Changing weather factors implication on the prevalence of malaria in Ado-Ekiti, South west, Nigeria.

A. Akinbobola, J. Bayo Omotosho and E.C. Okogbue,
Department of Meteorology,
Federal University of Technology,
P.M.B 704, Akure.
Phone no: 08034619238
E-mail- aakinbobola@futa.edu.ng, desmondbobola@gmail.com

Abstract

The impact of weather factors on human health has been greatly realized in recent times; the effects these variables have on malaria prevalence have been of particular interest because the disease is a public health burden and its transmission is sensitive to changing weather and climate as a result of urban development. .This study explored the impact of weather and climate and its variability on the occurrence and transmission of malaria in Ado Ekiti, a tropical rain forest area of south-west Nigeria. We investigate this supposition by looking at the relationship between rainfall, relative humidity, minimum and maximum temperature, and malaria in Ado Ekiti. This study uses monthly data of 8 years (2005-2012) for both meteorological data and record of reported cases of malaria with different age groups.

We evaluated a simple statistical model that permitted valuable and novel insights into the simultaneous/single effects of weather factors (rainfall, relative humidity, maximum and minimum temperature on malaria prevalence. The results from temperature and relative humidity threshold shows significantly that malaria prevails more between the temperature range of (30.1-32)°c and relative humidity of (60.1-80)% than any other temperature and relative humidity threshold. Malaria prevalence among children <5 years old was higher than that of adults.. Also surveys conducted among the people in the station revealed that, the interplay of poverty and other socio-economic variables have intensified the vulnerability of this community to the impacts of this disease. The results improved our understanding of how temperature and humidity shifts affect the distribution of at-risk regions, as well as how rapidly malaria outbreaks take off within vulnerable populations The result of this study will also help individuals, government, policy makers and professionals in guiding against or planning ahead for possible outbreak of malaria.

Keywords: Disease, prevalent, public health, malaria, weather, climate

1.0 Introduction

Malaria is a major public health problem in Africa with over 200 million clinical episodes and nearly one million deaths occurring annually (WHO, 2003). However, the risks of morbidity and mortality associated with malaria, particularly in semi-arid and highland regions, vary temporally. In semi-arid and highland regions of Africa, malaria is unstable and epidemic malaria is a common problem, causing an estimated 12.74 million clinical episodes and 155,000–330,000 deaths annually (WHO, 2003). In Nigeria, Malaria is the leading cause of morbidity and mortality accounting for over five million cases and thousands of deaths annually (bureau of statistics 2005). The risks of morbidity and mortality associated with malaria are characterized by spatial and temporal variation across the country. Malaria is a complex disease and its transmission and prevalence is influenced by many factors, amongst which is the changing weather and climate which are considered to play a major role. With increasing weather variability and ability to forecast weather, there is an interest in developing systems for malaria forecasting that incorporate weather related factors as explanatory variables. Many studies in various parts of the world have linked malaria time series to weather variables such as rainfall, temperature and humidity. For instance, Teklehaimanot and colleagues 2004 found that malaria was associated with rainfall and minimum temperature (with the strength of the association varying with altitude) in Ethiopia. Meteorological/climatic factors like temperature, rainfall, relative humidity etc have been widely associated with the dynamics of malaria vector population and, therefore, with spread of the disease. However, at the local scale, there is inadequate systematic quantification of the effects of these factors on the transmission of this disease. Furthermore, most attempts to quantify these effects are based on proxy meteorological data acquired from the satellites or interpolated from different scale. This had led to controversies about the contribution of changing weather and climate to malaria prevalence. This study examines the implication of changing weather and climate on malaria prevalence in Ado Ekiti, South western Nigeria. Temporal analysis of temperature, rainfall and relative humidity in relation to temporal variation of malaria occurrence in the study area. This research work will also address the original question of relating meteorological factors measured at the surface with malaria prevalence which will help to seek the particular interventions for malaria control.

2.0 Methodology

2.1 Study area

Selection of study site

Two criteria were used to select the study site. First, was the presence of a government or a missionary hospital with well maintained and credible accessible malaria data while the second criterion is that, the site was required to have a meteorological station with long term data located nearby and the station must be within the same climatological zone as the study site.

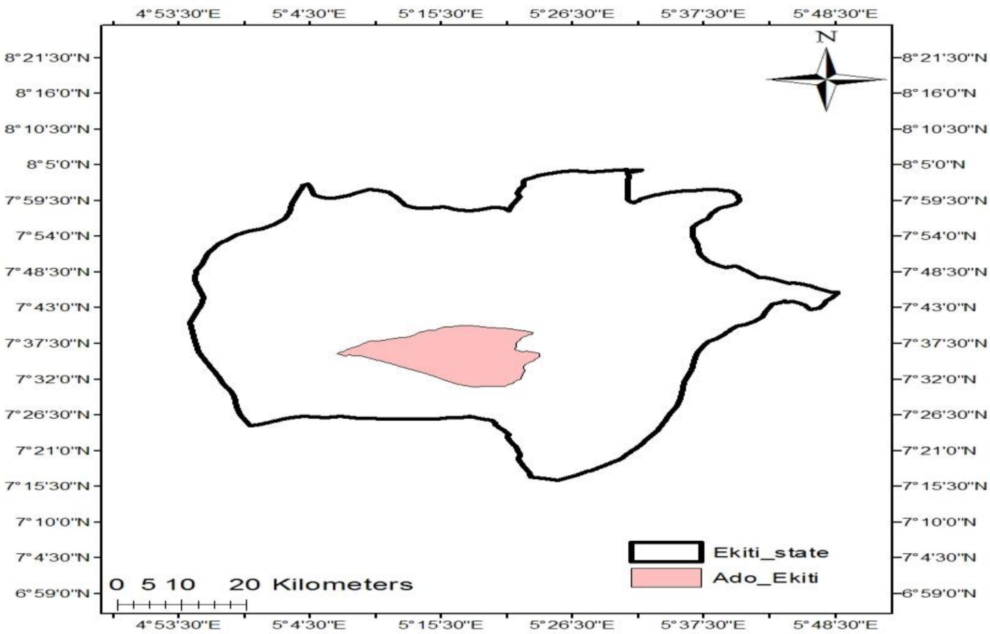


Figure1: Map of the study area

Ekiti State is located between latitude 7°25' and 80°5'N and between longitudes 4°45' and 5°46 east. Ekiti State is a landlocked state, having no coastal boundary. The climate is of the Lowland Tropical Rain Forest type with distinct wet and dry seasons. The dry season comes up between November and April while the wet season prevails between May and October. In the south, the mean monthly temperature is about 28°C with a mean monthly range of 3°C while the mean relative humidity is over seventy five per cent. However, in the northern part of the state, the mean monthly temperature may be over 30°C while the mean monthly range may be as high as 8°C.The mean monthly relative humidity here is about 65 per cent. The mean annual total rainfall in the south is about 1800mm while that of the northern part is hardly over 1600mm.

2.2 Data collection

This work makes use of medical data and meteorological data spanning eight years period (2005-2012). The medical data was gotten from the standard government hospital located in the study area under the state ministry of health while the meteorological data was obtained from meteorological station situated in the study area under the state ministry of agriculture.

The medical data collected include monthly diagnosed cases of malaria. Malaria data were collected for ages less than 5yrs, above 5yrs, and those in pregnancy while meteorological data collected were monthly values of relative humidity(%),minimum and maximum temperature(°C) and rainfall(mm)

3.0 Methods of analysis

3.1 Basic statistical analysis

Simple and basic statistics like mean, variance and standard deviation were employed to compute for both monthly trends of the medical and meteorological data.

3.2 Simple stepwise regression analysis

Simple linear regression analysis and correlation co-efficient were employed and performed to identify the specific parameter that explains the temporal pattern of the monthly data and ascertain the degree of relationship of both monthly medical and meteorological data. That is, simple mathematical formulation will be performed on the medical and meteorological data to ascertain and establish significant relationship.

$$Y_i=\beta_0+\beta_1+\xi$$

β_0 = Y – intercept for the population

β_1 = slope for the population

ξ = random error in Y for on observation *i*

The sample coefficient of correlation r is obtained from the co efficient of determination $r^{2.}$

Coefficient of correlation r = $\sqrt{r^2}$

Anomaly of both monthly medical and meteorological data was computed. That is, to ascertain the degree of deviation from the actual mean using a statistical package.

3.3 Temperature and relative humidity threshold

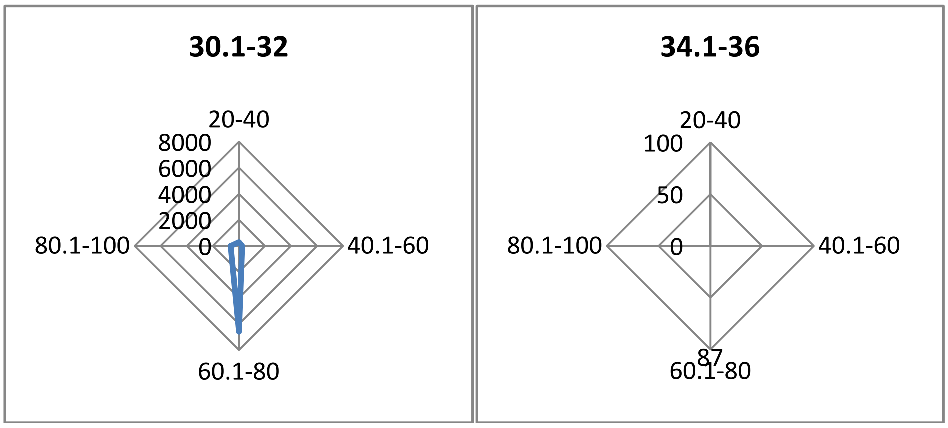
There were various numbers of these diseases occurrences under different temperature and relative humidity. Based on this behaviour, a temperature range of 2°C was created against relative humidity range of 20%. The number of disease occurrences was classified into the temperature and relative humidity threshold they assume. For each temperature threshold, a graph of the number of diseases occurrences against relative humidity threshold was derived.

4.0 Results and discussions

4.1 Correlation coefficients between malaria occurrence and weather factors

Table 1 shows the correlation coefficients of malaria occurrence and weather parameters. From the table there is a clear correlation between the two variables. It is generally weak with cases of malaria during pregnancy while there are strong correlations for ages below 5years and above five years with the strongest but positive relationship with rainfall. A negative relationship was observed in maximum temperature and minimum temperature. This may likely suggest that

4.2 Weather parameter thresholds



a b

Figure 2(a&b) Tmax and RH threshold for malaria in pregnancy

These figures indicate that between this temperature range of (30.1-32) and relative humidity range of (60.1-80) there were 6700 number of malaria cases recoded for pregnant women. While about 87 number of malaria cases were recorded at temperature between 34.1-36 and relative humidity of between (80.1-100) % which shows that at (30.1-32)°c of temperature and (60.1-80) of relative humidity favours the prevalence of this disease.

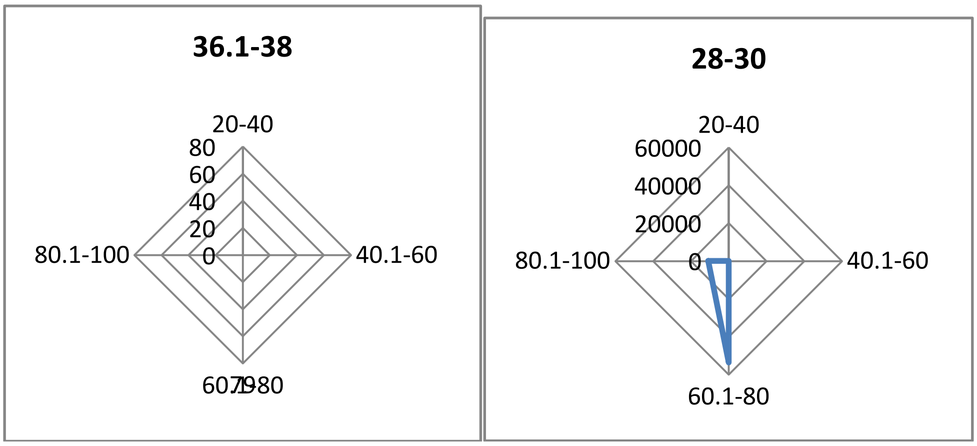


Figure 2(c&d) Tmax and RH threshold for malaria in children more than 5years

Fig.2c&d show the meteorological parameter thresholds that favours the prevalence of malaria in for people from 5yrs and above in the station. In figure c, it shows that at (36.1-38) of temperature and (60.1-80) of relative humidity about 80 cases of malaria cases were recorded.

Fig.d shows that at (28-30) of temperature and (60.1-80) of relative humidity about 53500 cases of malaria incidence were recorded

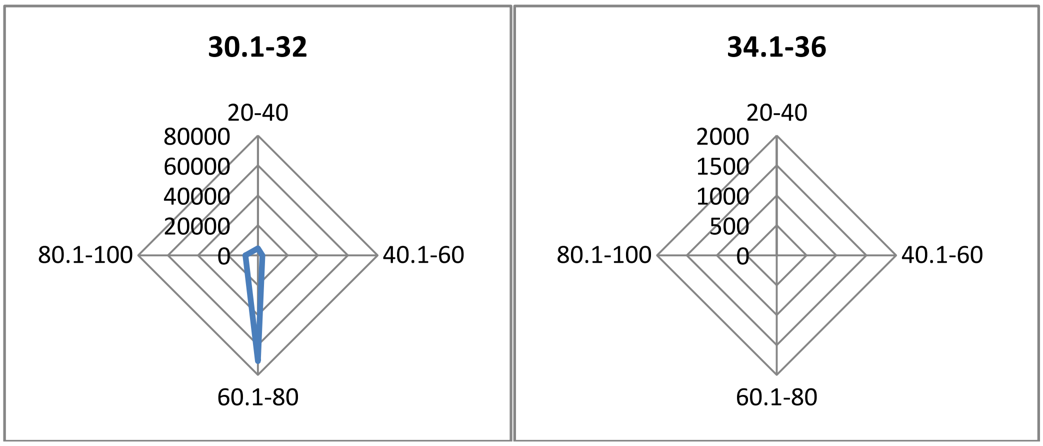


Figure 2(e&f) Tmax and RH threshold for malaria in children less than 5years

Fig.e shows the meteorological parameter thresholds for malaria prevalence in children under 5years. This figure shows that at (30.1-32) of temperature and (60.1-80) of relative humidity malaria cases recorded for children below 5yrs was about 72000.while Fig.f shows that at (34.1-36) of temperature and (60.1-80) of relative humidity we have very reduced number of malaria cases recorded within this threshold.

4.3 Discussions

Characterizing temporal patterns of clinical malaria provides insights into the important drivers of this disease, including meteorological variables such as rainfall, temperature and relative humidity that influence seasonal patterns and also influence long-term trends. This study confirmed that meteorological variables had a strong relationship with the prevalence of this disease with children less than five years having the highest risk.

Global temperatures are presently increasing which has began 250–300 years ago. Speculations on the potential impact of continued warming on human health often focus on vectors transmitted diseases, like malaria because of the strong correlation between the disease and climate variables. Elementary models suggest that higher global temperatures will enhance their transmission rates and extend their geographic ranges [Paul 2001]. Increasing temperatures are estimated to consistently extend the distribution of malaria, also making the mosquito population to increase. The results of Ado Ekiti temperature changes was also observed in the temperature data, they are somewhat consistent and mostly in the range of 0.5 to 1.5℃ warmer. Rainfall data have potential use for malaria prediction. However, the relationship between rainfall and the number of malaria cases is indirect and complex. The annual rainfall in Ado varies from close to 800mm to about 1500 mm, but it has been declining in recent times.
The geographic landscapes and complex climate situations provide favorable breeding sites for mosquitoes in this area, Meteorological variables are considered as the environmental factors for increased risk of malaria because of their impacts on the mosquito vector activities and Plasmodium incubation rate. The main vector involved in transmission is the mosquito Plasmodium falcipram is the main parasite for the majority of the infections (90%) with other species P. vivax, P. ovale and P. malariae rarely found[Ali etal 2008].

4.4 Socioeconomic and vulnerability to Malaria

One of the critical factors influencing the vulnerability of human health to climate change is the extent to which the health and socio-economic systems are robust enough to cope with demand (WHO 2003). Some Communities have added risks of malaria disease due to climate variability and change, lack of immunity, and poverty. The changing weather/climate observed in this study indicates that the station has a higher disposition to malaria epidemics. Additionally, the poor are further disadvantaged by their inability to access medical treatment and the lack of health care facilities during such epidemics. There is, however, a need for a detailed explanation of how other socioeconomic indicators, including poverty, is linked to malaria incidences. Poverty, however, seems to play a very big role in the vulnerability of the communities to climate variability and change. Due to poverty and inadequate, or lack of, early warning mechanisms, the communities lack effective strategies for coping with climate-induced shocks such as disease and weather extremes. Therefore, the local capacity to develop adaptive strategies to cope with climate variations and extremes is still very low, at all levels, and remains a big challenge.

5.0 Conclusions

Malaria incidence varies according to gender and age. Malaria incidence was higher in 2006–2007 than in other periods of observation.
This study has shown that changing weather/climate has altered the climates of the area. The maximum and minimum temperatures have changed, with significant increases generally recorded. The temperature change has been more pronounced. The observed temperature increase has enabled malaria vector mosquitoes to find new habitats in the area. This has resulted in a higher frequency and severity of malaria epidemics in the community. The major outbreaks are associated with the unusually wet and warm climate events.

Acknowledgment

The authors acknowledge the ministry of Health, Ekiti State for releasing the medical data and also the Nigerian Meteorological Agency for the meteorological data

6.0 References

WHO (2003) Methods for assessing human health vulnerability and public health adaptation to climate change. *Health and Global Environmental Change* Series No. 1. WHO Regional Office for Europe, Copenhagen

Teklehaimanot HD, Lipsitch M, Teklehaimanot A, Schwartz J, (2004): Weatherbased prediction of Plasmodium falciparum malaria in epidemic-prone regions of Ethiopia I. Patterns of lagged weather effects reflect biological mechanisms*. Malar J,* 3:41

Paul R., (2001). Climate Change and Mosquito-Borne Disease. Environ Health Perspect 109(suppl 1):141–161

Ali H, H., Ahmed, S., and Sulaiman, S., (2008). Climate change and health in Sudan. Capacity strengthen in the least developed countries for adaptation to climate change

Rasha A. Aal1 , Ayman A. Elshayeb (2011) The Effects of Climate Changes on The Distribution and Spread of Malaria in Sudan *American Journal of Environmental Engineering*; 1(1):15-20 DOI:10.5923/j.ajee.20110101.0

Shem O. Wandiga · Maggie Opondo · Daniel Olago · Andrew Githeko · Faith Githui· Michael Marshall·Tim Downs· Alfred Opere · Christopher Oludhe · Gilbert O. Ouma ·Pius Z. Yanda · Richard Kangalawe · Robert Kabumbuli· James Kathuri· Eugene Apindi·Lydia Olaka ·Laban Ogallo ·Paul Mugambi· Rehema Sigalla · Robinah Nanyunja ·Timothy Baguma ·Pius Achola (2009) Vulnerability to epidemic malaria in the highlands of Lake Victoria basin: the role of climate change/variability, hydrology and socio-economic factors *Climatic Change* DOI 10.1007/s10584-009-9670-7