Seasonal Variation and Trend of Malaria Prevalence in the Mpohor District of Ghana

Senyefia Bosson-Amedenu [1*] senyefia@yahoo.com , Kojo Amuah Prah[2] kojoprah@yahoo.com
Francis Hull Adams[3] hullaf@yahoo.com

1. Holy Child College of Education, P.O. Box 245, Takoradi, Ghana
2. Holy Child College of Education, P.O. Box 245, Takoradi, Ghana
3. Holy Child College of Education, P.O. Box 245, Takoradi, Ghana

ABSTRACT

The objective of this study was to determine the trend and the seasonal variation of prevalence of malaria (if any) in order to assist health policy makers in the Mpohor district. Monthly malaria morbidity cases over six year period (from January 1, 2008 to December 31, 2013) were analysed in the wet (March- July) and dry (November- January) seasons in four selected communities in the Mporhor District of Ghana.

The Chi square test was performed to assess the nominal variable difference between malaria prevalence in wet and dry seasons.

The results showed that Malaria prevalence in the wet and dry seasons were not equal $\left(\text{P-value, } 0.072 > 0.05\right)$. Also Malaria prevalence was 56.4 % in the wet season and 43.6 % in the dry season.

Malaria prevalence in the district increased by 22.1% and 35.0% respectively in 2009 and 2010. However, there was a marginal decline in prevalence by 4.6% and 7.5% respectively in the years 2011 and 2012 and then saw an astronomical increase of 66.4% in 2013.

Malaria prevalence was significantly different in male and female children below the age of five (0.007 <0.05) with female children in this category being at a greater risk than the males.

Children below the age of four in Ayiem were found to have 18% increase in risk than their counterparts in other communities of the district.

It was recommended among other things that further research involving more communities in the District to provide complete and more reliable information that is useful in malaria control.

INTRODUCTION

Malaria is the world's most widespread human infection caused by protists of the genus Plasmodium which are introduced into the circulatory system by the bite from an infected female Anopheles mosquito or rarely, through transfusion of infected blood products or in utero from the mother to the new born through the placenta or during delivery . Malaria is the fifth leading cause of death from infectious diseases in low-income countries; it is a global public health problem in many developing countries including Ghana (Mwangangi *et al.*, 2013).

Rainfall is one of the climatic variables that aid in the multiplication of mosquito breeding places and increases humidity, which improves mosquito survival rates. The rainy season is a fertile period for the breeding sites, which are numerous. These species have the highest population density during the rainy season and these accounts for the high incidence of malaria at this period of the year. Studies have established complex relationship between malaria and rainfall because water is very vital for larval development (Akhtar, 1996).

A prolonged dry season can decrease mosquito numbers by reducing breeding sites and also minimizes malaria incidences. It was also found from his research that malaria transmission was higher in the wet season (positively associated).According to a lot of researchers, wetter rainy season is more favorable for the demonstrated a link between long term reductions in precipitation and reduction in malaria incidence. transmission of malaria. Rain increases the atmospheric humidity and is fundamental to the relationship between mosquitoes and its breeding places (Akhtar, 1996).

Rainfall also affects relative humidity and the expected lifespan of adult mosquitoes. Studies have established complex relationship between malaria and rainfall because water is very vital for larval development. A prolonged dry season can decrease mosquito numbers by reducing breeding sites and also minimizes malaria incidences. It was also found from his research that malaria transmission was higher in the wet season (positively associated) (Akhtar, 1996).

STATEMENT OF THE PROBLEM

It is on record that, Sub-Saharan Africa accounts for 90 % of the world's 300 – 500 million cases and 1.5 –2.7 million deaths annually. About 90 % of all these deaths in Africa occur in young children. Economists believe that malaria is responsible for a 'growth penalty' up to 1.3 % per year in some African countries of which Ghana is no exception. When compounded over years, this penalty leads to substantial differences in Gross Domestic Product (GDP) between countries with and without malaria and severely restrains the economic growth of the region (Asante *et al*., 2003).

Malaria is governed by a large number of environmental factors, which affect its distribution, seasonality and transmission intensity. The peak in morbidity and mortality is generally obtained in the rainy season, the time when malaria transmission is at its peak and the number of deaths during this period has been shown to be over threefold higher than in the rest of the year. High levels of parasiteamia are also found much more frequently in the rainy season than in the dry season, and the mean packed cell volumes are lower in the rainy season than in the dry season (Jaffar *et al*., 1993).

Although Insecticide Treated Nets (ITN's) provide a cost effective means of ameliorating the effects of malaria, this measure will be expensive if large human populations must be protected in the Mpohor district. Hence the need to analyze, monitor and predict the pattern of the disease in the district, so as to come up with a measure to curb the spread.

METHODS

1.1 Study Area and Source of Data

The Mpohor District is one of the 22 Districts in the Western Region. The District is located at the south-eastern end of the region and was carved out from the erstwhile Mpohor Wassa East District in 2012 and established with a Legislative Instrument (L.I). The population of the Mpohor District, according to the 2010 Population and Housing Census, is 42,923 representing 1.8 percent of the region's total population. Mpohor District has four Area Councils namely Mpohor, Adum Banso, Manso and Ayiem. The malaria morbidity cases in the Mpohor, Adum Banso, Manso and Ayiem health centres were used in the study Nyarko *et al*., 2010). The drainage pattern of the Mpohor District is largely dendritic. There are a number of rivers and streams in the District (e.g. Subri, Butre and Hwini). The wet period in the District is between March and July while November to January is dry. Generally, the rainfall pattern is supportive of agricultural activities (Nyarko *et al*., 2010).

Figure 1.0 District Map of Mpohor (Source: Ghana Statistical Service, GIS 2014)

Table 1 : Number of major communities in Mpohor District

Area Council	Number of Communities
Edum Banso	14
Manso	9
Mpohor	8
Ayiem	6
TOTAL	**37**

The Mpohor district is made up of four (4) Area Councils which has a total of 37 major communities.

1.2 *Data Collection and Management*

The demographic data of the areas involved in the study were obtained using the 2010 Population and Housing Census of Ghana. The populations from 2011 to 2013 used in the study were extrapolated using the 2009 and 2010 growth rates computed with the help of SPSS software.

The malaria cases data were obtained from Mpohor District Health Centre and three other health centres in Manso, Edum Banso and Ayiem. The malaria incidence per thousand (1000) people of the population was then calculated over the periods in the wet and dry seasons in children below age five, pregnant women and in patients above the age of five.

That is, $\text{Prevalence} = \{(\text{number of cases/population}) \times 1000\}$ for the communities under study (at each cell level). The chi-square test was used to assess the difference between prevalence in the wet and dry seasons. Geographic Information Systems (GIS) data of the District was obtained from the Department of Geological Engineering in the University of Mines and Technology, Ghana.

The chi-square test statistic is given by:

$$\lambda^2 = \sum_n \frac{(O_i - E_i)}{E_i} \tag{2.1}$$

Where O_i is the observed value, E_i is the expected value for the ith observation and n is the number of cells.

RESULTS

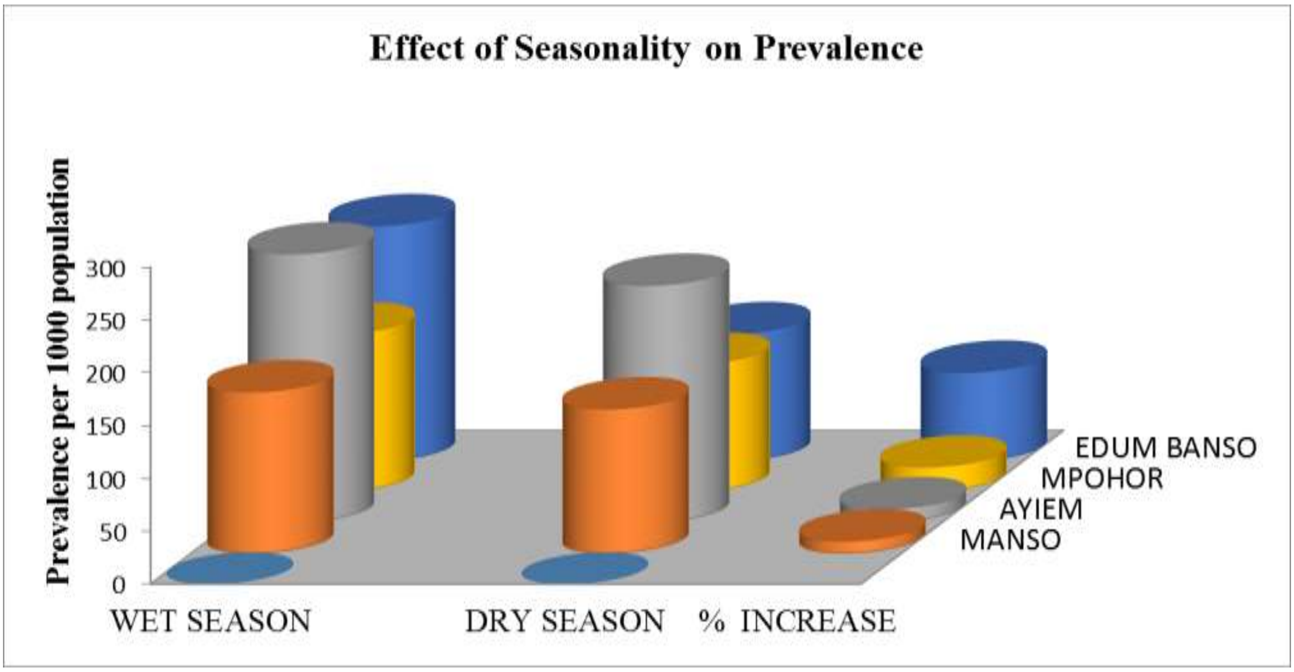

Figure 5.1 Graph Showing the Effect of Seasonality on Prevalence

From Figure 5.1 above, the study found that the increase in rainfall resulted in increase in malaria prevalence in all the communities considered in the study. Rainfall might have increased the humidity which may have improved mosquito survival rates.

The malaria prevalence in the wet season in each of the four communities was higher The increase in malaria prevalence in the wet season in other communities such as Ayiem, Manso and Mpohor are respectively 13.3 % (225/1000 to 255/1000) , 11.8 % (137/1000 to 153/1000) and 23.74 % (121/1000 to 150/1000).

This confirms the study by Traore (2003) who found that during the wet season, breeding sites are created in stagnant water leading to high mosquito populations and hence increased malaria transmission.

Many other studies has found malaria related morbidity and mortality showing seasonal trends with peaks in the wet season and a low level in the dry season (Gadzama, 1983; Molta et al., 1995; Oguche et al., 2006).

Table 5.1 Chi-Square Test of Difference in Seasonal Prevalence

	Value	df	P-value
Pearson Chi-Square	7.000[a]	3	0.072

From Table 5.1 above, malaria prevalence in the wet and dry seasons is not equal $\left(\text{P-value, } 0.072 > 0.05\right)$.

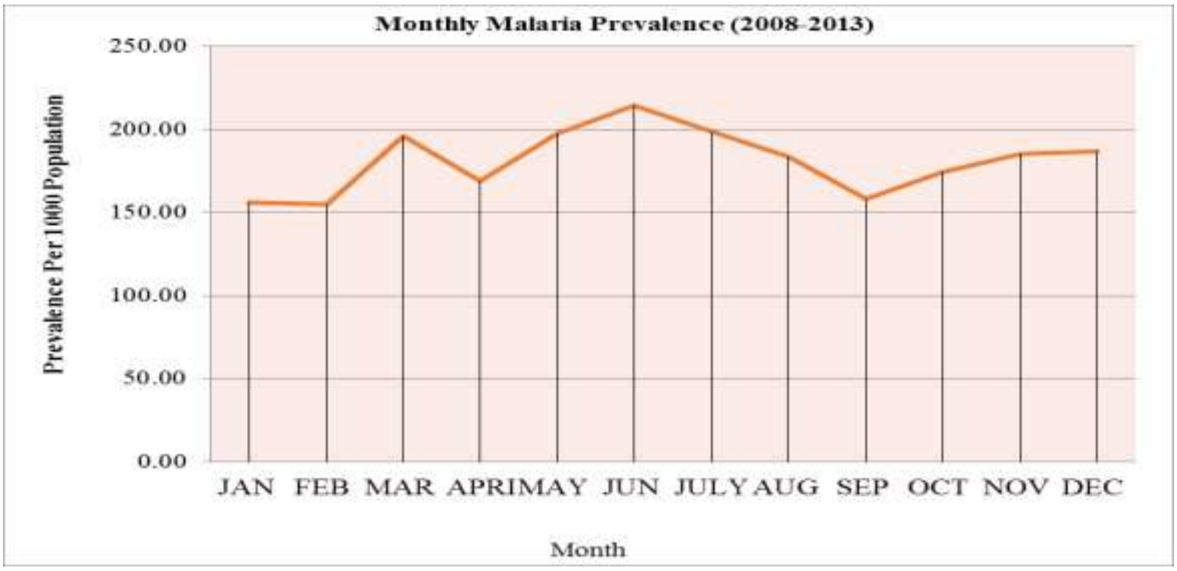

Fig 5.2 Average monthly prevalence of malaria

The maximum malaria prevalence occurred in the months of the wet season namely May, June and July; with the month of June recording the highest peak of prevalence (214.38 per 1000 population) in the District. Maximum malaria cases were observed almost all year-round in the wet season. This is not surprising as the biting density and infectivity of the vector intensify during the rainy season. The high transmission of malaria all over the district follows the May to July rains and occurs between September and December while the low transmission occurs between January and February.

This might be associated with the universal fact that the range of malaria infection is not solely determined by seasonality but also factors such as social, biological and economic factors such as mosquito control measures, immunity of population, policy of government, drug resistance among others (Adhanom *et. al*, 2006).

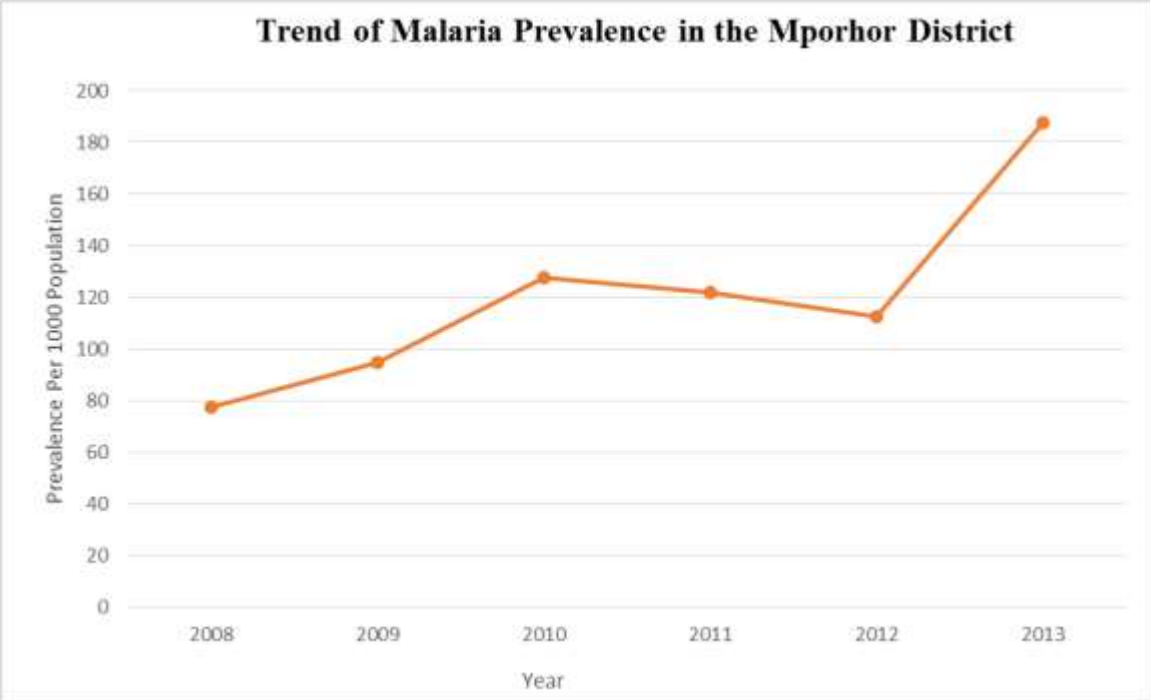

Fig 5.3 Trend of Malaria Prevalence in the Mpohor District

With reference to Fig 5.3 the malaria prevalence in the district increased by 22.1% and 35.0% respectively in 2009 and 2010. However, there was a marginal decline in prevalence by 4.6% and 7.5% respectively in the years 2011 and 2012 and then saw an astronomical increase in rate of 66.4% in 2013.

The decreased prevalence in 2011 and 2012 may have been as a result of intensified malaria control and preventive measures put in place to check the increase in the prevalence between 2008 and 2010.

The sudden astronomical increase in prevalence in 2013 may have been due to relaxed malaria control and preventive measures put in place in 2011 and 2012.

Table 5.1 Chi-Square of Difference in Male and Female for children under age Five

	Value	df	P-value
Pearson Chi-Square	12.00	**3**	0.007

From Table 5.1, malaria prevalence was significantly different in male and female children below the age of five (0.007 <0.05). The mean prevalence of malaria in the male and female children under the age of four are respectively 441.16 and 561.66 per 1000 population.

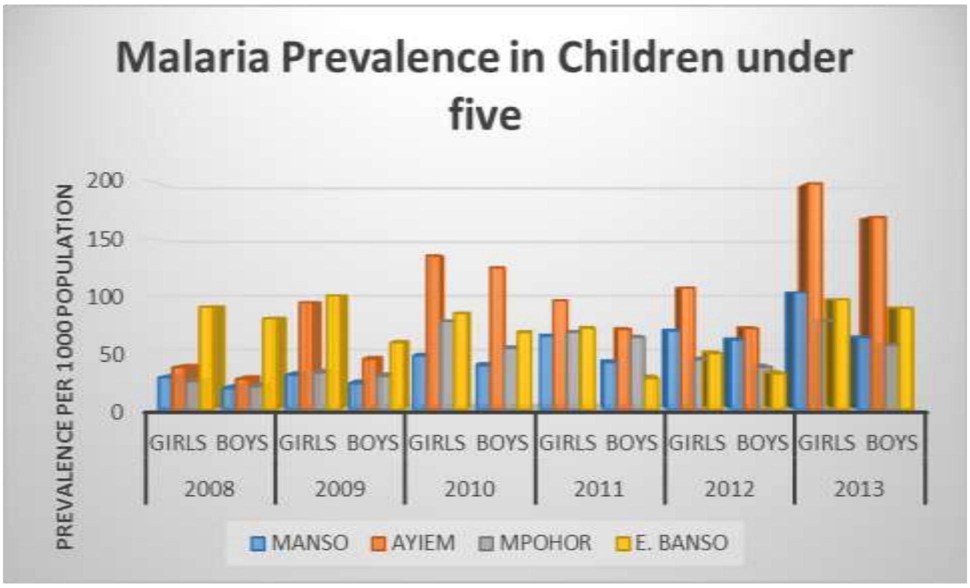

Fig 5.5 Malaria Prevalence in Children under five

From Figure 5.5, it can be inferred that the malaria prevalence in girls has been generally higher in Edum Banso and Ayiem over the six year scope of the study in all four communities in the study.

Fig 5.6 Trend of malaria prevalence among boys and girls under age five

Figure 5.6 shows an increasing trend of malaria prevalence among boys and girls below the age of five. It is also evident the prevalence among girls were consistently higher than boys. This finding supports the findings (Otieno, 2015) in Kenya's Kisumu County that women are 50% more likely to be infected with malaria than men.

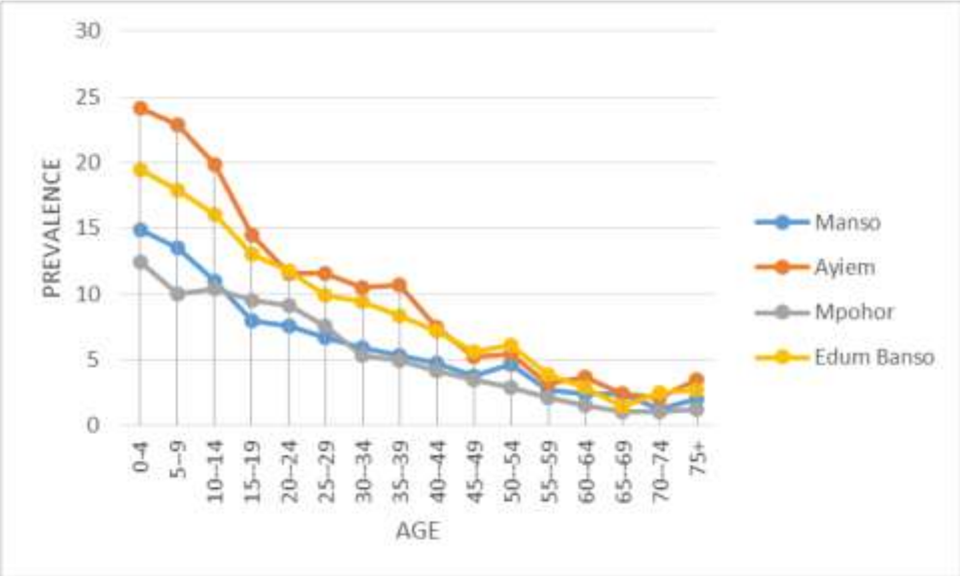

Fig 5.7 Distribution of Malaria Prevalence in the Mpohor district

From Fig 5.7**,** Children under 5 years of age are the most vulnerable age groups affected by malaria in the Mpohor district. The figure also shows that the vulnerability to malaria infection declines with increase in age. Children under the age of five years are the most vulnerable to malaria infection due to the fact that they have not yet developed any immunity to the disease.

This finding is in tandem with Sani (2015) who found that malaria prevalence and parasite density decreased as age increased.

Fig 5.7 also shows that the children under age five in the Ayiem community are the most at risk in the district.

Table : 5.2 Relative Risk of malaria prevalence

Malaria Infection in Ayiem?	Patients below age five	Patients not below age five	Total	Cumulative Risk	Risk Ratio	Percent Relative Effect (RR-1)x100%
Yes	196	280	476	0.411764706	1.180311	18%
No	337	629	966	0.348861284		

We can conclude from table 5.2 that children below age five in the Ayiem community have 18% increase in risk of malaria than their counterparts in other communities of the district.

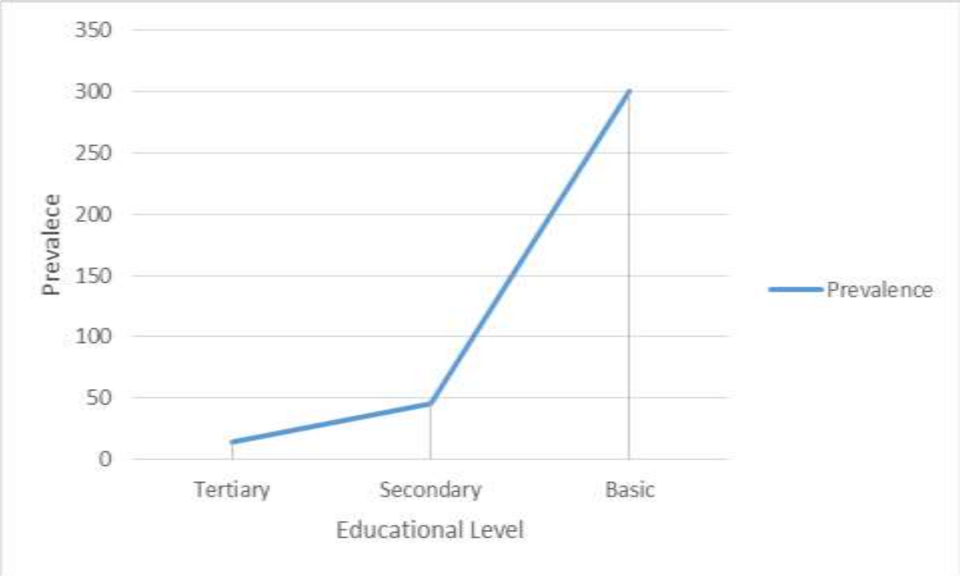

Fig. 5.8 Malaria prevalence and level of Education

From Fig. 5.8 Malaria prevalece was found to decrease with increasing level of education. This finding is understandable since patients at the basic (Creche, Kindergarten, primary and Junior High) level of their education are expected to be in the lowest age bracket which buttress the universal fact by most researchers that malaria infection decrease with increase in age.

A whopping 83% prevalence of malaria was found in patients at the basic level of their education. This finding shows that malaria is the primary cause of school absences in the district..

This finding supports the study of Tusting (2013) that the probability of dying from malaria is inversely proportional to income and education; meaning the higher educated you are, the less likely it is for you to die from malaria infection.

CONCLUSSIONS

Malaria prevalence was 56.4 % in the wet season and 43.6 % in the dry season. There was a statistical outcome that malaria prevalence was not the same $\left(\chi^2 = 6.00,\ df = 3,\ p > 0.05\right)$ in the wet and dry seasons.

Again, the malaria prevalence in the district increased by 22.1% and 35.0% respectively in 2009 and 2010. However, there was a marginal decline in prevalence by 4.6% and 7.5% respectively in the years 2011 and 2012 and then saw an astronomical increase of 66.4% in 2013.

Malaria prevalence was significantly different in male and female children below the age of five (0.007 <0.05) with female children in this category being at a greater risk than the males.

Children under 5 years of age were found to be the most vulnerable age groups affected by malaria in the Mpohor district.

Children below age five in the Ayiem community have 18% increase in risk of malaria than their counterparts in other communities of the district.

Finally, Malaria prevalence was found to decrease with increasing level of education.

RECCOMENDATION

The present findings are therefore valuable to an already existing pool of knowledge on malaria and could help in designing control programmes such as Malaria Early Warning Systems (MEWS) which is relevant where malaria transmission is unstable. Considering the menace of malaria infection in this area; the Roll Back Malaria Strategies are needed to be fully implemented to reduce infections in pregnant mothers and children. Health education and environmental modifications involving the inhabitants of Mpohor district is advocated to prevent or control malaria transmission in its communities.

While advocating for the continuation of education on the use of the ITNs, it is recommended that serious efforts are made by the major players in the health sector to make the mosquito net readily available in the communities at low prices to enable ordinary Ghanaian to purchase it.

It is also recommended that similar research is conducted to involve far more communities in the district. There should be prompt diagnosis and effective treatment of malaria infections. In areas of moderate-to-high transmission in the district, intermittent preventive therapy for infants (IPTi) should be administered.

Seasonal malaria chemoprevention (SMC) for children aged between 3 and 59 months should be administered during the wet season.

The vulnerable age group needs more attention not only in treatment but also in policies framed for education and prevention regarding malaria prevention and control programmes.

REFERENCES

Agresti, A. (2013), Categorical Data Analysis, Third Edition, John Wiley and Sons, Inc. New York, pp.12-30.

Akhatar, R. (1996), “The Contextual Determinants of Malaria”, A. P. H. Publishing Cooperation, New Delhi, pp. 65 – 92.

Asante, F. A. and Asenso-Okyere, . (2003),” Economic Burden of Malaria in Ghana”, *Technical Report Submitted to the World Health Organization (WHO)*, University of Ghana, Legon , pp. 1-444.K

Bødker, R., Akida, J. and Shayo, D. (2003), “Relationship between Altitude and Intensity of Malaria Transmission in the Usambara Mountains, Tanzania” *Journal of Medical Entomology*, Vol.1, pp. 706-717.

Brooker, S., Ponka, R., Moyou, R. S., Ndzi, E. S. and Tchinda, M. G. *(*2000), Estimating the Number of Helminthic Infections in the Republic of Cameroon from a data on Infection Prevalence in Schoolchildren, *Bulletin of the world Health Organization*, 78:1456-1465.

Carnevaleet, P., Guillet, P., Robert, V., Fontenille, D., Doannio, J., Coosemans, M., and Mouchet, J. (1999). “Diversity of Malaria in rice growing areas of the Afrotropical Region”, *Parassitologia , No.* 41, pp.273-276.

Cohen, J. M., Smith, D. L., Cotter, C., Ward, A., Yamey. G., Sabot, O. J. and Moonen, B. (2008), “Malaria Resurgence: a Systematic Review and Assessment of its causes”, No. 11, pp.122.

Duker, B. B. and Minkah, A. A. (2014), *2010 Population and Housing Census, Western Regional Analytical Report*, Ghana Statistical Service, Accra, Ghana, 81pp.

Field, A. (2009), *Discovering Statistics Using SPSS*, London-Thousand Oaks-New Delhi: SAGE Publications Vol.3, 16 pp.

Githeko, A. K., John, M. A., Peter, K. O., Francis, K. A, Bryson, A. N., John, I. G., and Guiyun, Y., (2003), “Topography and Malaria Transmission Heterogeneity in Western Kenya Highlands: Prospects for focal vector control”, *Malaria Journal, Vol* 5, pp. 107.

Hanke, J. E. (1991), *Understanding Business Statistics*, Irwin, Inc., pp. 414.

Jackson, A. K. and Yan, G., (2010),” Effects of microclimatic changes caused by land use and land cover on duration of gonotrophic cycles of Anopheles gambiae (Diptera: Culicidae) in western Kenya highlands” *Journal of Medical Entomology*, Vol.42, No.6, pp. 974– 980.

Jaffar, S., Leach, A., Greenwood, A. M., Jepson, A., Muller, O., Ota, M. O. C., Bojang, K., and Greenwood, B. M. (1993),” Changes in the pattern of infant and childhood mortality in Upper River Division: The Gambia”, *Tropical Medicine and International Health Journal* Vol.2, pp.28-37.

Kumi-kyereme, A., Nyarko, P., Minkah, A. A., Owusu, G. and Duker, A. A. (2012), *Population and Housing Census, 2010; Summary Report of Final Results*,Ghana Statistical Service, Accra, 81 pp.

Lindsay, S. W. and Martins, W. J. M. (2000),” Malaria in the African Highlands: Past, Present and Future”, *Bulletin of the World Health Organization, Vol. 76*, No. 1, pp. 33-45.

Lubetzky-Vilnai, A., Ciol, M., and McCoy, S. W. (2013), “Statistical Analysis of Clinical Prediction Rules for Rehabilitation Interventions: Current State of the Literature”, *Archives of Physical Medicine and Rehabilitation*.

Minakawa, N. Sonye, G., Mogi, M., Githeko, A., Yan, G. (2002),” The Effects of Climatic Factors on the distribution and abundance of Malaria vectors in Kenya”, *J Med Entomol Vol.39, pp.8*33–841.

Montgomery, D. C., Peck, E. A. and Vining, G. G., (2001), Introduction to Linear Regression Analysis, 3rd Edition, Jon Wiley and Sons, New York, U. S.A, pp. 672.

Mwangangi, J. M., Ephantus, J., Muturi, Simon, M., Muriu, Joseph, N., Midega, J. T. and Mbogo, A. C. (2013), “The role of Anopheles arabiensis and Anopheles coustani in indoor and outdoor malaria transmission in Taveta District, Kenya”, *Parasites and Vectors Vol. 6, No.* 114.

Nyarko, P., Minkah, A. A., Owusu, G., Kumi-Kyereme, A. and Duker, A. A.(2010), 2010 Population and Housing Census, Mpohor District Analytical Report, Ghana Statistical Service, Accra, Ghana, 81pp.

O’Connell, D., Mossler, A., and Rajora, O. P., (2006), Impact of forest fragmentation on reproduction success in white spruce, Can J. Bot 84: 152-169.

Packard, R. M. (1984), “Maize, Cattle and Mosquitoes: the political economy of Malaria Epidemics in colonial

Swaziland", *Journal of African History*, No. 25, pp. 189-212.

Pindolia, D. P., Andres, J. P., Aleganor , V. A., Zhuojie, H., Noor, A. M., Tatem, A. J. and Snow, R. W. (2013*), "The* Demographics of Human Malaria Movement and Migrations Patterns in East Africa", *Malaria Journal*, Vol. 12, Number 397, pp. 12-23.

Sani . A.F, Mohammed, D.A, Suley A. A,, (2015), "Prevalence and risk factors associated withmalaria infection among pregnant women in a semi-urban community of north-western Nigeria",BioMed Central Publisher.

Tusting, L.S. *et al.* Socioeconomic development as an intervention against malaria: a systemic review and meta-analysis.Lancet, 2013;382:963-972.