Central African Journal of Public Health
2022; 8(2): 51-58
http://www.sciencepublishinggroup.com/j/cajph
doi: 10.11648/j.cajph.20220802.15
ISSN: 2575-5773 (Print); ISSN: 2575-5781 (Online)

Exposure and Determinants of Mosquito's Bite Within Health Facilities in Northern Ghana

Iddi Ziblim Yakubu[1], Adadow Yidana[2]

[1]Department of Epidemiology and Biostatistics, School of Public Health, University for Development Studies, Tamale, Ghana
[2]Department of Social and Beahavioral Change, School of Public Health, University for Development Studies, Tamale, Ghana

Email address:
ziblimudssahs@yahoo.com (I. Z. Yakubu), a.yidana@uds.edu.gh (A. Yidana)

To cite this article:
Iddi Ziblim Yakubu, Adadow Yidana. Exposure and Determinants of Mosquito's Bite Within Health Facilities in Northern Ghana. *Central African Journal of Public Health*. Vol. 8, No. 2, 2022, pp. 51-58. doi: 10.11648/j.cajph.20220802.15

Received: April 21, 2021; **Accepted**: May 20, 2021; **Published**: April 9, 2022

Abstract: Mosquitoes are considered the main agents for the transmission of several deadly diseases including malaria with controlling and preventing exposure to this vector being one of the main strategies for malaria control and prevention in Ghana. Exposure to this vector by patients/caretakers and hospital staff within wards of hospitals is a public health threat and should be a public health concern. The study assessed exposure to mosquitoes, the determinants of exposure to the vector by patients and hospital staff within wards of hospitals. A descriptive cross-sectional survey involving a mixed-method research design was conducted among 313 patients and nurses/midwives within the selected hospitals and 5 members of hospital management including ward in-charges and medical superintendents. A structured questionnaire was used for the quantitative data and an interview guide for the qualitative data collection. The data were analyzed using SPSS version 22.0 for the quantitative data and NVivo version 10.2, and content analyses for the qualitative data. Majority of the respondents (69.3%) were females and almost all the respondents were exposed to mosquitoes. About 98.4% experienced the presence of mosquitoes, 95.2% reported yes to have bitten by mosquitoes, 69.6% were unable to sleep due to mosquitoes the night preceding the study interview and 69.3% were highly exposed. Access to health information, state of nets of windows and doors of the ward, cracks on the walls of the ward, broken ceilings on the ward and grown bushes around the ward were observed to be significantly related to exposure to mosquitoes. Exposure to mosquitoes within the health facilities is obvious and considered normal as there is no or little effort towards preventing such a public health threat. All hospital stakeholders should work to curb this menace, the national malaria control program should consider hospitals as a priority area as far as controlling and preventing malaria is concerned.

Keywords: Determinants, Exposure, Mosquitoes, Bite, Health Facilities

1. Background

Mosquitoes are species of small insects, about 0.3 cm - 0.6 cm long, [1-2]. They are the world's greatest nuisance causing arthropod due to their blood-sucking and accounts for the most deadly disease transmission in the world including malaria and many other lethal diseases [1].

An entomological and human behavioral data suggested that about three-quarters of host exposure to the bites of the *Anopheles* mosquito takes place when people are indoors [3] and simple house designing could be a factor that exposes individuals to mosquito bite such as lack of screens of windows and doors [4-5]. Mosquito exposure can also be determined by factors such as the income of the household, late outdoor choirs, time spent outdoor, non-possession and usage of an Insecticide Treated Nets, the structure of hut/house and location of homestead from water bodies [6]. Higher indoor malaria vectors presence can also be due to factors such as mud walls houses, open eaves and windows which are unscreened [7].

Around the world, mosquito-borne illnesses are accountable for a great number of morbidity and mortality and all the diseases are of public health concern such as malaria, filariasis and yellow fever that affect a large number of people every year, causing massive suffering and deterring development [8]. Their presence among people does not only present its inevitable pain to human by its bite but also

responsible for the transmission of the life-threatening condition known as malaria and in Ghana, it is a common disease and a greater public health threat [9].

The malaria parasite known as plasmodium exists in several classes: P. falciparum, P. Malariae, P. Ovale, P. Vivax and P. Knowlesi and these parasites can be transmitted through the bite of infected Anopheles (females' mosquito) species [10]. Even though the parasite can also be transmitted through substances of human origin such as infected erythrocyte-containing blood substances and peripheral blood stem cells or bone marrow [10]. the mosquitoes are considered the primary agents of transmission [11]. These events are indications that transmission of malaria within the hospital is likely to occur and the risk of transmission increases if proper precautions are not strictly applied [12].

The malaria burden among African countries is still high despite increasing efforts to control and possibly eliminate the impact of the diseases as a result of the persistent greater level of spread [12]. The entire populations of Ghana are considered at risk of malaria infection with pregnant women, children under the age of five years, and immuno-compromised being the worst affected groups within the population [9, 13]. From the World Health Organization (WHO) 2018 world report on malaria, Ghana was named among the top ten (10) African countries within which the incidence of malaria cases is high. And the burden is predominant in the northern part of the country [14].

In Ghana, organizations and programs such as the Ghana National Malaria Control Program, The Ghana Health Service, Policy Planning Monitoring and Evaluation Division, Regional Malaria Focal Persons, WHO, Global Fund, USAID/PMI, DFID, CDC, have been working hard to control malaria and with one of the main focus on the vector control and prevention of human exposure to the vector and research on impact assessment of programs [13]. And unfortunately, the rising efforts to control the disease does not head towards the expected significant reduction in infection especially among young children [9].

The epidemiology of this infectious condition is dependent on the frequency and the proficiency of the contacts within the human host and the anopheles mosquitoes which is explained as how many of the mosquitoes infections resulting from an infected human host and the frequency of infections of uninfected mosquito that occurred from the bite of the infected host [15, 16]. Yet exposure to the vector within hospitals is obvious and seemed normal in the Tamale Metropolis.

With several studies on malaria, the attention of researchers is yet to be drawn to the fact that, though hospitals provide diagnosis and treatment of malaria to both outpatients and those on admission, it could also bring about malaria infection and transmission if clients and their relatives are being exposed to the vector. This study, therefore, assessed the exposure to mosquitoes within wards of a hospital in the Tamale Metropolis and its associated factors.

This study is based on the systems model approach. A system may be defined as a structured set of objects or attributes, where these objects and attributes consist of components or blocks that have connections drawn between them, is interrelated with one another and operate together by way of some driving process [17]. The concept of the system is very useful in providing a means of understanding the complex relationship between human population exposure to mosquitoes and factors that brings about the exposure.

To assess and understand the exposure of a population to mosquitoes and factors of the exposure within a particular place, its exposure-outcome chain should be described and analyzed comprehensively. The system model approach was adapted to explain adequately the complex relationships between the human population exposure to mosquitoes and the factors of the exposure dynamics [18]. This system model consists of several linked subsystems: the factors of exposure (environmental factors, structural and other factors), the human population exposure systems (divided into a human subsystem and a mosquito subsystem), and thus the possible impact so far as malaria parasite development and transmissions are concerned.

Though vector density and rate of vector population growth can determine typical human exposure to the vector and strongly related to local environmental conditions [4, 18]. But these may not be enough factors to cause human exposure to the vector in some places such as hospital wards unless there are other factors such as structural defects and lack of personal protective measures within the wards.

Human population exposure to mosquitoes within communities is related to factors such as lack of screens of windows and doors, open eaves, open doors and windows, the income of a household, late outdoor choirs, time spent outdoor, non-possession and usage of an Insecticide Treated Nets, the structure of hut/house [5, 4, 7]. This study assessed simultaneously an exposure to mosquitoes in the wards of hospitals and the factors of the exposure.

2. Methods

2.1. Study Area

Tamale Metropolis is among the fourteen (14) districts in the Northern Region of Ghana and is the capital town in the region. It is located in the center of the region which has a total population of 371,351 projected at a 2.9% regional growth rate [19]. It shares boundaries with only two districts in the region; thus, the Sagnarigu District to the West and North and Mion District to the east. The metropolis also shares boundaries to some other two districts within the Savanna Region; thus, East Gonja to the south and Central Gonja to the south-west. The metropolis has four main hospitals including Tamale west and central hospitals, Tamale Teaching Hospital and the Seventh Day Adventist (SDA) hospital. However, the Central hospital and West hospital in the metropolis were among the hospitals that were considered for this study since they are the two main government and public hospitals. The Central Hospital has a bed capacity of 186 and a Neonatal Intensive-Care Unit (NICU) with a bed

capacity of 8 and West hospitals has a bed capacity of 150 without a NICU [20].

2.2. Study Population

This study considered its target population which consists of all patients/caretakers and hospital staff (nurses/midwives) in the hospital that at least spent one night preceding the day of the survey on the wards (kids/pediatric ward, maternity ward, female ward and male ward) within each of the hospitals selected for this study. The study also considered an in-depth interview with ward in-charges drawn from some selected wards and hospital management.

2.3. Sampling Techniques

The Tamale West Hospital and the Tamale Central Hospital were purposively selected for this study and a simple random sampling technique was used to randomly select participants. The participants for the qualitative data were purposively selected for the in-depth interview. A self-administered structured questionnaire was used with the aid of Computer-Assisted Interviewing (CAPI) application CS Entry version 7.2 installed in android phones and tablets to collect quantitative data from caregivers (nurses and midwives) on the demographic characteristics of the respondents, the experience of their exposure and magnitude of exposure to mosquitoes, the contributory factors of their exposure to mosquitoes. Also, an observation checklist was developed to collect the data on the contributory factors of patients/clients and hospital staff exposure. With regards to the qualitative data collection, an interview guide with the aid of a voice recorder, and in-depth interviews were conducted with five (5) key informants including ward in-charges and medical superintendents on their opinions on the exposure of clients and staff to mosquitoes, causes of exposure of clients and staff to mosquitoes, possible effects of exposure of clients and staff to mosquitoes and measures to prevent or control exposure to mosquitoes. Also, information was obtained about recommendations on how to prevent mosquito exposures onwards. This qualitative data was transcribed verbatim after recording.

2.4. Data Analysis

The quantitative data was entered, processed and analyzed using SPSS version 22.0 for windows. The descriptive statistics were analyzed and presented in tables with frequencies and percentages. The descriptive statistics of the study was also analyzed using interactive variables to described and summarized using frequencies, percentages and pie chart for the assessment of the outcome variable.

With regards to the qualitative data analysis tools and procedures, the transcribed data was read thoroughly and issues relating to each other were highlighted and coded according to individual themes. The coded themes were realigned and coded into sections under transcripts. These processes were done with the aid of NVIVO software version 10.1.

3. Results

3.1 Exposure to Mosquitoes

Respondents were asked if there had the experience of mosquito presents, mosquito bite and whether they were unable to sleep due to mosquitoes within their respective ward in which they passed the night preceding the day of the data collection. Almost all the respondents, (98.4%) experience the presence of mosquitoes and the majority of the respondents (95.2%) reported yes to have bitten by mosquitoes a night preceding the interview. More than half 218 (69.6%) also said they were unable to sleep due to mosquitoes a night before the study.

Table 1. *Exposure to mosquitoes.*

Variables	Frequency (%)
Presence of mosquitoes	
No	5 (1.6)
Yes	308 (98.4)
Mosquito bites	
No	15 (4.8)
Yes	298 (95.2)
Unable to sleep due to mosquitoes	
No	95 (30.4)
Yes	(69.6)

Source: Field survey, 2019.

3.2. The Magnitude of Exposure to Mosquitoes

The magnitude of exposure to mosquitoes within the wards was determined by the number of the exposure variables (experience of mosquito presents, mosquito bite and unable to sleep due to mosquitoes) out of three variables that a respondent experienced a night preceding the interview. An individual experiencing all three variables were considered high exposure experiencing one or two of the three variables were considered low exposure. Out of the 313 respondents interviewed, more than 69% of the respondents were exposed to mosquito bites, sleep discomfort and nuisance (mosquito exposure) in a ward at a hospital.

3.3. The Association Between Other Variables and Exposure to Mosquitoes

The bivariate Chi-square test for associations showed the independent variables such as access to health information from a newspaper or magazine, access to health information from listening to radio, torn state of nets of windows of the ward, torn state of nets of doors of the ward, cracks on the walls of the ward, broken ceilings on the ward and grown bushes around ward were realised to be significantly related to exposure to mosquitoes.

Respondents who had no access at all to health information from a newspaper or magazine were more likely (67.7%) to be highly exposed to mosquitoes compared to those who had access to health information from a newspaper or magazine less than once a week (20.3%) and those with access to such information at least once a week (12.0%) ($p<0.001$). Exposure

to mosquitoes varied considerably with access to health information from listening to the radio (p<0.001).

Respondent onwards with torn window nets, 88.5% were most likely to be exposed to mosquitoes compared to those who were onwards that did not have torn window nets, 66.4% (p<0.001). Fewer respondents (29.7%) onwards with torn door nets had high exposure to mosquitoes compared to those (70.5%) onwards with intact door nets (p=0.005). Respondents with no cracks on their wall, 77.4% were less likely to have high exposure to mosquitoes than those with cracks on the walls to their wards, 22.6% (p=0.045).

In furtherance, respondents onwards without broken ceilings (66.8%) had more high exposure to mosquitoes compared to those respondents (33.2%) onwards broken ceiling (p<0.000). High exposure to mosquitoes also significantly differed with wards with grown bushes around them (p=0.008). Recruited respondents from West hospital were significantly more likely to have high exposure to mosquitoes relative to those recruited from Central hospital (p=0.042).

Table 2. *The association between other variables and exposure to mosquitoes.*

Variable	Exposure to mosquitoes		Test Statistic
	Low Exposure n (%)	High Exposure n (%)	
Ward			
Kids ward	24 (25.0)	75 (34.6)	
Male ward	32 (33.3)	51 (23.5)	Chi-squared (χ^2) = 4.798, p =
Female ward	19 (19.8)	49 (22.6)	0.187
Maternity (OBG) ward	21 (21.9)	42 (19.4)	
Patient/Staff			
Patient/Caretaker	64 (66.7)	179 (82.5)	χ^2 = 9.596, p = 0.992
Hospital Staff (Nurse …….)	32 (33.3)	17.5)	
Sex			
Male	37 (38.5)	71 (32.7)	χ^2 = 0.999, p =0.310
Female	59 (61.5)	146 (67.3)	
Religion			
Islam	65 (67.7)	63 (29)	
Christianity	31 (32.3)	63 (29.0)	χ^2 = 1.173, p = 0.556
AFTR	0 (0.0)	2 (0.9)	
Education			
No Education			
Primary	28 (29.2)	70 (32.3)	
JHS	5 (5.2)	19 (8.8)	χ^2 = 3.027, p = 0.553
SHS	12 (12.5)	25 (11.5)	
Tertiary	12 (12.5)	33 (15.2)	
Access to health information from a newspaper or magazine			
At least once a week	19 (19.8)	26 (12.0)	
Less than once a week	2 (2.1)	44 (20.3)	χ^2 = 18.825, p = 0.000
Not at all	75 (78.1)	147 (67.7)	
Access to health information from listening to a radio			
At least once a week	44 (45.8)	76 (35.0)	
Less than once a week	3 (3.1)	58 (26.7)	χ^2 =23.637, p = 0.000
Not at all	49 (51.0)	83 (38.2)	

Source: Field survey, 2019.

Table 3. *The association between other variables and exposure to mosquitoes.*

Variable	Exposure to mosquitoes		Test Statistic
	Low Exposure n (%)	High Exposure n (%)	
Access to health information from watching television			
At least once a week	58 (60.4)	141 (65.0)	
Less than once a week	8 (8.3)	23 (10.6)	χ^2 =1.732, p = 0.421
Not at all	30 (31.3)	53 (26)	
Mosquito Net use			
No	94 (97.9)	204 (94.)	χ^2 =2.227, p = 0.136
Yes	2 (2.1)	13 (5.0)	
Mosquito coil Use			
No	80 (81.3)	173 (97.9)	χ^2 =0.560, p = 0.454
Yes	16 (16.7)	44 (20.3)	
Mosquito spray use			
No	92 (95.8)	213 (98.2)	Fisher's exact test =1.442, p =
Yes	4 (4.2)	4 (1.9)	0.255
Mosquito repellent use			
No	38 (39.6)	76 (35.0)	χ^2 = 0.598, p=0.439
Yes	58 (60.4)	141 (65.0)	

Variable	Exposure to mosquitoes		Test Statistic
	Low Exposure n (%)	High Exposure n (%)	
Ward Congestion			
No	76 (79.2)	183 (84.3)	χ^2 =1.244, p = 0.265
Yes	20 (20.8)	34 (15.7)	
Are ward windows closed at night			
No	54 (56.3)	117 (53.9)	χ^2 =0.146, p = 0.702
Yes	42 (43.8)	100 (46.1)	
Torn state of nets of windows of the ward			
No	11 (11.5)	73 (33.6)	χ^2 = 16.679, p =0.000
Yes	85 (88.5)	144 (66.4)	

Source: Field survey, 2019.

Table 4. *The association between other variables and exposure to mosquitoes.*

Variable	Exposure to mosquitoes		Test Statistic
	Low Exposure n (%)	High Exposure n (%)	
Are doors of the wards closed at night			χ^2 =3.631, p = 0.057
No	45 (46.9)	77 (35.5)	
Yes	51 (53.1)	140 (64.5)	
Torn state of nets of doors of the ward			
No	52 (54.2)	153 (70.5)	χ^2 = 7.863, p =0.005
Yes	44 (45.8)	64 (29.5)	
Cracks on the walls of the ward			
No	64 (66.7)	168 (77.4)	χ^2 = 4.012, p =0.045
Yes	32 (33.3)	49 (22.6)	
Broken ceilings on the ward			
No	40 (41.7)	145 (66.8)	χ^2 = 17.422, p=0.000
Yes	56 (58.3)	72 (33.2)	
Stagnant water in gutters around wards			
No	60 (62.5)	139 (64.1)	χ^2 = 0.07, p = 0.792
Yes	36 (37.5)	78 (35.9)	
Grown bushes around the ward			
No	50 (52.1)	147 (67.7)	χ^2 = 6.996, p =0.008
Yes	46 (47.9)	70 (32.3)	
Age of respondents			
>= 25	28 (29.2)	52 (24.0)	
26 – 45	59 (61.5)	147 (67.7)	χ^2 = 1.194, p =0.550
46+	9 (9.4)	18 (8.3)	
Wealth Index			
Poor	10 (10.4)	20 (9.2)	
Average	68 (70.8)	159 (73.3)	χ^2 =0.212, p = 0.900
Rich	18 (18.8)	38 (17.5)	
Duration of stay on the ward			
<= 3	59 (61.5)	141 (65.0)	χ^2 =0.357, p = 0.550
4+	37 (38.5)	76 (35.0)	
Access to health information			
Low	41 (42.7)	106 (48.8)	χ^2 = 1.007, p =0.316
High	55 (57.3)	111 (51.2)	
Hospital			
Central Hospital	54 (56.3)	95 (43.8)	χ^2 = 4.150, p =0.042
West Hospital	42 (43.8)	122 (56.2)	

Source: Field survey, 2019.

4. Qualitative Analysis

4.1. Participants Opinions on the Exposure of Clients and Staff to Mosquitoes

Participants were asked if in their opinion and experience there are presents of mosquitoes and if patients/clients and the staff are exposed to the mosquitoes within the wards of the hospital in which they work. Unanimously, all participants attest to the fact that mosquitoes are presents in the hospital and exposure of both clients and staff to the mosquitoes is an obvious situation. Some of the participants added that mosquitoes are everywhere and the hospitals should not be seen as an exception since it is found in sub-Saharan Africa and in the northern region to be precise. And some made it clear that the question as to whether there are presents of mosquitoes within hospitals and if clients and staff are being exposed to the vector should not be asked in sub-Saharan Africa or even precisely in the northern region of Ghana.

"Well, that is a question normally an African should not

ask because you know that the mosquitoes are everywhere, it is a pandemic, I would say within this our west African sub-region, nurses are crying when they are in the wards, errrrh, on duties, OPD they are crying all this is the mosquitoes are everywhere,"(hospital management).

"Eeeehh, under our table all they are there, day time kuraaa! they bit us, although they said the day time one cannot transmit malaria, day time too we get mosquito bites" (participant in the maternity ward).

"There are a lot of mosquitoes within the ward especially in the night when you come for night duties" (participant in the paediatric ward).

4.2. Participants Opinions on Causes of Exposure of Clients and Staff to Mosquitoes

Participants were asked the possible causes of exposure of clients and staff alike to mosquitoes on the wards. The majority attributed the cause of the exposure to mosquitoes on the wards to the fact that the buildings were old and the doors and windows were always open to aid ease the reception of clients, particularly laboring women. Some added that outlets within the wards were too many owing to torn nets and broken windows and the presence of bushes outside the immediate surroundings of the wards was a boost for mosquito breeding. Inability to keep up with the maintenance needs of the wards was blamed on the low finances of the hospitals.

"Our windows, our open doors, because as for women in labor you can't close the door, you can lock the door and when a woman in labor come in front of the door so our doors are always open for clients to come inside" (participant in the maternity ward).

"……. eeehh! the hospital environment and the ward too, you can see that it is crowded, all over so many things clients will eat food and leave it around all this thing can collect eerrrh! breed mosquitoes" (participant in the female ward).

hhhhhnnnnn, okay, is just that the outlets are too many, the outlets, we don't close our doors, the windows, the nets are torn so, and there are bushes outside, there weeds that are grown outside the hospital, so through that, they enter wards, they serve as a breeding ground and then they enter the ward. (participant in the pediatric ward)

5. Discussion

Exposure to mosquitoes is considered so deadly in the world because mosquitoes are vital vectors responsible for the spreading of several deadly diseases pathogens as indicated by several studies around the world [21-22]. but not only these vectors transmit diseases pathogens, their presence alone within and among people also cause much discomfort to their host either on duty or their resting period with painful bite and nuisance sound in the ear. Obviously in Africa, and some parts of the world mosquito's presence may be considered normal due to certain environmental factors, but as much as mosquitos' control is being a priority to the world to eliminate the impact of the burden that its presence imposed on the health of the populace, their presence and a certain category of people's exposure to the vector should be a matter of concern.

Globally, there have been great efforts with huge investments towards the controlling and elimination of malaria in the world health organization regions. According to the 2018 report of the World Health Organization, as of 2017, about US$ 3.1 billion was spent on efforts targeted at controlling and possible elimination malaria worldwide by governments of countries with endemicity of malaria and a significant part of it went into vector control, prevention of exposure to the vector and research with public health education on how and the need for prevention of exposure to mosquitoes [12]. Almost all these interventions are implemented by the health workers within and outside health facilities.

This is in contrast to the findings of this study within the health facilities where the presence of mosquitoes and patients/clients and hospital staff especially nurses and midwives on the ward's exposure to the mosquitoes seems obvious to everyone including hospital authorities. This phenomenon is the biggest health threat to children under the ages of five and pregnant women in malaria-endemic zones such as Sub-Saharan Africa of which Ghana is not an exception [9, 10].

It has been acknowledged that, though the malaria parasite can also be transmitted through substances of human origin such as infected erythrocyte-containing blood components and peripheral blood stem cells or bone marrow, mosquitoes are considered the primary agents of transmission of the parasite [10]. In areas of possible rotation of vectors that could transmit the parasite of malaria, the transmission is expected in hospitals, if mosquito exposure prevention interventions are not properly applied [9].

This public health problem could be worsened if there is an outbreak of different diseases which is also transmitted by mosquitoes such as arboviruses; which include the Yellow fever virus (YFV), Dengue virus (DENV), and Chikungunya virus (CHIKV) and before detection this patient might have been admitted into the hospital where several kinds of mosquitoes are being exposed to. Mosquitoes are considered to be responsible for the transmission of several disease pathogens including arboviruses; which include the Yellow fever virus (YFV), Dengue virus (DENV), and Chikungunya virus (CHIKV) [22, 21].

The exposure to mosquitoes is determined by host availability including the amount of time a person remains not protected against the bites of mosquitoes in a particular place where mosquitoes, especially the *Anopheles* are abundant and the factors that enhance the person's attractiveness to mosquitoes [23, 3].

In this study, factors such as access to health information from a newspaper or magazine, access to health information from listening to radio, torn state of nets of windows of the ward, torn state of nets of doors of the ward, cracks on the walls of the ward, broken ceilings on the wards and grown

bushes around ward which made participants available to mosquitoes were realised to be significantly related to exposure to mosquitoes.

This study also reveals that other variables such as gender (both females and males), age (both children and adults) and either a hospital staff or patient were all insignificantly associated ($\chi^2 = 0.999$, p =0.310, $\chi^2 = 1.194$, p = 0.550 and $\chi^2 = 9.596$, p = 0.992 respectively) with the magnitude of exposure. The most important understanding from these results and worrying aspect is that the group of people that are considered highly vulnerable to malaria infection such as the children in pediatric wards including under five (5 years) and females in the maternity wards and their babies (WHO, 2018) and with their highly compromised immune systems are all at a higher risk of exposure to mosquitoes within hospitals.

In Ghana, even though the entire country's population is vulnerable to malaria, the children under five years of age and pregnant women are the highest susceptible groups with an alarming number of 590 under-five deaths by malaria in the year 2016 representing a case mortality rate of 0.32 and with the northern region recording the second-highest case fatality rate of 0.49 [13].

6. Conclusion

The finding from this study reveals public health threat within the Tamale metropolis and its surroundings so far as malaria transmission prevention and control is a concern. As found in the results, one's presence within a health facility is a guarantee of your exposure to mosquitoes and a high risk of malaria infection. As indicated, almost all respondents were exposed to the vector of malaria. As indicated almost all (98%) of the respondents said they had experienced the presence of mosquitoes, (95.2%) reported yes to have bitten by mosquitoes a night preceding the interview and the majority 218 (69.6%) were highly exposed to the vector within the wards of the hospitals. Ward congestion, broken ceilings and stagnant water in the gutter around the wards turned out to be statistically significant with the outcome variable. The maternity ward was more likely to be congested than the other wards ($p < 0.001$). The broken ceilings in the male ward also differed significantly from the other wards ($p = 0.047$). access to health information from a newspaper or magazine, access to health information from listening to radio, torn state of nets of windows of the ward, torn state of nets of doors of the ward, cracks on the walls of the ward, broken ceilings on the ward and grown bushes around ward were significantly related to exposure to mosquitoes. Health staff on the wards at the hospitals had about 54% less chance of having high exposure to mosquitoes compared to the patients. It was made clear that cross-infection of malaria is highly possible. Patients admitted with a condition either than malaria and staff are likely to be infected with malaria within the hospital due to the exposure to the infected vector. Because there is a high risk of exposure to mosquitoes within health facilities in the Tamale metropolis, there is a public health threat against the control and elimination of malaria or reduction of its burden on our health systems and economy since it will create a room for malaria transmission cycle between hospitals and the communities.

References

[1] Khan, S. A., Hanif, H., Abbas, Z., Saeed, A., & Ahmad, M. (2016). *Makeup ingredients (lactic acid, getyl alcohol, and citric acid) attract mosquitoes*. 4.

[2] Koenraadt, C. J. M., & Harrington, L. C. (2008). Flushing effect of rain on container-inhabiting mosquitoes Aedes aegypti and Culex pipiens (Diptera: Culicidae). *Journal of Medical Entomology*, *45* (1), 28–35.

[3] Guelbéogo, W. M., Gonçalves, B. P., Grignard, L., Bradley, J., Serme, S. S., Hellewell, J., Lanke, K., Zongo, S., Sepúlveda, N., Soulama, I., Wangrawa, D. W., Yakob, L., Sagnon, N., Bousema, T., & Drakeley, C. (2018). Variation in natural exposure to anopheles mosquitoes and its effects on malaria transmission. *ELife*, *7*, e32625. https://doi.org/10.7554/eLife.32625

[4] Lindsay, Steve W., Jawara, M., Mwesigwa, J., Achan, J., Bayoh, N., Bradley, J., Kandeh, B., Kirby, M. J., Knudsen, J., Macdonald, M., Pinder, M., Tusting, L. S., Weiss, D. J., Wilson, A. L., & D'Alessandro, U. (2019). Reduced mosquito survival in metal-roof houses may contribute to a decline in malaria transmission in sub-Saharan Africa. *Scientific Reports*, *9* (1), 7770. https://doi.org/10.1038/s41598-019-43816-0

[5] Lindsay, Steven W., Jawara, M., Paine, K., Pinder, M., Walraven, G. E. L., & Emerson, P. M. (2003). Changes in house design reduce exposure to malaria mosquitoes. *Tropical Medicine & International Health*, *8* (6), 512–517.

[6] Chirebvu, E., Chimbari, M. J., & Ngwenya, B. N. (2014). Assessment of Risk Factors Associated with Malaria Transmission in Tubu Village, Northern Botswana. *Malaria Research and Treatment*, *2014*, 1–10. https://doi.org/10.1155/2014/403069

[7] Kaindoa, E. W., Finda, M., Kiplagat, J., Mkandawile, G., Nyoni, A., Coetzee, M., & Okumu, F. O. (2018). Housing gaps, mosquitoes and public viewpoints: A mixed-methods assessment of relationships between house characteristics, malaria vector biting risk and community perspectives in rural Tanzania. *Malaria Journal*, *17* (1), 298. https://doi.org/10.1186/s12936-018-2450-y

[8] Killeen GF, Fillinger U, Kiche I, Gouagna LC, Knols BG. (2002) Eradication of Anopheles gambiae from Brazil: lessons for malaria control in Africa? Lancet Infect Dis. 2: 618–27.

[9] Afoakwah, C., Deng, X., & Onur, I. (2018). Malaria infection among children under-five: The use of large-scale interventions in Ghana. BMC Public Health, 18. https://doi.org/10.1186/s12889 018-5428-3

[10] ECDC. (2018). *Hospital acquired malaria infections in the European Union*. 11.

[11] WHO. (2000). *The world health report 2000: Health systems: Improving performance*. World Health Organization.

[12] WHO. (2018). World malaria report 2018.

[13] NMCP (2016) Annual_Bulletin. pdf. (n. d.).

[14] FY. (2017). President's malaria initiative. Ghana malaria operational plan.

[15] Athrey, G., Hodges, T. K., Reddy, M. R., Overgaard, H. J., Matias, A., Ridl, F. C., Kleinschmidt, I., Caccone, A., & Slotman, M. A. (2012). The Effective Population Size of Malaria Mosquitoes: Large Impact of Vector Control. *PLoS Genetics*, *8* (12), e1003097. https://doi.org/10.1371/journal.pgen.1003097

[16] Atwa, A. A., Bilgrami, A. L., & Al-Saggaf, A. I. M. (2017). Host–parasite interaction and impact of mite infection on mosquito population. *Revista Brasileira de Entomologia*, *61* (2), 101–106. https://doi.org/10.1016/j.rbe.2017.03.005

[17] Okoye, C. O And Nwachukwu, M. C. (2014). human induced environmental factors and mosquito breeding in Enugu urban-Nigeria. American Journal of Engineering Research (AJER) e-issn: 2320-0847 p-issn: 2320-0936 volume-03, issue-05, pp-57-63 www.ajer.org

[18] Martens, W. J. M., Niessen, L. W., Rotmans, J., & McMichael, A. J. (n. d.). Potential impact of global climate change on malaria risk. *Environmental Health Perspectives*, 7.

[19] Robert B. K., Rhubamatu I. and Issahaku M. (2015). Strengthening Health Systems and Interventions towards Quality Maternal Care: A Focus on Millennium Development Goal Five. Public Health Research 2015, 5 (1): 16-23. DOI: 10.5923/j.phr.20150501.03.

[20] Adzitey S. P., Wombeogo M., Mumin A. H., & Frederick Adzitey F. (2017). Knowledge and Attitude of Nurses in the Tamale Metropolis toward Kangaroo Mother Care (KMC). Ann Med Health Sci Res. 2017; 7: 454-459.

[21] Ferreira-de-Brito, A., Ribeiro, I. P., Miranda, R. M. de, Fernandes, R. S., Campos, S. S., Silva, K. A. B. da, Castro, M. G. de, Bonaldo, M. C., Brasil, P., & Lourenço-de-Oliveira, R. (2016). First detection of natural infection of Aedes aegypti with Zika virus in Brazil and throughout South America. *Memórias Do Instituto Oswaldo Cruz*, *111* (10), 655–658.

[22] Farraudière, L., Sonor, F., Crico, S., Étienne, M., Mousson, L., Hamel, R., Missé, D., Failloux, A.-B., Simard, F., & Yébakima, A. (2017). First detection of dengue and chikungunya viruses in natural populations of Aedes aegypti in Martinique during the 2013–2015 concomitant outbreak. *Revista Panamericana de Salud Pública*, *41*, e63.

[23] Childs, L. M., Cai, F. Y., Kakani, E. G., Mitchell, S. N., Paton, D., Gabrieli, P., Buckee, C. O., & Catteruccia, F. (2016). Disrupting Mosquito Reproduction and Parasite Development for Malaria Control. *PLOS Pathogens*, *12* (12), e1006060. https://doi.org/10.1371/journal.ppat.1006060