Risk Factors Associated with *Plasmodium Falciparum* Infection in Zaria, Kaduna State.

G.Y. Benjamin, C.M.Z. Whong and E.D. Jatau

Department of Microbiology, Ahmadu Bello University, Zaria, Nigeria.

Abstract- A study of the risk factors associated with *Plasmodium falciparum* infection in patients attending selected hospitals in Zaria Kaduna State was carried out. Four hundred blood samples were collected by venipuncture from consenting patients. The blood samples were examine microscopically for *Plasmodium falciparum* on thin and thick blood smears prepared for each sample. The results were analysed statistically using the Chi square test at 95% confidence interval. Only the ring trophozoites of *Plasmodium falciparum* were observed in the infected samples. Those who were always sleeping under insecticide treated mosquito nets at home had the least prevalence (5.5%) which was lower than the 6.7% prevalence of those who were not sleeping under insecticide treated nets always. The highest prevalence was found among those who were not sleeping under insecticide treated mosquito nets at home with 94.1% (χ^2=293.088, p<0.05). Respondents who were using insecticides at home always had the least prevalence with 5.9% the highest prevalence (88.8%) however was found in those not using insecticide at home (p<0.05). Alcohol consumption and smoking were significantly associated with *Plasmodium falciparum* infection. Smokers had a prevalence of 62.5% which was higher than the 27.6% found in non-smokers. Alcohol users also had a higher prevalence (83.3%) than non-alcohol users with 27% (χ^2=9.118, p<0.05). We concluded that consistent use of insecticide and insecticidal nets at home reduced malaria prevalence, while smoking and alcohol consumption increased malaria prevalence due to *Plasmodium falciparum* infection. In conclusion, alcohol consumption, smoking, use of insecticidal net and insecticides at home were the risk factors found to be significantly associated with malaria infection in this study

Index Terms- Plasmodium falciparum, Insecticide-treated-net, trophozoites, insecticide

I. Introduction

Malaria is caused by intracellular parasites belonging to the genus *Plasmodium*; 5 species are recognized as pathogens of humans, namely, *P. falciparum, P. vivax, P. ovale, P. malariae, and P. knowlesi*. Depending on the intensity of transmission and the parasite species involved, the clinical and public health impact of malaria is geographically variable. Most serious illness and mortality from malaria in the world is caused by *P. falciparum*. Complications of severe anaemia and cerebral malaria are thought to be the major cause of morbidity and mortality (Malaguarnera and Musumec, 2002). It has been estimated that half of the world's population (3.5 billion people) will live in malaria transmission areas in 2010 (Hay *et al*., 2004). Half of the world's population (3.3 billion) is at risk of malaria (WHO, 2010). The profound effect of malaria on much of sub-Saharan Africa, in particular, is well known, and most of the estimated 1 million deaths caused annually by malaria occur in Africa (Breman *et al*., 2004). Insecticides-Treated Nets (ITNs) offer a form of personal protection and have repeatedly been shown to reduce severe diseases and mortality due to malaria for both the pregnant women and children in endemic regions. Community- wide trials in several African settings, ITNs have been shown to reduce all-cause mortality by about 20% (Carol *et al.*, 2007). The insecticides used for treating the nets kill mosquitoes and other insects. These insecticides also have repellent properties that reduce the number of mosquitoes that enter the house and attempt to feed thereby offering protection not only for the person under the net but also for those in the same room with the net owner (Carol *et al.*, 2007).

II. Materials and Methods

2.1 Study design

The study was a cross sectional study which lasted for six months. Data was collected from consenting individuals who attended the hospitals during the period of the research.

2.2 Study area and study population

The study was carried out in four selected hospitals in Zaria, Kaduna State. Major Ibrahim B. Abdullahi memorial hospital Zaria- former Limi, Hajiya Gambo Suwaba Hospital Kofan Gaya Zaria, Salama Hospital and St. Luke's Hospital Wusasa Zaria. Zaria is situated at Latitude 11° 25″ North and Longitude 4° 27″ East of Nigeria (The World Gazetteer, 2007). Zaria is located in the North Western part of Nigeria. The inclusion criteria of the studied population were patients who came to carryout blood related test in the laboratories of the hospitals where the research was conducted.

2.3 Sample collection and processing

A well-structured questionnaire was used to obtain samples and bio-data from consenting individuals. The sample size was determined using the equation $n= Z^2p(1-p)/d^2$ as described by Naing *et al*. (2006). A total of 400 blood samples were collected from the four hospitals; 100 samples from each hospital. Venipuncture technique was used for blood sample collection. A soft tubing tourniquet was fastened to the upper arm of the patients to enable the index finger to feel a suitable vein. The puncture site was then cleansed with methylated spirit (methanol) and venipuncture was made with the aid of a needle attached to a 5 ml syringe. When sufficient blood was collected, the tourniquet was then released and the needle removed immediately while the blood was transferred into an EDTA bottle (Epidi *et al*.,

2008).Thick and thin blood films were prepared immediately after the blood samples were collected according to the technique outlined by Cheesbrough (2009). A drop of each blood sample was placed in the center of a grease-free clean glass slide, and immediately it was spread using a smooth edged slide spreader to make a thin film. The thin film was allowed to air dry before it was fixed with methanol. The thick film was made by transferring a drop of blood to another clean slide and spread in such a way that it was possible to see (but not read) newsprint, it was then allowed to dry properly. The blood films were stained using 10% Giemsa working solution for 30 minutes. After staining the blood films, they were allowed to air-dry (Cheesbrough, 2009).

2.4 Microscopic examination of the stained blood films

The stained blood films were examined under the microscope using 100X objective lens after focusing. Presence of ring forms of *Plasmodium* and Trophozoites of *Plasmodium* indicated positive results. A blood smear was considered negative after examining at least 100 high power (100X objective) microscopic fields for parasites (Cheesbrough, 2009).The prevalence rate of malaria was determined by the number of positive over the number of specimens collected.

Prevalence rate = $\frac{No.\ positive}{Total} x100$

2.5 Ethical Clearance

Ethical approval and consent was sought and obtained from the ethical committee of Kaduna State Ministry of Health and the ethical committees of the various hospitals included in the study.

2.6 Data analysis

Data generated from the research were analysed using SPSS version 20 from SPSS Inc., USA. Chi square analysis was used to check the level of significance in the occurrence of malaria parasite in relation to different variables at 95% confidence level.

III. Results

Table 1 shows the relationship between malaria and the use of insecticide treated nets. Those who were always sleeping under insecticide treated nets at home had a prevalence of 5.5% which was lower than the 6.7% prevalence of those who were not sleeping under insecticide treated nets always. The highest prevalence was found among those who were not sleeping under insecticide treated nets at home with 94.1% (χ^2=293.088, p=0.000).

Table 2 Shows malaria prevalence in relation to the use of insecticides at home. The highest prevalence (88.8%) was found among those who were not using insecticides at home, followed by those who were not using insecticide at home always with 7.1%. The least prevalence was found in those who were using insecticides always with 5.9% (χ^2=264.123, p=0.000).

Parasitaemia in relation to presence of bush and gutters around the house of respondents is shown in table 3.Those who had bushes/gutters around their houses had 32.0% while those without bushes/gutters around their houses had 27.4% (χ^2=0.640, p=0.424) .

Table 4 shows malaria prevalence in relation to alcohol usage and smoking. Those who used alcohol and those who were smokers had 83.3 and 62.5% prevalence respectively, which were higher than the 27.4% and 27.6% in those who were not drinking alcohol and non-smokers respectively (χ^2=4.724, p=0.030).

Table 1: Use of insecticide treated nets (ITN)

Use of ITN	N screened	N positive	% Prevalence	χ^2	P value
Always	238	13	5.5	293.088	0.000*
Not always	60	4	6.7		
Never	102	96	94.1		

Key: ITN=Insecticide treated nets, N=number, χ^2=chi square,%= percentage

Table 2: Malaria prevalence in relation to use of insecticides at home

Use of Insecticide	N screened	N positive	% Prevalence	χ^2	P value
Always	237	14	5.9	264.123	0.000*
Not always	56	4	7.1		
Never	107	95	88.8		

Key: N=number, χ^2=chi square, %=percentage, *=significant at p≤0.05

Table 3: Parasitaemia in relation to presence of bush and gutters around the house

Bushes/gutter	N screened	N positive	% Prevalence	χ^2	P value
Yes	75	24	32.0	0.640	0.424
No	325	89	27.4		

N=number, χ^2=chi square, %=percentage

Table 4: Malaria prevalence in relation to alcohol usage and smoking

Use of alcohol	N screened	N positive	% Prevalence	χ^2	P value
Yes	6	5	83.3	9.118	0.003*
No	394	108	27.4		
Smoking					
Yes	8	5	62.5	4.724	0.030*
No	392	108	27.6		

N=number, χ^2=chi square, %=percentage,*=significant at $p \leq 0.05$

IV. Discussion

This study shows a significant ($p<0.05$) relationship between malaria prevalence and the use of insecticide treated mosquito nets (ITN) at home. Those who were always using ITN, had a lower prevalence (5.5%) as compared to those who were not always using ITN, with a prevalence of (6.7%). Those who were not using ITN had a very high prevalence (94.1%). This suggests that the constant and appropriate use of insecticidal net decreases the prevalence of malaria. The protective effect of insecticide-treated mosquito net use shown in this study adds to the vast body of evidence supporting the efficacy and effectiveness of insecticide-treated mosquito nets for protection against malaria and other vector-borne diseases in this setting. Long Lasting Insecticidal Nets (LLINs) have been successful in reducing malaria incidences by either reducing or not allowing human exposure to the vector mosquitoes (Sunil and Vijay, 2014). A reduction in malaria prevalence was also observed among those who used insecticides to control mosquitoes at home. Those who used insecticides always, had a lower prevalence (5.9%) compared to those who were not using insecticides always, with a prevalence of (7.1%). Those who were not using insecticides at all had significantly high prevalence (88.8%).The number of people protected as a result of insecticide usage increased from 13 million in 2005 to 75 million in 2009 (WHO, 2010).

The presence of bush/gutter at home was not significantly associated with malaria, even though those who had bush/gutter around their houses had a higher prevalence (32.0%) than those without bush/gutter around their houses (27.4%). This is in agreement with the findings of Nkuo-Akenji *et al.* (2006) who reported that malaria parasite prevalence and parasite density was higher in children living in houses surrounded by bushes/garbage and swamps/stagnant pools of water when compared with those inhabiting cleaner environments. This could be justified by the fact that bushes, swamps/stagnant pools and gutters serve as breeding grounds for mosquito (the vector that transmits malaria parasites).

In this study, respondents who consumed alcohol had a higher prevalence (83.3%) than those who were non-alcohol users with 27.4%. This may be because the body odour of alcohol consumers increases their attractiveness to mosquitoes. Thierry *et al.* (2010) reported that beer consumption consistently increased volunteer's attractiveness to mosquitoes by increasing mosquito's activation (proportion of mosquitoes engaging in take-off and up-wind flight) and orientation (proportion of mosquitoes flying towards volunteers' odours). According to their report, beer consumption is a risk factor for malaria and needs to be integrated into public health policies for the design of control measures. Smokers also had a higher prevalence than non-smokers. This implies that smoking increased their susceptibility to malaria.

V. Conclusion

Alcohol consumption, smoking, use of insecticidal net and insecticide at home were the risk factors found to be significantly associated with malaria infection in this study. Consistent use of insecticides and insecticide treated mosquito nets at home reduced malaria prevalence significantly.

References

[1] Breman, J.G., Alilio, M.S., Mills, A. Conquering the intolerable burden of malaria: what's new, what's needed: a summary. American Journal of Tropical Medicine and Hygiene; 71 (2): 2004, pp1-15.

[2] Carol, G., Paul, G. and Feiko, O. Insecticide-Treated Nets (ITNs) for the prevention of malaria in pregnancy: A Systematic Review of Randomised Controlled Trials. PLoS Med 4(3), 2007, pp107.

[3] Cheesebrough, M. District laboratory practice in tropical countries. Part 1.Second edition updated, 2009, pp. 245-249.

[4] Hay, S,I., Guerra, C.A., Tatem, A.J., Noor, A.M., Snow, R.W. The global distribution and population at risk of malaria: past, present, and future. Lancet Infectious Diseases; 4, 2004, pp327-336.

[5] Malaguarnera, L and Musumec, S. The immune response to Plasmodium falciparum malaria. Lancet Infect Dis; 2, 2002, pp472–78

[6] Idoko, M.O., Ado, S. and Umoh, V. Prevalence of Dangue virus and Malaria in patients with febrile complaints in Kaduna metropolis, Nigeria. British Research Journal 8(1), 2015, pp343-347.

[7] Naing, L., Winn, T., Rusli, B.N. Practical issues in calculating the sample size for prevalence studies. Archives of Orofacial Sciences; 1, 2006, pp9-14.

[8] Nkuo-Akenji T., Nelson N. N., Maze, B.N., Helen, K. K., Edith, L. A., Armand, N., Damain, N. A., Michael, S., Michael, G. B., Kenneth, N. N. and Vincent, P.K. T. (2006). Environmental factors affecting malaria parasite prevalence in rural Bolifamba, South- West Cameroon. Afr J Health Sci.; 13, 2006, pp40-46.

[9] Sunil, D., Vijay V. Culminating anti-malaria efforts at long lasting insecticidal net? The Journal of Infection and Public Health,7 (6), 2014, pp457–464. DOI: http://dx.doi.org/10.1016/j.jiph.2014.06.002

[10] Thierry, L., Louis-Clément, G., Kounbobr, R.D., Eric E., Didier, F., François, R., Carlo, C., and Frédéric, T. Beer Consumption Increases Human Attractiveness to Malaria Mosquitoes. PLoS One.; 5(3),2010. doi: 10.1371/journal.pone.0009546

[11] W.H.O. Guidelines for the treatment of malaria, second edition, 2010.

AUTHORS

First author- G.Y. Benjamin, B.Sc. Biology, M.Sc. Microbiology (in view)
Second author-C.M.Z. Whong, Professor of Microbiology, A.B.U. Zaria.
Third author-E.D. Jatau,Professor of Microbiology, A.B.U. Zaria.

Correspondence author:gbydchamp@yahoomail.com