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Factors Influencing Malaria Incidence among Rural Farming Households: Evidence from Kogi Agricultural Zones

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Authors' contributions

This work was carried out in collaboration among all authors. Author FOO designed the study, performed the statistical analysis. Author SIA wrote the protocol and managed the analyses of the study. Author YEA wrote the first draft of the manuscript. Author ATA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The high incidence of malaria epidemic among rural households in developing countries is not in doubt. The study assessed factors influencing malaria incidence in rural Kogi State, Nigeria. This study aimed to identify farmers' socioeconomic characteristics in relation to malaria occurrence and determinants. Structured questionnaire was used to gather data from 240 randomly selected registered farming households in the State's Agricultural Zones B and D. Data obtained were analysed using descriptive and inferential statistics. Result of the study revealed good knowledge on malaria prevention, causes and symptoms among the farming households. Despite their level of knowledge, malaria was prevalent and significantly influenced by closeness to bush and dumps, closeness to stagnant water, and distance to health centres with the coefficient of 1.341, 1.520 and 1.741 at 5%, 5% and 1% level of significance respectively. Household with access to health campaign and subsequent use of insecticide treated mosquito nets had low probability of malaria infection. These predictors, however, need further work to validate reliability.

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1. INTRODUCTION

Malaria still remains a life threatening disease in Sub-Saharan Africa (SSA). It is caused by plasmodium parasites that are transmitted as a result of the bites of infected female *Anopheles* mosquitoes [1]. The scourge of malaria is on the increase because according to the world health organization, there were estimate of 216 million cases of malaria and death toll of 445 000 persons in 2016 compared to 211 million cases in 2015. African region carries a disproportionately high share of this global malaria burden with 90% of malaria cases and 91% of malaria deaths [2].

Malaria and agriculture are related because agricultural such as water resource development, deforestation, wetland cultivation, crop cover, land-use changes for agricultural purposes in the highlands, and an increase in urban agriculture provide suitable conditions for breeding of mosquitoes which are vectors of Plasmodium parasites that cause malaria [3]. There are multiple channels by which malaria impedes development, including effects on fertility, population growth, saving and investment, worker productivity, absenteeism, premature mortality and medical costs [4]. [5], maintained that malaria's effect on smallholder farmers can be devastating. When a farmer is ill at planting season, he may not be able to cultivate as much land and engage in intensive farming practices. Such a farmer will plant less labour-intensive crops and change cropping patterns, which may involve raising few crops with consequent low return.

According to [6] farmers´ health status has a significant effect on their capacity to increase output because ill health could impact negatively on the number of hours spent on farm and amount of income earned. Health risk and particularly malaria has some debilitating effects on the output and income through cost of health care, man days of labour lost to malaria medication and physical weakness. [5], pointed out that malaria leads to loss of agricultural labour due to illness and death, wastage of family members' time and energy in caring for malaria patients and grieving for people killed by malaria. Malaria also results into loss of agricultural knowledge and skills especially if it kills an experienced farmer. [7] established a positive relationship between the health status and productivity of workers. Malaria incidence among farmers has consequences ranging from loss of man days of labour, low output, loss of income and diversion of capital for treatment and even death in severe cases. Failure to wipe out and prevent resurgence can translate into loss of majority of work force needed for efficient agricultural production in the economy. The consequences of malaria include emotional distress caused by illness and sometimes death of the affected individuals. Critical need to care for those infected and to find ways of replacing their contributions to the household and the community are also associated with this as affirmed by [8]. In addition to loss of life, malaria places an economic burden on nations and rural households. It is estimated that malaria costs Africa US$12 billion per year in direct costs and reduces GDP growth by 1.3 percent annually [9]. The burden is carried mostly by poor, rural families that have less access to prevention and treatment services.

In most rural areas, quacks have taken over the functions of trained and licensed medical personnel. Studies that should have brought medical situation in the rural areas to the glee of the policy makers are inadequate. Most medical studies have concentrated in the urban areas and among the educated elites because of the easy terrain of the areas and the understanding of the urban dwellers. The study was carried out as a result of this loss of time and other resource which affected farm activities and output. Therefore, the objective of the study was to identify factors influencing malaria incidence among rural farmers of Kogi Agricultural Zones.

2. METHODOLOGY

2.1 Study Site

The study was carried out in Kogi state of Nigeria using respondents in the Eastern Agricultural Zones of State. Kogi State is divided into four Agricultural Zones namely, Zone A comprising Kabba/Bunu, Ijumu, Mopamuro, Yagba East and Yagba West Local Gvernment Areas (LGAs); Zone B comprising Ankpa, Bassa, Dekina and Omala LGAs; Zone C , comprising Kogi, Lokoja, Ajaokuta, Adavi, Okehi and Okene LGAs and Zone D comprising Olamaboro, Ofu, Igalamela/Odolu, Idah and Ibaji LGAs with their zonal headquarters at Aiyetero-Gbede, Anyigba, Kotonkarfe and Alloma respectively (Kogi State

Agricultural Development Project [10]. Geographically, Kogi East is located between latitudes 6°30'N and 8°50'N and longitudes 5°51'E and 8°00'E as shown in Fig. 1.

2.2 Sample Size Determination

The study covered all registered farmers in Agricultural Zones B and D of Kogi State and focused on farmers who had reported malaria cases and were diagnosed (infected) and farmers who had not reported any malaria case (non-infected) in the last cropping season. Purposive sample of two Local Government Areas (LGAs) were selected from each of the two zones using riverine terrain as a guide. In this wise, Bassa and Omala LGAs which are at the bank of river Benue were selected to represent zone B while Idah and Ibaji LGAs which are at the bank of river Niger were selected to represent zone D. Then two settlements were randomly selected from each LGA making eight settlements. A sampling frame of 47397 registered farmers in the zones obtained from ADP and their distribution into four LGAs is as follows: Bassa (9, 397 farmers); Omala (11, 500 farmers); Idah (3, 500 farmers) and Ibaji (25, 000 farmers). A proportionate number of farmers was obtained for each LGA through random sampling of 48, 58, 18 and 116 farmers from Bassa, Omala, Idah and Ibaji respectively, making the 240 respondents that were selected for the study.

The proportionate sampling model is specified as;

$n_h = N_h(n/N)$

Where;

n = sample size,
n_h = number of farmers selected from each LGA,
N = Total number of farmers from the selected LGAs,
N_h = total number of farmers in each LGA.

2.3 Data Collection

Primary data were collected through structured questionnaire and were used together with secondary data. Information was on farmers' socioeconomic characteristics, incidence of malaria, in relation to causes and symptoms. Information about infected farmers was obtained from General Hospitals and Health centres in the localities. Name and addresses of those who came for treatment were obtained under confidential cover and were traced to their places. Enumerators were trained and used to administer the questionnaire. The researcher and the enumerators were on the field to collect the information from the respondents.

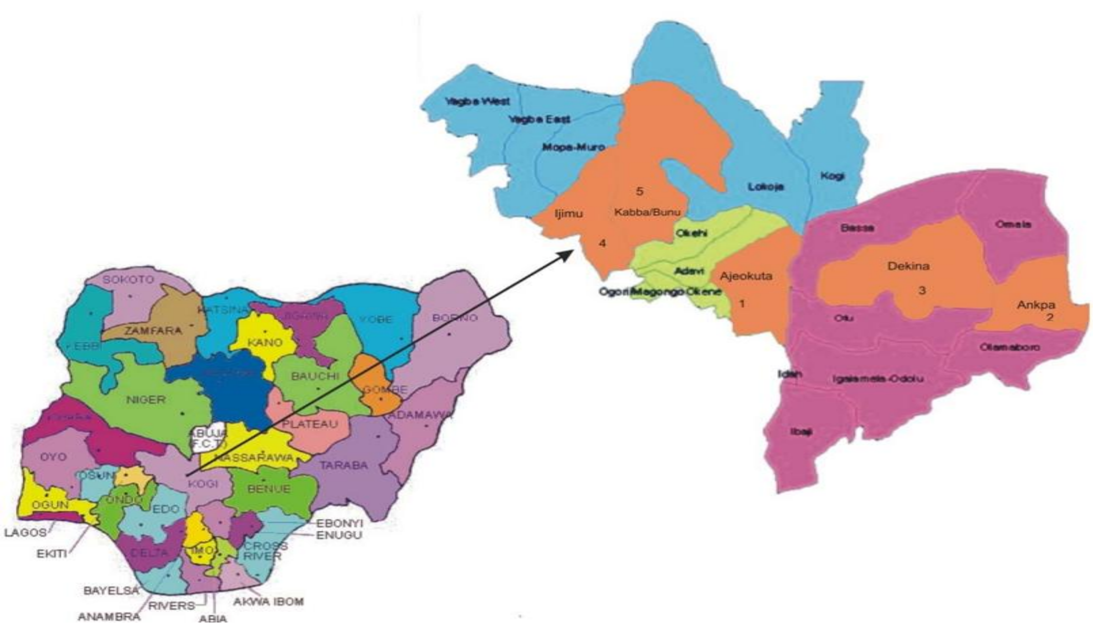

Fig. 1. Map of Nigeria showing Kogi State [11]

2.4 Data Analysis

The binary logit regression model used to identify the determinants of malaria incidence is stated as follows [12]:

$$P_i = f\,(Z_i) = f(\beta_0 + {}^{n}\Sigma_{j=1}\,\beta_i X_{ji}) = \frac{1}{1 + e^{-z}{}_i} = \frac{e^{z}{}_i}{1 + e^{z}{}_i} \quad (1)$$

Where;

P_i = malaria incidence
f = function,
Z_i = index of farmer's reaction,
β_0 = latitude from origin of the model,
n = total number of observations,
X_j = explanatory variables of the model which contain a set of economic and social features of an individual,
i = farmer number,
e = basis of natural logarithm, and
B_j = model of parameters which are under estimation.

At Logit model, Z_i (reaction index) is a random variable which predicts probability of dependent variable occurrence. If the quantity of Z_i becomes more than threshold extent (like Z_i*), a farmer will be infected; otherwise he won't be infected. This index is obtained for ith farmer as specified below:

$$Z_i = Ln\frac{P_i}{1 - P_i} = Y = \beta_i + {}^{n}\Sigma_{j=1}\,\beta_j X_{ji} \quad (2)$$

Where;

P_i = probability of occurrence of dependent variable and X_{ji} = vector of explanatory variable of the model.

The explicit form of the logit regression model is as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \text{----------} + \beta_8 X_8 + e_i \quad (3)$$

X_1 = Years of formal education
X_2 = Household size
X_3= Output (in naira)
X_4 = access to health campaign
X_5 = Use of mosquito net
X_6 = Closeness to bush and dumps
X_7 = Closeness to stagnant water
X_8= Distance to hospital
β_0, β_1..... β_8 are the regression parameters (estimated coefficients)
μ_i is the disturbance term.

3. RESULTS AND DISCUSSION

3.1 Socioeconomic Characteristics of the Respondents

Results on the socioeconomic characteristics of infected and non-infected farmers are presented in Table 1. The male farmers' dominance is in line with African tradition where men are household heads. The mean age of the infected and non-infected farmers was 33 years and 40 years respectively, which is an indication that most of the farming population are relatively young and active. By implication, they could be innovative and dynamic, with more strength to carry out agricultural work which is physically demanding as stated by [13]. The mean household sizes for the infected and non-infected farmers were 8 and 7 persons respectively. Large household can serve as a reservoir of labour especially for members who do not go to school. [14] reported that household size had implication for labour availability and could influence the likelihood of innovation adoption. On the negative side as reported by [15] families with large household size usually have low income which in turn increases their poverty status and by implication predisposed to malaria infection.

On average, the infected farmer spent 5 years schooling and the non-infected farmers also spent 5 years schooling. This showed that the respondents had attained one form of education predominantly primary education. Educational status of an individual plays a significant role when it comes to their health status as the most educated farmers are well equipped with both preventive and curative strategies. This result supports the findings of [16], who with data from the Malawi 2000 DHS, revealed that women with lower levels of education were more likely to have fever than women with higher levels of education. The result further showed an average year of farming experience of 18 years and 19 years for infected and non-infected farmers respectively with a pooled mean farm size of 1.5 hectares. This is an indication that the farmers were experienced in farming activities and operates on a small scale. Also, high farming experience could mean higher income because more farming skills and techniques are expected to be gained over time. Perhaps, household heads with large farm size may be more susceptible to malaria illness because of the drudgery nature of crop farming in the state, which could lead to a lot of emotional stress, thereby predisposing them to malaria infection [17]. The average annual output valued in naira was N53,334 ($139.44) and N66,250 ($173.20) for the infected and non-infected farmers respectively. The monthly income of infected and non-infected households was N634.9 ($1.66) and N788 ($2.06) respectively; this is an indication that the non-infected farmers were better off. Since these figures are less than the national average of N834.02 ($2.13) [18] and the average of N814.24 ($2.13) found for agricultural workers, it could be inferred that in terms of agricultural production, farmers in the area are sinking deeper into poverty [19]. In addition, the difference in the mean output could be attributed to effect of malaria attack.

Table 1. Distribution of respondents according to socioeconomic characteristics

Variables	Infected			Uninfected			Pooled		
	Freq.	%	Mean	Freq.	%	Mean	Freq.	%	Mean
Sex									
Male	81	67.5		86	71.7		167	69.6	
Female	39	32.5		34	28.3		73	30.4	
Total	120	100		120	100		240	100	
Age (Years)									
21-30	19	15.8		26	21.7		45	18.8	
31-40	42	35.0		46	38.3		88	36.7	
41-50	36	30.0	33yrs	28	23.3	40yrs	64	26.7	40yrs
51-60	17	14.2		14	11.7		31	12.9	
Above 60	06	5.0		6	5.0		12	5.0	
Total	120	100		120	100		240	100	
Household size									
1-5	29	24.2		41	34.2		70	29.2	
6-10	75	62.5	7.5	64	53.3	7	139	57.9	7
11-15	15	12.5		11	9.2		26	10.8	
Above 15	01	0.8		04	3.3		05	2.1	
Total	120	100		120	100		240	100	
Years spent schooling									
0 (No formal education)	70	58.3		30	25.0		100	41.7	
1-6	31	25.8	5yrs	48	40.0	5yrs	79	32.9	5yrs
7-12	12	10.0		25	28.8		37	15.4	
Above 12	07	5.8		17	14.2		24	10.0	
Total	120	100		120	100		240	100	
Farming experience(Yrs)									
1-10	34	28.3		25	20.8		59	24.6	
11-20	36	30.0	18yrs	49	40.8	19yrs	85	35.4	19yrs
21-30	31	25.8		29	24.2		60	25.0	
Above 30	19	15.8		17	14.2		36	15.0	
Total	120	100		120	100		240	100	
Farm size(Ha)									
≤ 1.0	60	50.0		13	10.8		73	30.4	
1.1-2.0	39	32.5	1.5ha	07	5.8	1.6ha	46	19.2	1.6ha
2.1-3.0	09	7.5		46	38.3		55	22.9	
> 3.0	12	10.0		54	45.0		66	27.5	
Total	120	100		120	100		240	100	
Output (N)									
≤50,000	40	33.3		22	18.3		62	25.8	
50,001-100,000	52	43.3	53,334	10	8.8	66,250	62	25.8	59,792
100,001-150,000	15	12.5		15	12.5		30	12.5	
150,001-200,000	06	5.0		08	6.7		14	5.8	
Above 200,000	07	5.8		10	54.2		72	30.0	
Total	120	100		120	100		240	100	

3.2 Respondents' Knowledge of Malaria Causes, Symptoms and Prevention

The distribution of the respondents according to their accurate knowledge on malaria, causes, symptoms and prevention is presented in Table 2. The result indicated that a majority of the respondents (96.7%) and (91.7%) knew that mosquito bites and dirty water respectively, could cause malaria. While low proportion accepted that heavy oil consumption (50%) and work related fatigue (37.1%) can be the main cause of malaria.

This finding could be associated to the fact that dirty environment serve as hide out for malaria vector and also encourages their breeding thereby increases famers' exposure to mosquito bite accordingly. Farming household members could also be exposed to malaria as a result of frequent farming activities and its related stress. Finding of this study agrees with [20] and [21] when they reported that agricultural activities increases exposure of individuals to mosquito bites which could lead to malaria transmission.

More so, a majority of the respondents identified fever (91.3%), high temperature (83.3%), persistent fever (82.9%), headache (50.8%) and vomiting (42.9%) as the main symptom of malaria. About 38% of the respondents reported jaundice as the common symptom. Farmers generally believed that working under the sun will lead to malaria infection and days of incapacitation. This is evident in the findings as high temperature and it accompanied fever were reported to be symptoms of malaria in the area. [22] reported that working under sun increases farmer's body temperature and can lead to malaria infection. [23] reported similar finding and attributed it to high prevalence of malaria virtually in most rural farming households.

In addition, the best practices to prevent malaria are to sleep under a treated mosquito net (96.3%) and use of insecticide coil (95.4%). Furthermore, about 90% of respondents reported that keeping the surrounding clean is the best preventive measure. On the other hand, a low proportion of the respondents opined that; using insecticide spray, creams and lotions (6.1%), taking preventive medications like drinking plant juice/root (42.1%) and coil smoke (42.1%) were the best preventive measures. This finding could be attributed to successes recorded by the Kogi state government who made it mandatory for every house to maintain cleanliness and healthy environment together with her efforts toward preventing malaria infection through the distribution of mosquito nets. This finding agreed with [24], who reported that, malaria can be prevented through the cleanliness of environment. In addition, the use of mosquito net reduces farmers' contact with mosquito hence; reduce the rate at which they get infected with malaria parasite. [25] reported that malaria cases in households decrease with the use of insecticide treated nets (ITNs).

3.3 Determinants of Incidence of Malaria Attack on the Farmers

Results of the binary logit regression analysis on the determinants of malaria incidence among farmers are presented in Table 3. The result shows that all the independent variables jointly accounted for the variation in malaria incidence (x^2 = 244.188, P<0.01).

The coefficient of access to health campaign is -1.185 and significant at 10%.The inverse relationship of access to health campaign with malaria incidence implies that farmers who had access to health campaign in the last cropping season were equipped and knowledgeable about malaria infection, symptoms and control measures. Also health campaigns contribute to sensitization and awareness on the ailment with associated reduction in malaria incidence.

The coefficient of use of mosquito net is -1.733 and significant at 5%. This negative relationship is an indication of reduction in the incidence of malaria with households that uses mosquito net. Mosquito net prevents contact with mosquito and their bite which result in malaria. This is in agreement with [26] who reported user's preference to mosquito nets as a protective measure because of its effectiveness and availability. On the contrary, [27] noted "the speed with which a population acquires functional immunity to the severe consequences of *P. falciparium* infection depends on the frequency of parasite exposure from birth as measured by the intensity of parasite transition in a given locality".

Closeness to bushes and dumps has a coefficient of 1.341 which is significant at 5%. Being hiding places for mosquitoes, bushes and dumps directly influence malaria incidence. It creates favorable environment for mosquito vector breeding. Therefore, people who live close to them are likely to suffer from malaria. Very often, malaria attacks are associated with poor social, economic and environmental conditions and victims are the poor who are often forced to live on marginal lands [26].

The coefficient of closeness to stagnant water is 1.520 and significant at 5%, positively signed. This implies that, farmers who are exposed to stagnant water will be more vulnerable to malaria attack. This finding agrees with [28] who reported stagnant water bodies as malaria vector utmost breeding in environment.

Distance to hospital has a coefficient of 1.741 and is significant at 1%. The positive relationship implies an increase in incidence of malaria with a kilometer increase in distance to the hospital. Distance from health centre relates to level of health expert visit, consciousness and transport fare among farmers. Farmers who are living far from the health centre are less conscious of malaria ailment thereby prone to the disease while those closer to the centre are conscious of the disease and attend to the preventive measures thereby reducing the spread of the disease. Huge sum of money is required for transportation to the hospitals for farmer living long kilometers from the hospital. Long distance also discourages health expert visit thereby reducing farmers' awareness and consciousness, consequently malaria attack. This is in accord with the finding of [14].

Table 2. Respondents' knowledge of malaria causes, symptoms and prevention

Items	Frequency	Percentage
Causes of Malaria		
Mosquito bite	220	91.7
Heavy oil consumption	120	50.0
Work-related fatigue	89	37.1
Insufficient sleeping	190	79.2
Direct exposure to sun light	210	87.5
Milk consumption	176	73.3
Dirty water	232	96.7
Symptoms of Malaria		
Fever	219	91.3
Vomiting, lack of appetite	103	42.9
High temperature with convulsion	200	83.3
Persistent fever	199	82.9
Jaundice	92	38.3
Headache	122	50.8
Malaria Prevention Methods		
Use of treated mosquito net	231	96.3
Use of insecticide spray, cream or lotion	187	77.9
Taking preventive medications	160	66.7
Use insecticide coil	229	95.4
Decoction/plant juice/root to drink	101	42.1
Clean surroundings	211	87.9
Use of a coil smoke	101	42.1

Table 3. Results of the logistic regression showing the determinants of malaria incidence among farmers

Variable	Coefficient	z-value	p/z/
Constant (K)	-5.482	1.045	0.307
Education (X_1)	-0.037	0.096	0.757
Household size (X_2)	-0.102	0.346	0.556
Output (N) (X_3)	-0.149	0.015	0.902
Access to campaign (X_4)	-1.185	2.598	0.100*
Use of mosquito net (X_5)	-1.733	4.816	0.028**
Closeness to Bush and dumb (X_6)	1.341	5.128	0.024**
Closeness to stagnant water (X_7)	1.520	4.315	0.038**
Distance to hospital (X_8)	1.741	47.767	0.000***

*Log-likelihood= 287.457, LR $\chi2$ = 244.188, Prob>$\chi2$ = 0.000; *** = significant at 1%, ** = significant at 5% and * = significant at 10%*

4. CONCLUSION AND RECOMMENDATION

Malaria affected the farmers and their families because of loss of man days and the expenditure that it inflicted on them. Farmers had good knowledge on the preventive measures, causes and symptoms of ailment. However, malaria incidence among farming households was significantly influenced by stagnant water, distance to hospital and dirty environments.

Based on these findings, the following recommendations are made:

1. Hospitals and clinics should be established in many settlements so that people do not travel long distances to get medication
2. Since the use of mosquito nets was identified as the major method of protection, its efficacy could be improved through its availability and affordability to many households
3. Medical personnel such should be trained and posted to rural areas so that people can have access to them.
4. Sanitary inspector should be trained and posted to the villages so that the sanitary standards can be maintained.
5. Public health programmes of enlightenment on the need to prevent the infection must be taken to all categories of people through the print and electronic media. This will go a long way to support the popular saying "prevention is better than cure".

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the authors.

EHTHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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