2013). Anopheles mosquitoes biting humans when  
they are unprotected outdoors is the most obvious of  
these behaviours (Sougoufara et al, 2014). Even when  
LLINs are used, they may show reduced physical  
integrity, deterrent effect and mortality effect  
(Egbuche et al., 2019a). 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 (Killeen and Chitnis 2014).

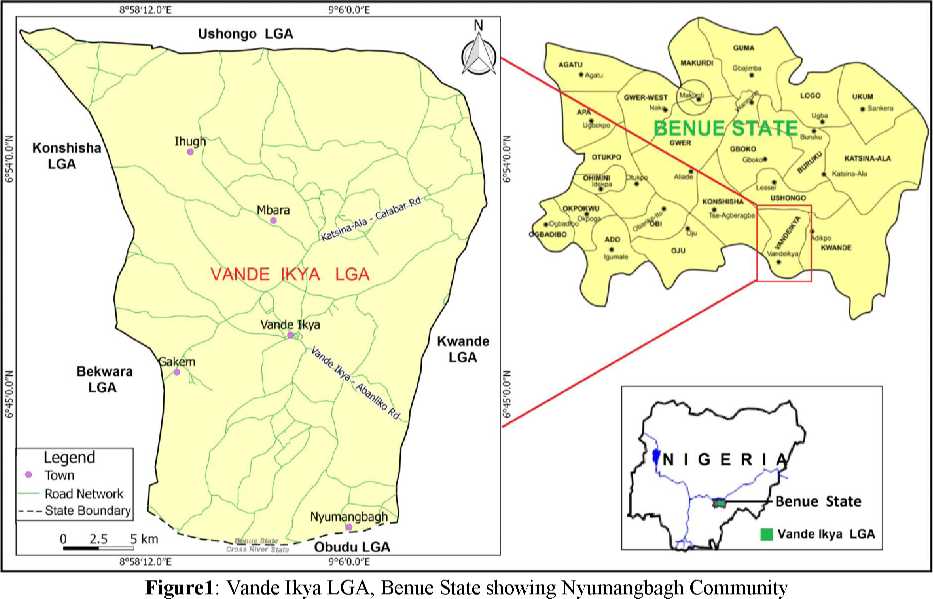
Socio-cultural practices at both individual and  
community levels that contribute to outdoor malaria

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 required in providing  
personal protection against mosquito bites in specific  
time and space (Seyoum et al, 2013). 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

The study was conducted in Nyumagbagh (Lat  
60659'N and Long 9009859'E), Vandeikya LGA of  
Benue State in North- Central Nigeria as seen in  
(Figure 1). Vandeikya LGA has a projected  
population of 316,600 (National Population  
Commission, 2016)) 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 LGA in Benue State to the North and  
Konshisha LGA in Benue State 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



land area 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 is mainly Block  
house, Huts, and farm houses. The Block and Huts  
houses 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 also  
to collect mosquitoes from their houses. Participants  
for in-depth interviews also provided written informed  
consents. Additionally, consent was obtained from  
Officer in Charge of the Primary health Centre Ichighi  
to observe their records on malaria investigations.

Study design

The study has a cross-sectional and tripod stand  
(Cresswell et al., 2003) designs that spans through  
households, peri-domestic settings and health facilities.  
This study involved a quantitative component (in  
health facility and households) and qualitative  
component (interviews in household and in non-peri-  
domestic settings) that 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).  
Households selected for the study have an average  
number of 4 persons which majorly included 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 varied as most of the  
respondents were from ages 31and above followed by  
individuals in ages 16 and 30.

Qualitative and quantitative data collection on  
household characteristics as well as human  
behaviour and Socio-cultural factors.

A Structured questionnaire for members of 50  
households was administered in a quiet, private space,  
inside or close to the respondent's home. Each  
questionnaire session lasted between 5-9 minutes. The  
questionnaire which is basically for the household  
interview contained the following: number of people  
in the household, presence of LLINs, time of sleep

and the activities keeping persons outdoor before  
sleeping. In addition to household questionnaire  
administration, Community leaders were asked to  
inform the survey team of any night-time gatherings  
in their communities. There was direct observation  
and administration of 50 questionnaires to each of  
three selected known spots in the community where  
people gather in the evening. These spots included  
bars and kiosks where people drink and watch football  
games, market-square and phone charging spot. There  
was assisted translation of the questionnaire  
administration from English language to Tiv language,  
and vice versa. 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 they suffered  
malaria.

Quantitative data collection for incidence of  
malaria

Hospital records were observed from PHC  
Ikpoikpo Nyumangbagh for malaria prevalence. This  
retrospective search covered the period from August,  
2017 to September, 2018 for monthly prevalence of  
malaria. The reported malaria cases were diagnosed  
with Rapid Diagnostic Test kits which has been  
reported to have similar pattern of performance with  
microscopy (Egbuche et al., 2019b) and  
recommended by WHO for use in rural settings.

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 and around 3  
households out of the fifty (50) households selected  
for the interview for indoor and outdoor mosquito  
collections, from 18.00hr to 06.00hr. 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 Laboratory  
of National Arbovirus and Vectors Research Centre  
Enugu Nigeria. Anopheles mosquitoes were  
differentiated to siblings 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 sibling 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 14|il 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

The PCR condition for amplification was  
programmed as Initial denaturation @94oC for 30 sec,  
Denaturation @ 94oC for 60 sec, Annealing @68oC  
for 30 sec, Elongation @72oC for 30 sec, for a total of  
40 cycles, final Elongation @72oC 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, interviews and  
entomological data were entered into MS Excel and  
analysized using SPSS version 25.0. Tests for  
statistical significance were performed at 5% level.  
Chi-square analysis was used to test for association  
between house types and each of the household  
characteristics: gender, age and highest level of  
education. Chi-square analysis was used to test for  
association between house types and LLINs  
ownership, as well as usage. Chi-square analysis was  
used to test for association between occurrence of  
malaria and number of episodes in a year. Analysis of  
Variance was used to compare the frequency of  
occurrence of different outdoor activities listed by the

respondents. Chi-square analysis was used to test for  
association between outdoor activities stated by the  
respondents and the peri domestic settings where they  
gathered. Chi-square analysis was used to compare  
mosquito abundance in indoor and outdoor locations.

Results

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. The number of  
respondents in each of the house type is 146 (44.4%)  
in block house, 131 (39.8%) in hut and 52 (15.8%) in  
farm house. The number of males in the study was  
149 (45.3%) while the number of females was 180  
(54.7%). Gender based distribution of the respondents  
in the different house types is shown in Table 1. There  
was significant association between gender of the  
respondents and the house type they live in (P =

0.006).

Age distribution of the respondents showed that  
39 (11.9%) respondents were in age group 0 - 5 years,  
64 (19.4%) respondents were in age group 6 - 15  
years, 112 (34.0%) respondents were in age group 16  
- 30 years and 114 (34.7%) respondents were in age  
group 31 years and above. Age distribution of the  
respondents in the different house types is shown in  
Table 1. There was significant association between  
age of the respondents and the house type they live in

(P = 0.000).

Respondents with no formal education were 113  
(34.3%) in number, those that attained primary level  
of education were 101 (30.7%) in number, those that  
attained secondary education were 92 (28.0%) in  
number whereas those that attained tertiary education  
were 23 (7.0%) in number. Distribution of the  
respondents in the different house types, based on the  
highest level of education attained is shown in Table 1.  
There was significant association between the highest  
level of education attained by the respondents and the  
house type they live in (P = 0.000). The average  
sleeping time of the respondents in different house  
types are equally shown in Table 1.

Table 1: Household Investigation and Characteristics of the study participants in Nyumagbagh, Vandekyia

Number of occupants P - Value

Block house Hut (%) Farm house TOTAL

Categories

n = 17

Variables

(%)

n = 23

(%)

n = 10

(%)

n = 50

Gender

Male  
Female

67 (45.9)  
79 (54.1)

49 (37.4)  
82 (62.6)

33 (63.5)

19 (36.5)

149 (45.3)

180 (54.7)

0.006

Age

Educational  
status

Average  
sleeping time

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 0-5 years | 17 (11.6) | 11 (8.4) | 11 (21.2) | 39 (11.9) |
| 6-15 years | 29 (19.9) | 33 (25.2) | 2 (3.8) | 64 (19.4) |
| 16-30 years | 33 (22.6) | 56 (42.7) | 23 (44.2) | 112 (34.0) |
| 31 and above | 67 (45.9) | 31 (23.6) | 16 (30.8) | 114 (34.7) |
| Non-formal | 34 (23.3) | 51 (38.9) | 28 (53.8) | 113 (34.3) |
| Primary | 40 (27.4) | 43 (32.8) | 18 (34.6) | 101 (30.7) |
| Secondary | 49 (33.6) | 37 (28.2) | 6 (11.5) | 92 (28.0) |
| Tertiary | 23 (15.8) | 0 (0.0) | 0 (0.0) | 23 (7.0) |
| - | 22.00 hrs | 22.30 hrs | 23.00 hrs |  |

0.000

0.000

\* Statistically significant at P < 0.05

Net ownership, access and use Usage

Of the fifty households observed with the average  
number of 4, 3 and 2 occupants for Block, Huts and  
farm house respectively, 82.0% of them have at least  
one bed-net (LLINs) while 64.0% actually slept inside  
the treated net (LLINs) a day before with their nets  
still hanging (Table 2). Ownership of LLINs was  
highest, 40.0% among occupants of Block house and

least, 12.0% among occupants of farm house. There  
was significant difference in LLINs ownership based  
on house types (P = 0.006). Usage of LLINs was  
highest, 36.0% among occupants of Block house and  
least, 8.0% among occupants of farm house. There  
was significant difference in LLINs usage based on  
house types (P = 0.003).

Table 2: Net ownership and usage in Nyumangbah

House type

Households

Number interviewed Number that own LLINs (%)

Number that use LLINs (%)

Block house  
Huts

Farm house

23  
17  
10

20 (40.0)  
15 (30.0)

6 (12.0)

18 (36.0)  
10 (20.0)  
4 (8.0)

Total

50

41 (82.0)

32 (64.0)

Malaria episodes from household

Fifty-nine persons were interviewed for the  
incidence of malaria over the past 12 months and  
seven of them said they have not suffered from  
malaria for the period in question. Of the remaining  
52 persons, 17.3%, 55.8% and 26.9% of them  
reported that they have been diagnosed of malaria

thrice, twice and once respectively (Table 3). There is  
significant difference in the number of malaria  
episode per individual in a space of one year (P =  
0.000). Among those that suffered from malaria  
within the said period, the month of August and  
December were reported as months with the highest  
number of occurrence (n = 8).

Predominant Outdoor Activities in Nyumangbah

The socio-cultural and economic activities  
keeping people outdoors in the study area are shown  
in Table 4. The most reported activity was alcohol

drinking with 49.3% occurrence while the least  
reported activity was charging of phones with 22.0%  
occurrence. However, there was no significant  
difference in the frequency of occurrence of different  
outdoor activities listed by the respondents (P =

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| diagnosed | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | i (Hiii y/o) |
| Thrice | 1 | 0 | 1 | 0 | 1 | 2 | 0 | 1 | 1 | 1 | 0 | 1 | 9 (17.3) |
| Twice | 1 | 1 | 2 | 1 | 2 | 2 | 3 | 6 | 3 | 3 | 1 | 4 | 29 (55.8) |
| Once | 1 | 0 | 2 | 0 | 0 | 2 | 2 | 1 | 0 | 2 | 1 | 3 | 14 (26.9) |
| TOTAL (%) | 3 | 1 | 5 | 1 | 3 | 6 | 5 | 8 | 4 | 6 | 2 | 8 | 52 |

Table 3: Monthly occurrence of malaria parasitaemia amongst the residents of Nyumangbah

No. of times Number of people diagnosed of malaria in different months (n = 59)

0.263). In Bars and Kiosk, the most occurring  
response from the people that gathered there was  
alcohol drinking (n = 33) while the least responses  
were watching of football matches (n = 9) and post -  
harvest processing (n = 9). In the phone charging spot,  
the most occurring response from the people that  
gathered there was alcohol drinking (n = 22) while the

least response was marriage celebrations (n = 8). In  
the market, the most occurring response from the  
people that gathered there was trading (n = 34) while  
the least response was charging of phones (n = 4).  
There was significant association between outdoor  
activities stated by the respondents and the peri  
domestic settings where they gathered (P = 0.000).

Densities of host-seeking mosquitoes indoors and  
outdoors

In Table 5, 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 46.8% of the collections; while  
30.3%, 17.4% and 5.5% records were for Anopheles,  
Mansonia and Aedes species respectively. CDC light  
traps indoor collected 31.2% (n=46) mosquitoes while

the CDC light traps outdoor collected 68.8% (n=63)  
mosquitoes. Of the Anopheles mosquitoes (n=33)

collected, An. gambiae s. l. 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 s.  
l. were more (n=9) while, An. funestus were collected  
more (n=8) outdoors. Members of the An. gambiae  
complex were identified as An.gambiae s. s. using  
PCR. More mosquitoes (n=51) were collected were  
from the farm house and (n=39) Hut house than Block  
house (n=19). There was no significant association in  
the indoor and outdoor abundance of mosquitoes in  
the different house types (P = 0.382).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Bars and Kiosks | Phone charging | Market (%) | Total | mean±se |
|  | (%) n = 50 | spot (%) n = 50 | n = 50 | (%) n =  150 |  |
| Charging of phone | 15 (30.0) | 14 (28.0) | 4 (8.0) | 33 (22.0) | 11.0±3.5 |
| Marriages | 13 (26.0) | 8 (16.0) | 18 (36.0) | 39 (26.0) | 13.0±2.9 |
| Burials | 11 (22.0) | 19 (38.0) | 22 (44.0) | 52 (34.7) | 17.3±3.3 |
| Watching Football | 9 (18.0) | 17 (34.0) | 10 (20.0) | 36 (24.0) | 12.0±2.5 |
| Drinking alcohol | 33 (66.0) | 22 (44.0) | 19 (38.0) | 74 (49.3) | 24.7±4.3 |
| Trading | 13 (26.0) | 18 (36.0) | 34 (68.0) | 65 (43.3) | 21.7±6.3 |
| Planting / harvesting | 9 (18.0) | 12 (24.0) | 24 (48.0) | 45 (30.0) | 15.0±4.6 |
| Meetings | 23 (46.0) | 15 (30.0) | 12 (24.0) | 50 (33.3) | 16.7±3.3 |
| Total | 126 | 125 | 143 | 394 | - |

Table 4: Predominant Socio-cultural and economic activities keeping the people outdoors in Nyumangbah

Outdoor activities

Number of Responses from people found in the selected Non-

P - value for the association between activities carried out and non peri-domestic setting :P - value for the most reoccurring outdoor activity = 0.263

\* Statistically significant at P < 0.05

0.000

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Mosquito species |  | Indoor |  |  | Outdoor |  | TOTAL |
| Block | Hut Farm House | | Block | Hut Farm House | |  |
| Cx. quenquefasciatus | 6 | 9 | 8 | 5 | 9 | 14 | 51 |
| An.gambiae s. s. | 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 |

Data from Health Facility

A retrospective data from August, 2017 through  
September, 2018 were collected from the Primary  
Health Facility Ikpoikpo. From the facility record, 398  
persons (163 patients < 5 years old and 235 other  
patients above 5 years) presented with fever and were  
tested for Plasmodium with RDT kit. The overall  
prevalence of 66.6% (n = 265) was observed.  
Prevalence of Plasmodium falciparum infection

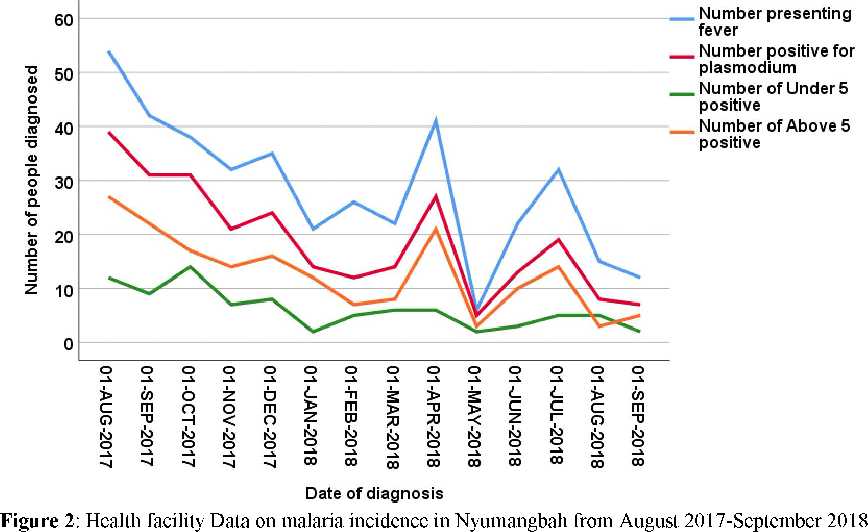
among patients < 5 years old was 52.8% (n = 86)  
while prevalence among participants above 5 years  
was 76.2% (n = 179). There was significant difference  
in the prevalence of Plasmodium falciparum infection  
between patients < 5 years old and those above 5  
years (P = 0.000). The pattern of malaria parasite  
infection over the months within the duration of data  
generation is shown in Figure 2.

Discussion

Household characteristics show that inhabitants of  
Nyumangbah were found to either live in a block  
house, hut or farm house. From the study, those who  
live in farm houses were mostly males. It shows that  
the workforce involved in large scale agricultural  
activities in the study area are males. It equally  
showed that males may have higher level of exposure  
to mosquito bites than females since the farm houses  
may lack windows, good doors and good roofing. On  
the other hand, females were found mostly in block  
houses or huts. They might be the wives and female  
children of those males in the farm houses. In age  
stratification, teenagers and young adults dominated  
the huts and farm houses whereas individuals aged 31  
years and above dominated the block house. This age  
stratification may simply suggest that children whose  
parents are actively involved in farming activities  
stayed with their parents in the farm houses or huts.  
Then adults, 31 years and above may be involved in  
economic activities other than agriculture in the study

area. Some of them who are still active in agriculture  
may have realized some money with which they can  
build or rent a block house and also buy motor cycle  
for shuttling between their farm lands and their  
residence. Thus, they are less likely to be found in  
farm houses. To a very large extent, the farming  
population in the study area comprised those who  
obtained at most primary level of education. This is  
evident by considering the number of them that are  
found in farm houses. Majority of those who attained  
secondary level of education were able to afford living  
in block houses.

Irrespective of house types, this study revealed  
that 82% of the households own at least one LLINs  
while 64% of them used the net a night before the  
survey. LLINs have proven to be effective against  
endophilic vectors such as An. gambiae s.s, An.  
arabiensis, and An. funestus as seen in the study of  
Wanji et al., (2003), Oyewole et al., (2007) and Tuno  
et al., (2010). This study recorded higher level of  
LLINs ownership than usage. Findings from Tobin-



West and Alex Hart (2011) in Rivers State, Egbuche  
et al. (2013) in Anambra State and Omonijo Adetunji  
and Omoniji Adejumoke (2019) in Ekiti, all observed  
this same pattern of more net ownership than usage as  
seen in this study. The 64% level of usage in this  
study is below the 80% national target for LLINs  
utilization unlike in the work of Adaji and Gabriel  
(2019) in the adjoining Local Government Areas with  
86% net utilization. Nevertheless, households living in  
block houses showed the highest level of ownership  
and usage of LLINs as compared to those living in  
huts and farm houses. This may be because of their  
level of education as more educated people (those  
who attained secondary and tertiary levels of  
education) lived in block houses. According to  
Mmbando et al. (2009) educational status has shown  
to affect the ability to understand written or verbal  
information about symptoms, treatment, and  
transmission mechanisms of malaria. Also, Goesch et  
al., (2008), showed an association between  
educational status and health seeking behaviours in  
terms of protecting one's self from mosquito bite (bed  
net ownership and use).

From the study, it was observed that individuals  
living in the block houses mostly retire to their  
sleeping rooms around 22:00hrs as compared to those  
in the huts (22:30hrs) and farm houses (23:00hrs).  
This late hours outside houses may be due to lack of  
electricity, so they prefer staying outdoor for some to  
receive "fresh air" while indulging in other activities.  
The long stay outdoors where LLINs usage is very  
difficult exposes them to mosquito bites and  
mosquito-borne diseases, especially malaria. For  
instance, it was gathered from this study that  
individuals in the study area may experience up to  
three malaria episodes in a year, with an average  
number of two episodes mostly occurring in August  
and December. This agrees with the findings of Rono  
et al., (2015) which reported that some people suffer  
more than one episode of malaria in the sub-Saharan  
Africa. The multiple malaria episodes may be as a  
result of reinfection due to individual and community  
social behavior, although there is still possibility of  
recrudescence and relapses from previous infections.  
Thus human behavioural changes alongside early  
diagnosis, early treatment, and use of vector control  
tools are required to bring a drastic reduction  
inmalaria incidence in Nyumagbagh as this was the  
same measures applied on the Thai-Myanmar border  
(Parker et al., (2015) and Carrara et al.,2013).

Among several studies that have been conducted  
on ITNs / LLINs ownership and use, only a few of

them had concentrated on identifying factors  
associated with usage particularly in the rural  
communities which are often characterized by socio-  
economic features that are different from that of urban  
communities. Predominant socio- cultural and  
economic activities within the community and  
households altering the normal sleeping pattern and  
making the use of insecticide treated net non-effective  
were identified in this study. The routine of drinking  
of alcohol, charging of phones, meetings, watching  
football matches, visiting the farms at night, selling of  
farm produce late into the night, burials and weddings  
that lasts late into the night increases the risk of  
exposure to mosquito bites and malaria transmissions.  
Similar outdoor activities were also observed in the  
studies of Munroe et al., (2014, 2015, 2019a), Dunn et  
al, (2011) and Alaii et al. (2003). People staying for  
long periods of time taking alcohol outdoors still  
engage in other activities. This finding is in line with  
that of Monroe et al., (2019b) 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 (Cotter et al., 2013;  
Jacobson et al., 2017). 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 produce to sell in  
the markets and majority of the sellers are women  
with babies. Thus, selling of farm produce at the  
market which runs late into the night is another high  
impact activity with respect to potential malaria  
transmission in the study area.

Among the mosquito species found in the study  
area were: An. gambiae s. s.., An. funestus, An.  
coustani, An. moucheti, Culex quinquefasciatus,  
Mansonia uniformis, Mansonia Africana, Aedes  
aegypti and Aedes albopictus. Most of these mosquito  
species have been reported in Nigeria (Aju-Ameh et  
al., 2016; Egbuche et al., 2016; Ezihe et al., 2017;  
Ogola et al.,2018; Ezihe et al., 2019; Egbuche et al.,  
2020). Even though more mosquitoes were collected  
outdoors than indoors using the same technique (CDC  
Light trap), the difference was not statistically  
significant. But then, it shows that most breeding  
habitats of mosquitoes are found outdoors and as the  
mosquitoes searches for hosts, they may fly inside the  
house to take blood meal or rest after blood meals.  
Studies in Southern Nigeria by Awolola et al., (2003)  
and Awono-Ambene et al., (2004) indicate that An.  
gambiae s. s seeks host outdoors.

The presence of Anopheles mosquitoes is an  
indication of malaria parasite transmission in the  
study area. This is evident in malaria prevalence  
record of 66.6% from the hospital data. Since the  
medical reports of the individuals in the hospital  
records shows that they had axillary temperature >  
37oC, malaria prevalence of 66.6% is a confirmation  
that all fever are not malaria related (Oladipo et al.,  
2015; Egbuche et al., 2019). 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. The principal  
transmitter of the malaria parasite in the study area  
may be An. gambiae s. s. which had earlier been  
implicated by Irikannu et al. (2019) in Awka. An.  
gambiae s. s. as seen in this study typically exhibited  
both endophagic and endophilic behaviours as in the  
study of Gillies and De Meillion (1968) and Pappa et  
al., (2011), though some level of exophily was also  
observed. The pattern of biting activity by the  
Anopheles mosquitoes in the study area tended to  
coincide with human sleeping patterns. For instance,  
An. funestus was collected mostly outdoors as people  
were carrying out activities outdoors and this is in line  
with the studies of (Killeen et al., (2016).  
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 Reddy et al., (2011) 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 (Dawa® net) given in year 2016 or the  
community members did not properly adhere to the  
usage. The Dawa® net distributed in the community  
have 50mg/m2 of deltamethrin (a pyrethroid) as  
chemical component although resistance to  
deltamethrin has been elucidated by Chukwuekezie et  
al., (2020). Furthermore, Pyrethroid resistance  
affecting both An. gambiae s. s. and An. coluzzii has  
been widely reported in Nigeria (Awolola et al., 2002,  
2007, Okorie et al., 2011, Nwankwo et al., 2017 and  
Chukwuekezie et al., 2020).

Outdoor activities in peri-domestic and non peri-  
domestic settings within the study area could be the  
reason for such high prevalence of malaria. Early  
biting of Anopheles gambiae s. l. has been seen to  
commence outdoors within a time range of 18:00hrs  
to 21:00hrs in Nigeria (Dandalo et al., 2007; Atting et  
al., 2016; PMI, 2017). From the household  
questionnaire, it is apparent that the earliest mean time  
the households retire to sleep was 22.00hrs. This is  
seen among those living in the block houses possibly  
because they power their small generators and enter  
indoors earlier than others, as Walch et al., (2016)  
suggested that the arrival of electric lighting in the last

few decades have changed behaviors of people over  
time. Before then there is biting and possible  
transmission of malaria parasites to the individuals  
while they are still outdoor. Irrespective of the  
availability of light, people who attends burials and  
weddings (especially traditional marriages) and stayed  
out till night are still exposed to mosquito bites.

Indoor biting is not ruled out because of housing  
type as well as LLINs ownership and usage. The  
graduation of housing type in sub-Saharan Africa  
from traditional huts with thatched-roof to cement  
houses with metal-roof was thought to have profound  
reduction in the transmission of malaria. This is  
because Lindsay et al., (2003) stated that poorly  
constructed houses allow easy entrance of mosquito  
vectors and increases chance of transmission among  
family members. Mosquitoes were equally distributed  
in the three housing types in the study area as no  
significant association was found between indoor and  
outdoor abundance of mosquitoes in and around the  
houses. It simply means that the housing conditions in  
the study area are poor and offers no protection from  
mosquito bites.

The farm houses surveyed were occupied by  
farmers and the numbers of Anopheles mosquitoes  
collected were higher than in huts and block houses.  
This suggests that the effect of occupation on malaria  
incidence can also be direct as seen in the study of  
Ghebreyesus et al., (2000). The finding in this present  
study like staying temporary in farm shelters has a  
likelihood of increasing contact of individuals with  
malaria vectors thereby increasing the risk of infection  
with Plasmodium as this is in line with the findings of  
Saita et al., (2019). Aside farm house, some  
respondents in this study 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 Jatta  
et al., (2018).

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 (Edelu et al., 2018, Mawili Mboumba et al.,  
2013) 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. This finding agrees with the studies of  
Chukwuocha et al., (2012) and Raimi and Kanu  
(2010) 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 Jenkins et al., (2015) 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 monthly distribution of malaria  
incidence, two peaks, August and December were  
recorded. It might be due to infection acquired during  
the raining season when mosquito population abounds  
(Egbuche et al., 2020). This finding is in line with the  
study of Umaru et al., (2015) and Satoguina et al.,  
(2009) in Gambia where malaria transmission  
occurred in the rainy seasons among children above  
five years.

Conclusion

This study has revealed the socio-cultural and  
economic activities that have high impact on malaria  
transmission in Nyumagbagh. The impact include:  
staying out late, rendering LLINs use irrelevant,  
exposure to mosquito bite, persistent prevalence of  
malaria and multiple malaria episodes in a year. It  
therefore becomes pertinent that complementary  
interventions like full protective wears, repellents and  
aerial fumigation for outdoor malaria vectors should  
be of high priority. Improvement on housing type,  
literacy level, occupation, electricity, knowledge  
about malaria and proper diagnosis of malaria for the  
rural dwellers will be an added assistance to the  
existing malaria control measures.

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