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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