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Effect of Climate variability on malaria infection in Isuikwuato Local Government Area of Abia State, Nigeria

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ABSTRACT
This study assesses the effect of climate variability on malaria infection in Isuikwuato Local area of Abia state, Nigeria. Both primary and secondary sources of data where employed. The data for this study were processed and analyzed quantitatively. The quantitative data were analyzed using both descriptive and inferential statistics with the help of Microsoft excel, and spas statistical package version 26. The descriptive statistics that was used consists of central tendency and the tie series trend analysis. the inferential statistics employed in the study were a linear regression and the person product moment correlation. The result revealed an increase in rainfall experience in the year 2005-2008. Majority of respondents 58% were aware of climate change. Majority of respondents agreed that there increase temperature and number of sunny days 54% 51% of the delivery that an increase in rainfall in area was as a result of climate change. Government at Local, National and international level should put more effort in combating malaria disease so as to achieve sustainable development.
Keyword: climate, Variability, Malaria, Infection, Change

INTRODUCTION
Malaria affects millions of people from all over the world every year. The death and the suffering that the disease causes in the human population are indeed enormous. Several people suffer repeatedly from the disease due to constant bites from the mosquito vector. Though malaria affects millions of people all over the world, the prevention and treatment are simple, unless the person suffers from the most severe type of malaria. Malaria is a common disease in all countries-both developed and underdeveloped. Malaria disease is transmitted from one person to another due to the bite of a mosquito. When the mosquito bites a person, who is infected with malaria and then bites another person who is not infected, the infection is transmitted from the affected person to the healthy person. Human health is affected by natural environmental factors such as temperature, rainfall, relative humidity, wind direction and others.

Climate affects health in a number of ways; this was reported by Tong (2002) who performed an ecological time series analysis to examine the ecological association between climate variability and the transmission of Ross River Virus (RRV) diseases between 1985 and 1996 in Queensland. The result indicated that although many factors can affect the RRV transmission cycles, RRV is generally sensitive to climate variability and that rainfall, temperature and tidal level appeared to be important meteorological determinants in the transmission cycles of RRV diseases at macro level. According to Thorpe, Frieden, Laserson, Wells and Khtri (2004), in the pre-antibiotic era, tuberculosis and mortality rate was higher in the late winter and early spring than any other time of the year, it was

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suggested that environmental and social factors such as temperature, humidity, sunlight as well as crowding and person-to-person contacts are a source of tuberculosis seasonality particularly in the winter time. Continuous research into the influence of meteorological parameters on infectious diseases is a veritable strategy for proffering sustainable solution to their morbidity; this is because climate affects infectious diseases more than most other disease categories especially in Africa, where the burden of infectious diseases is highest (Wilkinson, 2006). Of the 56 million deaths per annum estimated by the World Health Organization (WHO) as the global burden of diseases, infectious diseases accounted for more than 26percent. Tuberculosis and other respiratory infections are two of the four major contributors to these diseases (WHO 2004). Going by a recent WHO Global TB Report (2010) approximately 4,700 people die of TB infection daily and a total of 1.7 million deaths in 2009 were due to human infection by the disease.

Researchers like Sawa and Bukhari, (2010); Brunkard, Cifuentes and Rothenberg, (2008); Ayoade (1982) among others have found that there is a close link between local climate and the occurrence or severity of some diseases. Ayoade (1982) stated that weather has the potential to alter the average exposure of condition that is suitable for the vector and disease pathogen. Weather and climate can influence host defences, vectors, pathogens and habitat, (Epstein, 2002). The temporal and spatial changes in temperature, precipitation and humidity expected to occur under different climatic scenario could affect the biology and ecology of the vectors and intermediate hosts and consequently the risk of disease transmission, WHO (2002). Brunkard*et al,* (2008) stated that climate affects health in a number of ways. These effects may be direct as with heat stress, or indirect as with infectious diseases such as malaria and meningitis (Climate & Health Resources Room, 2008; Griffiths, 1976).The effect may also be either directly on the human body or indirectly through effects on disease-causing organism or their vectors (Checkley, Epstein, Gilman, Figueroa, Cama, Patz & Black, 2000; Chew, Doraisingham, Ling, Kumarasinghe& Lee, 1998; Sung, Murray, Chan, Davies & French, 1987). Temperature and rainfall are climatic causal factors of diseases and a small change in these parameters is likely to have a significant impact on the spread of diseases (Epstein, Diaz, Elias, Grabhern, Graham & Martens, 1998; Bate, 2004). The effects of high temperatures on human health are modified by the amount of moisture in the air.

Furthermore, the importance of examining the role of weather on human health cannot be over emphasized. Abrupt changes in weather, such as those associated with the passage of a weather front have been implicated in human discomfort with symptoms such as headache. Changes in weather have been demonstrated to be associated with changes in birth rates, sperm counts, outbreaks of pneumonia, influenza and bronchitis (Kalkstein &Valimont, 2008). Certain levels of humidity are ideally suited to the survival and reproduction of pathogens such as bacteria, viruses, parasites, and their vectors (Nathanson and Martin, 1979). Precipitation leads to increased humidity with consequent effects on humans (Greenwood, 1987) and cold weather adds to chilling of human body, thereby making it more susceptible to disease or aggravating chronic diseases. Scott-

Evans (2007), for example noted that some people have symptoms that worsen with cold weather while others suffer more in hot weather.

Climatic variations and extreme weather events have profound impacts on infectious disease. Air temperature dependencies are seen in correlations between disease rates and weather variations over weeks, months, or years (Omonijo&Oguntoke, 2009; Kuhn, Campbell-Lendrum, Armstrong & Davies, 2003; Omonijo, 2008) and in close geographic associations between key climatic/weather variables and the distributions of important vector-borne diseases (Hales, Wet &Maindonald, 2002; Rogers & Randolph, 2000). The impacts of global weather patterns on the environment and living beings are now more visible than ever before, as glaciers shrink, ice breaks up on lakes and rivers at faster rates, trees and animal population shift irregularly, and natural and devastating calamities become a common occurrence. The rate of reproduction, spread and bites by many pests and disease pathogens depends on weather patterns and are usually high in warmer and wetter conditions. Warming also increases the number of pests and microorganisms due to the creation of optimal circumstances for both metabolism and reproduction at the interface of temperate conditions; this is directly correlated to the transmission and spread of diseases (Robert, 2012).

Humans have long recognized that climatic conditions influence the appearance and spread of epidemic diseases (NRC, 2001). Hippocrates observation of seasonal illnesses in the fifth century B.C.E. formed the basis for his treatise on epidemics. Hippocratic medicine which attempted to predict the course and outcome of an illness according to its symptoms also considered winds, waters and seasons as diagnostic factors. Ancient notions about the effects of weather and climate on disease remain in the medical and colloquial lexicon, in terms such as "cold" for rhinovirus infections, "malaria" derived from the Latin word for "bad air" and the common complaint of feeling "under the weather".Today, evidence that the earth's climate is changing is leading researchers to revisit the long-standing relationship between climate and disease from a global perspective (IPCC, 2007). Increased atmospheric and surface temperatures are already contributing to the world-wide burden of disease and premature deaths, and are anticipated to influence the transmission dynamics and geographic distribution of malaria, dengue fever, tick-borne diseases and diarrhoea diseases such as cholera (IPCC, 2007). Global warming is also accelerating the world-wide hydrological cycle, increasing the intensity, frequency and duration of droughts; heavy precipitation events and flooding. These weather events may in turn contribute to and increase the risk for a wide range of vector and non-vector-borne diseases in humans and animals (IPCC, 2007).

MATERIALS AND METHODS

Location and Study Area

The study was carried out in IsuikwuatoLocal Government Area of in Abia State, Nigeria. The state is located east of Imo state and shares common boundaries with Anambra, Enugu and Ebonyi states in the North West andNorth East respectively. On

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the East and South East, it is bounded by Cross River and AkwaIbom states and Rivers state on the South. Abia State lies between latitudes 4°74ᴵ and 6°12ᴵNorth and longitudes 7°23ᴵ and 8°2ᴵ East of the Green which meridian in the south eastern partof Nigeria. The land area is 490,000 hectares and a population of 4,368,420 and an annualgrowth rate of 2.7 percent (National Population Commission, 2012). The mean annual rainfallin the state ranges between 2000mm-2500mm while the mean annual temperature, is estimatedat between 27°C and 31°C with a relative humidity of about 85 percent during the rainy seasonand 35 percent and 45.1 percent during the dry season (Nigerian Meteorological Agency,2009).

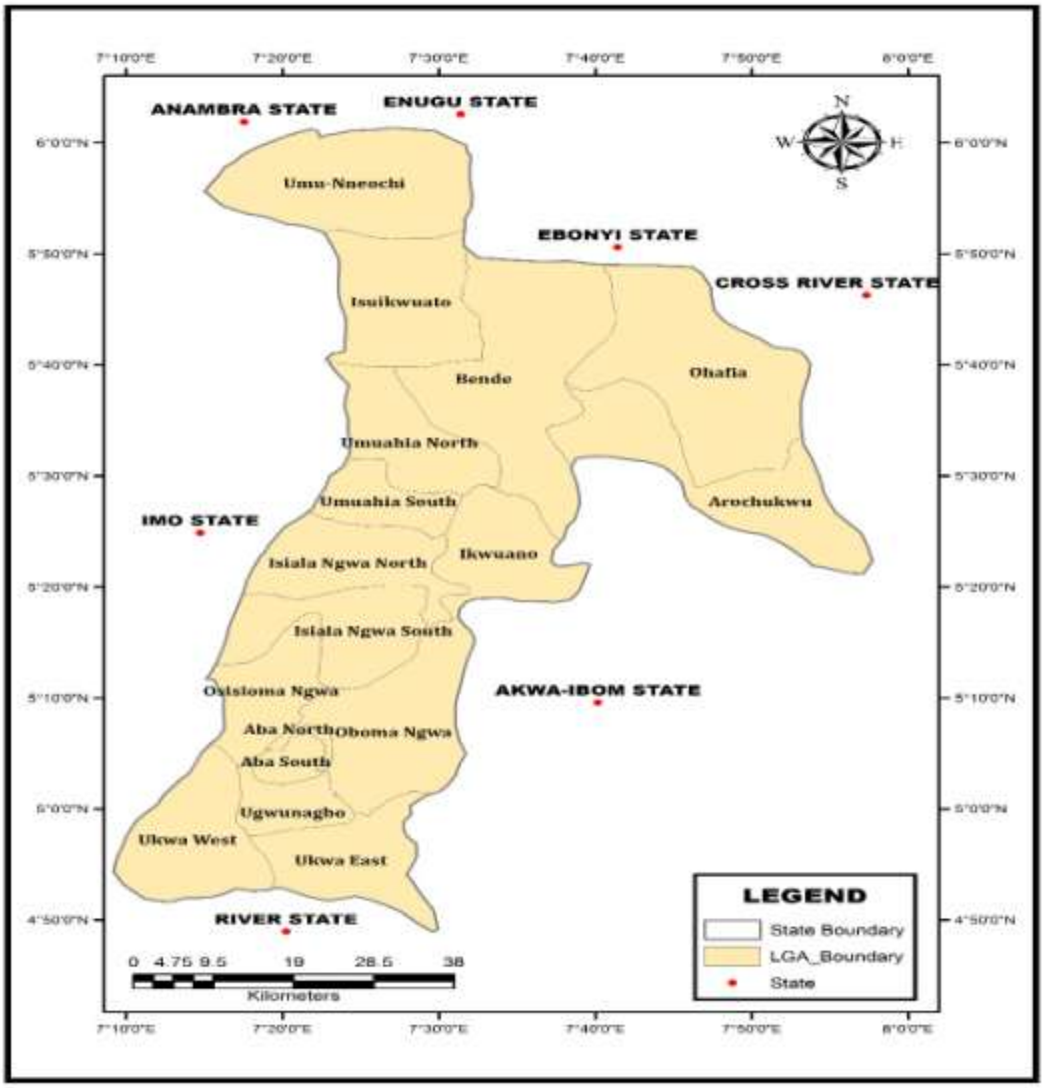

Fig. 3.1 Map of Abia State, Nigeria.
Source: Geospatial Analysis Mapping and Environmental Research Solutions, 2020.

The state comprises of three agricultural zones namely: Abia North (Ohafia), Abia South (Aba) and Abia Central (Umuahia). The state is made up of 17 local Government Area (LGAs). In Ohafia zone, there are five local government areas namely: Isuikwuato, Ohafia, Bende, Arochukwu, and Umunneochi. In Aba zone, there are seven local government areas namely: Aba North, Aba South, Obingwa, Ukwa East, Ukwa West, Osisioma Sand Ugwunagbo. In Umuahia zone, there are five local government areas namely; Umuahia North, Umuahia-South, Ikwuano, IsialaNgwa North, and IsialaNgwa South.

Isuikwuato Local government area has an estimated population of over 151,700 people (National Population Commission, 2016). Isuikwuatohas natural resources such as iron ore and kaolin (Nigeria: Abia-Mineral Resources in Abia State-Abia State, 2003). The people are predominantly Igbos and Christians. Subsistence farming is prevalent and about 70 percent of the population are engaged in agriculture. The main food crops grown are cassava, yam, rice, cocoyam and maize while the cash crops include: oil palm, rubber, cocoa, bananas and various types of fruits.Isuikwuato has two seasons in a year, the rainy and dry seasons. Farming in the state is determined by the seasonal distribution of rainfall. The soil at Isuikwuato is loose and suffers from Erosion and this left some dangerous erosion sites in the area. They lack the needed government backing to build drainages around the area to guide the flow of water without further harming the already crying soil. Blessed with hills and highlands, the town will appreciate water infrastructures because water is an important but hard resource to get in Isuikwuato (Abia State Government, 1992).

Research Design

A suitable research design for a study is one that minimizes bias, maximizes the reliability of data collected and in line with the purpose of the study. As such, this study employedsurvey research design. The rationale for this choice of research design was because the survey research design was because the study is a quantitative research, thus,the researcher administered surveys to the sampled population of the study.

Population of the Study

The population for this study consists of residence of Isuikwuato Local Government area of Abia State, consisting of 151,700 people (National Population Commission, 2016).

Sample and Sampling Techniques

In determining the sample size of a given population, different methods abound. Thus, in determining the sample size of the respondents of the study, the Taro Yamane (1967) formula for calculating sample size was used.

$$n = \frac{N}{1 + N(e)^2}$$

Where; N= the size of the population, n = the sample size, e = Acceptable margin of error (10% was employed).

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$$n = \frac{N}{1+N(e)^2} = n\frac{151700}{1+151700(0.10)^2} = \frac{151700}{1+151700(0.01)}$$
$$n = \frac{151700}{1+1517} = \frac{151700}{1518} = n = 99.9 = 100$$

Thus, the sampled respondents of the study were 100 residents of the study area. In determining the sample of hospital used in the study, Isuikwuato General Hospitalwas purposively sampled by the researcher.

The study employed the non-probability sampling technique (purposive sampling) in sampling the hospital used, while the probability sampling technique was used in sampling the respondents of the study. The rationale for the adoption of the probability sampling technique was because, probability sampling procedures has every item of the population given an equal chance of inclusion in the sample (Gay *et al.,* 2009). The probability sampling technique that was used was the simple random sampling technique.

Nature and Sources of Data

The study employed the use of both primary and secondary data. The primary data usedwas a cross sectional data from the respondents of the study in respect to objective 3, 5 and 6 of the study.The nature of the secondary data of the study were time series data on climate variables (in this case being rainfall and temperature) for a period of fifteen years (2004-2018), and medical records of the cases of malaria in the study area for the frame under study. The Secondary were sourced from the Nigeria meteorological Agency (NIMET) Abia state office, and Isuikwuato General Hospital.

Method of Data Collection

The secondary data of the study was obtained from the Nigeria meteorological Agency (NIMET) Abia state office, and medical records from Isuikwuato General Hospital. At the Nigeria Meteorological Agency (NIMET)Abia State office and Isuikwuato General Hospital. The researchers then administered the questionnaires to interested respondents, with instructions on how to address the questionnaires, after which the researcher waited for the participants of the study to finish answering the questionnaires, retrieved them back, and thank the participants of the study for their participation in the study.

Method of Data Analysis

The data for this study were processed and analysed quantitatively. The quantitative data were analysed using both descriptive and inferential statistics with the help of Microsoft Excel, and SPSS Statistical package version 26. The descriptive statistics that was used consists of central tendency and the time series trend analysis.The inferential statistics employed in the study were a linear regression, and the Pearson Product Moment correlation

Model Specification

The study postulates the functional relationship between malaria infection, and climate variability, where malaria infection was the dependent variable, and climate variability was the dependent variable. The relationship is expressed as follows;

$MI = f(, MRf, AVt,)$ - - - - - - - - (3.1)

Where:

MI = Malaria Infection

MRf = Mean Rainfall

AVt= Average Temperature

Writing equation 3.1 in the linear equation form, it becomes:

$OMS=\beta_0 + \beta_1 MRf + \beta_2 AVt + U_i$ - - - - - - (3.2)

The theoretical aprior expectation of the coefficientsof the parameters were;

$\beta_1, \beta_2 > 0$

This implies that we expect positive relationship between malaria infection, mean rainfall and average temperature in the study area across the period under consideration.

RESULTS AND DISCUSSION

Trend of Climate Change in the Study Area

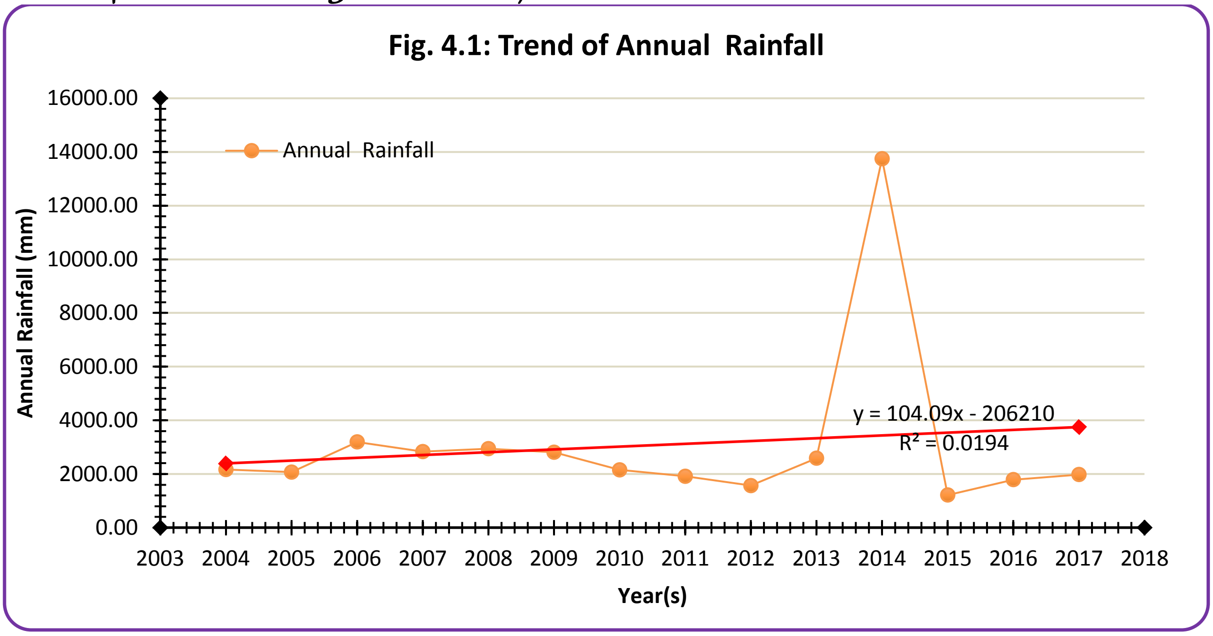

Figure 4.1depicts a detailed account of the rainfall trend in Isuikwuato Local Government Area of Abia State. The trend plot in the chart shows a fluctuating annual rainfall trend.From the trend chart, it can be observed that from the period of 1995 to 1997 recorded and steady increasing trend in mean rainfall at 259.80mm for the year 1995, 268.20mm for the year 1996, and 324.60mm. 1998 experienced a decline in annual rainfall in the study area, recorded at 2815.1mm and 2980mm respectively. In the year 1999, a significant increase in annual rainfall was experienced. This increase was stable and experienced through 2001. Within these three years, the following annual rainfall figures were recorded;

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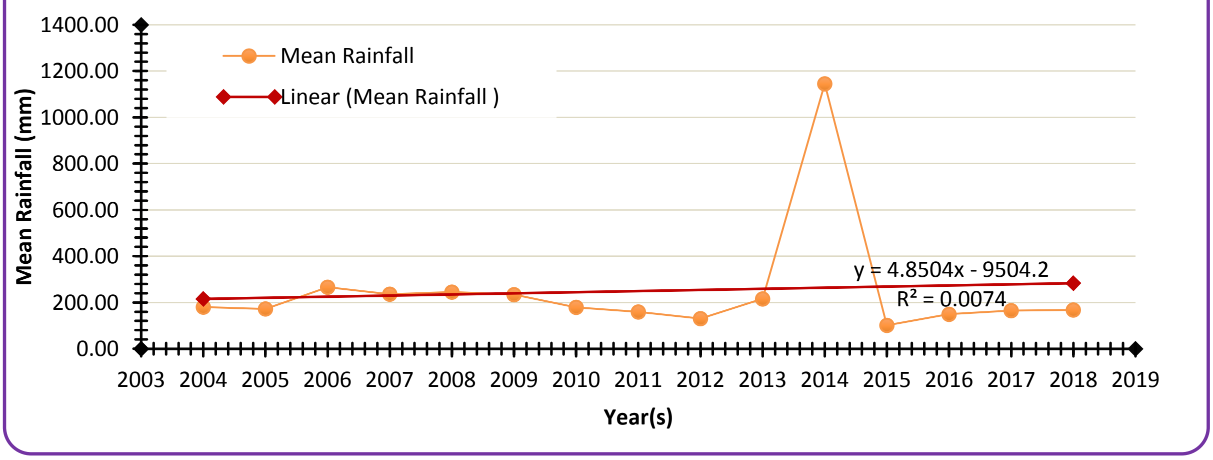
3212.4mm, 3014.5mm and 3112.1mm respectively. From the trend chart, it can be observed that slight fall in coursed in the trend plot the occurred in the year 2002 and was steady through 2004. By interpretation, this implies a steady decline in annual rainfall within these years as compared to the preceding period of 1999 to 2001, at 2214.1mm, 2165.3mm and 2069.6mm respectively. The period of 2005 to 2008 however, experienced an improvement in rainfall-compared increase in annual rainfall at 3195.3mm, 2833.8mm, 2942.8mm, and 2809.6mm respectively.

While the improvement in annual rainfall experienced in the year 2005-2008 can be said to be a remarkable increase compared to the preceding three years (200 to 2004), the period of 2009 to 2011 recorded a steady decline in annual rainfall. This decline is made vivid, as depicted by the downward slope of trend plot in the figure above. During these periods, the following the following amount of annual rainfall in the study area was recorded; 2153.1mm, 1913.1mm, and 1565.7mm respectively. A look at the trend plot shows that an upward movement occurred in the year 2012. This upward movement by interpretation signify an increase in annual rainfall in the year concerned. The year 2013 recorded a significant increase in annual rainfall in the study area. This increase is made vive by significant upward shift in the trend plot presented in the figure above. In this year, annual rainfall was recorded at 13745.0 mm. It important to state here that this year recorded the highest amount of rainfall in the study area across the entire period under consideration. Compared to that of the preceding period (2013), the period of 2014 to 2016 recorded a decline in annual rainfall at; 1218mm, 1790mm and 1980.5mm respective, while the year 2017 experienced an increase in annual rainfall at 2015.06mm. Worthy of note here is that that the year 2014 recorded the lowest amount of annual rainfall in Owerri Local Government Area of Imo State across the period of 1995 to 2017, while the year 2013 recorded the highest amount of annual rainfall at 13745.0mm. The value of r^2 in the trend equation indicates a variation in trend of annual rainfall at 0.3 percent.

Fig.4.2: Trean of Mean Rainfall in the Study Area



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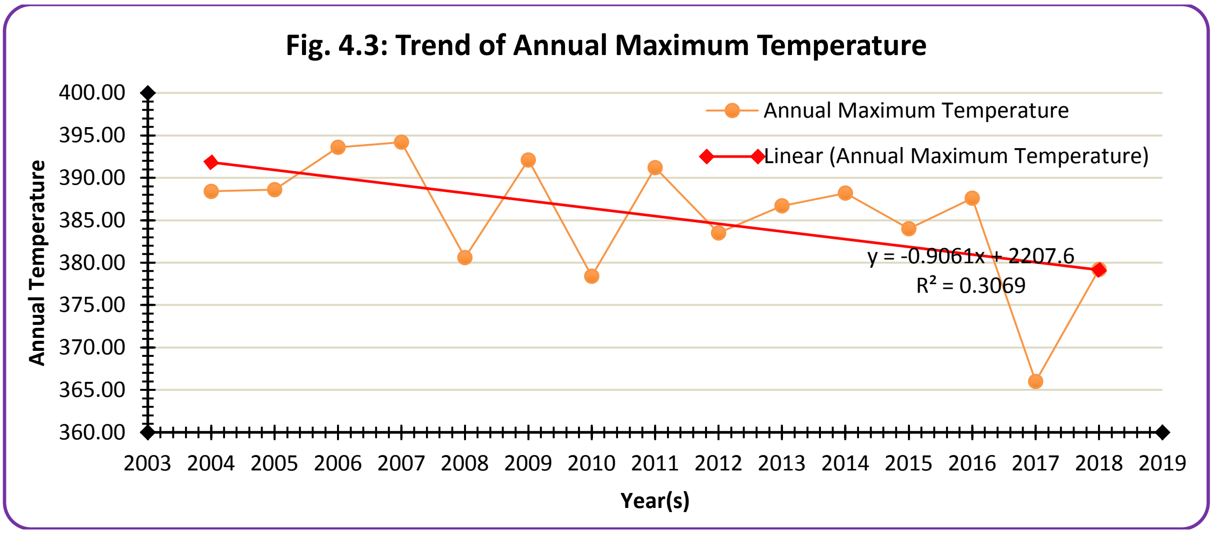
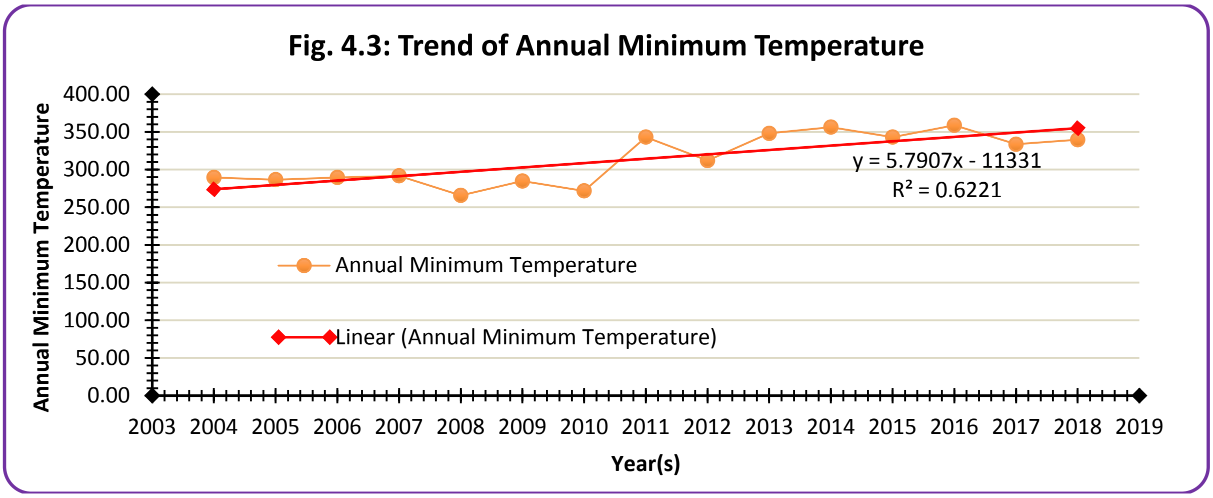




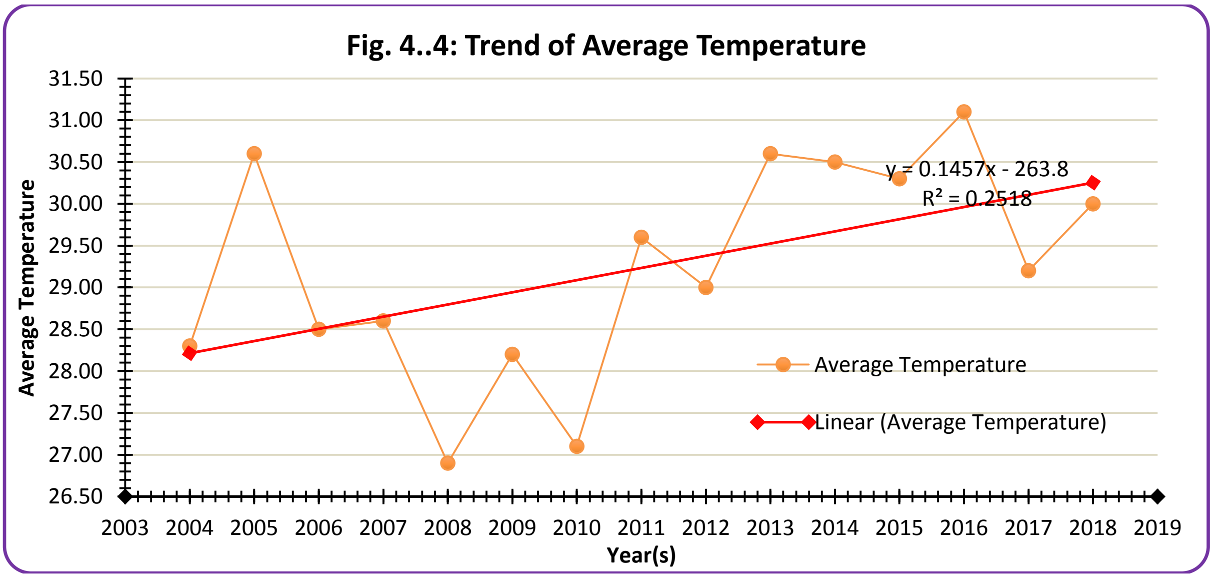
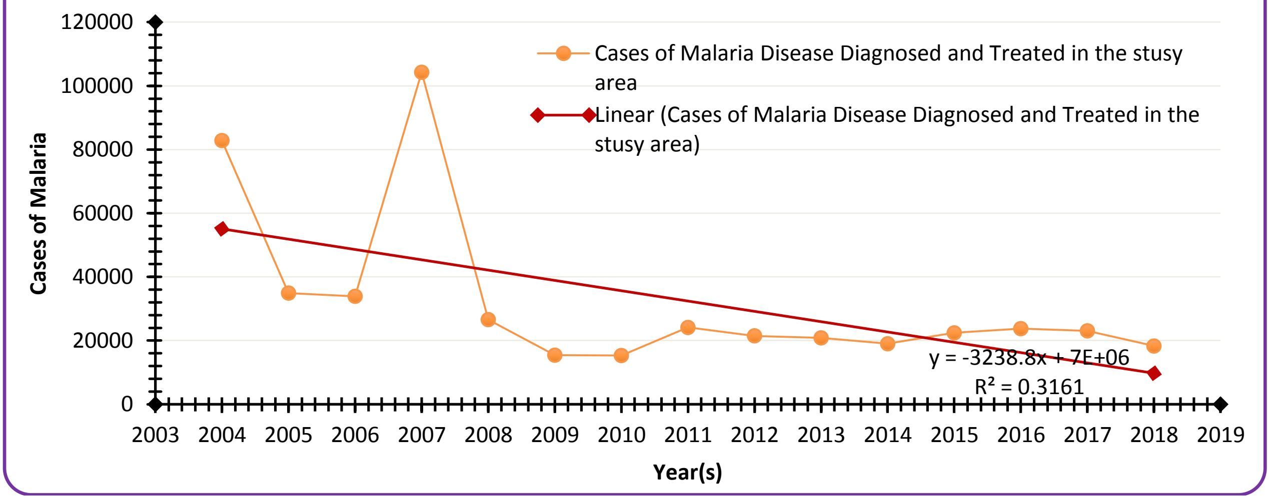


Fig. 4.5: Trend of the Cases of Malaria Disease Diagnosed and Treated



CONCLUSION

Malaria is one of the world's most serious disease and difficult public health problems. About 400–500 million cases of the disease occur every year and more than one million deaths, though children are more affected. Malaria is undergoing a global resurgence because of a number of factors. Malaria cases has been increasing in many countries since the 1970's all over the world, even after successful control and prevention, hence taken to be a new disease that can keep on occurring. Children and pregnant women are the most affected by malaria disease. Today, a child dies of malaria every 40 seconds and between one and three million people die each year around the world, especially in sub-Saharan Africa where it is more prevalent. Although these figures and estimates show spatially coarse patterns, they do not reveal the fact that spatially fine patterns have been changing. Such patterns are quite evident in the geographical malaria regions like the sub Saharan highlands. The World Health Organisation estimates that, by 2000, the global burden of diseases including malaria attributed to climate change and variability had exceeded 150,000 excess deaths annually. Continuous increase in the transmission and distribution of infectious diseases worldwide malaria, typhoid fever is speculated by models estimating the effects of climate change and variability while others for example will see a decrease in transmissibility due to excessive warming of some water as well as some regional drying.

A study carried out by Climate and Health Resources Room on climate and malaria in Africa showed that where malaria is not adequately controlled, its distribution and seasonality are closely related to seasonal characteristics of the weather, and where there were cases of anomalies such as rainfall anomalies, malaria which is seasonally endemic becomes epidemic in warm semi-arid regions of Africa. looked at the relationship between meteorological variables and the occurrence of malaria, measles, chicken pox, meningitis and pneumonia in Ikeja, Akure and Kaduna and their results showed that there is a relationship between diseases and the seasons. It showed that malaria and pnuemonia are associated with the rainy season while measles, chicken pox and meningitis are common during hot periods.

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