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Relationship among Some Prevalent Diseases and Changes in Weather at Ilorin over a Solar Cycle Period

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Abstract

A study of the relationships existing between the variations in the tropospheric weather and occurrences of three prevalent diseases namely: typhoid, meningitis and asthma in Ilorin (lat. 8.5ºN and long. 4.5ºE), located within the Guinea savannah zone of West Africa have been carried out using data covering a period of eleven years (1999-2010; one solar cycle). Variations in five weather parameters namely, minimum temperature, maximum temperature, rainfall, relative humidity and sunshine hour were studied and used to determine the relationship of the diseases with changes in weather. The results showed that tropospheric weather is solar cycle dependent while the (three) diseases studied were found to be influenced by changes in weather to different extents. Hence they are seasonal dependent. Typhoid showed 97% dependence on maximum temperature, relative humidity and sunshine hours thus revealing that typhoid is promoted during dry season at Ilorin. Asthma occurrence showed 93% dependence on rainfall and minimum temperature therefore showing that it is prevalence during rainy season. The results also showed that meningitis occurrence with 95% of agreement with maximum temperature and relative humidity can have prevalence any time of the year irrespective of season.

Keywords: tropospheric weather, prevalent diseases, Ilorin, Solar Cycle, Atmosphere

1. Introduction

The Earth's atmosphere is the gaseous envelope around the solid Earth. The importance of the atmosphere to life existence on the planet cannot be over-emphasized. The atmosphere supports life, both of plants and animals by providing a protective shield against the incoming radiations from the sun. Based on temperature, the atmosphere is classified into three major categories: the lower atmosphere (0 – 12 km); the middle atmosphere (12 – 60 km); and the upper atmosphere (> 60 km) (Smith, 2012).

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The lower atmosphere, otherwise known as the troposphere is the domain of meteorology, where both naturally existing and anthropogenic gases are found. The troposphere, being the closest layer to life on the planet earth is subject to activities both natural (e.g. land and seas breezes, clouds formation) and artificial (anthropogenic activities such as bush burning, industrial effluents etc.). These activities impact on the tropospheric condition over any particular location at any point in time. Thus the troposphere varies in time and space. Tropospheric changes over any particular location at any point in time are referred to as weather. Such changes over a very long period of time are known as climate. Climate change is the statistical variation in weather that persists for an extended period, typically for a decade or longer. Climate change includes shift in the frequency and magnitude of sporadic weather events as well as the slow but continuous rise in global average of surface temperature (IPCC 2001). It is the greatest challenge facing man's existence on earth in this century. Climate change involves a process of global warming which in part is attributable to the 'greenhouse gases' generated by human activities (Abdulkadir *et al.*, 2017; Barry and Chorley, 2010). The driving mechanism of global climate change is referred to as ‘radiative forcing’. Studies have shown that the weather/climate over a location may change in response to either external forcing due to solar activity or internal drivers such as atmospheric concentration of greenhouse gases, aerosols, cloud cover, volcanic and oceanic activities etc. (Turkes *et al.*, 2002). Long-time changes in solar radiation have been found to have signatures on climate. For example, the release of methane and carbon dioxide from stores of the oceans and icecaps has been linked with the warming of the planet due to increase in solar irradiance (Haigh, 2011). It has also been reported that the production and release of radiocarbon (^{14}C) into the atmosphere is related to solar activity. The concentration of ^{14}C is observed to be lowered during low solar activity and higher during high solar activity. Variation of 0.1% in total solar irradiance over one sunspot cycle translates to a global tropospheric temperature difference of 0.5ºC to 1.0ºC (USGS Fact Sheet, 2000). Yamakawa *et al.*, (2016) in a study to investigate the relationship between solar activity and variations in sea surface temperature have also shown that there exists about 11.7% of positive correlation between solar activity and the global sea surface temperature.

Since the atmosphere supports life existence on the planet earth, changes in the condition of the troposphere at any point in time is therefore expected to have its toll on life on earth. Thus, changes in the tropospheric weather over a location at any point in time can affect the health and the general well-being of the population of the location. Changes in weather at a location affect the atmospheric (gaseous) compositions and atmospheric dynamics which in turn have bearing on the health of the population. Changes in weather and climate can lead to the prevalence of sicknesses and diseases such as malaria, typhoid, meningitis, etc.

For example, the population and spread of infectious agents such as protozoa, bacteria and viruses are favoured by different climatic conditions. This is because their population is dependent on the population of their vectors which is weather/climate driven. The population of vector organisms such as mosquitoes, ticks, and sand flies is controlled partly by weather and climate. Malaria transmission has been associated with anomalies of maximum temperature in the highlands of Kenya. The Dengue Fever and the Dengue Haemorrhagic Fever (DHF) are caused by the carrier mosquito *Aedes Aegypti* whose population is dependent on the variability of climatic parameters such as temperature, moisture, and solar radiation. For instance, an increase in rodent infestation in the southern America (witnessed between 1991 and 1992) was attributed to the increase in the population of Hanta virus which was predicated upon the heavy rainfall experienced during the years (Patz *et al*., 2003).

Several studies have been carried out by researchers within Nigeria to study and document the relationship between one type of disease or the other and changes in weather by examining the variations in the occurrence of one or more atmospheric parameters and different types of diseases. Sawa *et al*. (2011) studied the relationship among two diseases (Meningitis and Measles) and changes in temperature in Zaria. Their results showed that about 78.4% and 85.5% of the variation in the occurrence of Meningitis and Measles respectively were as a result of high temperature. It was observed that increase in temperature of 1^0C resulted in people of ages between 6 and 19 being affected by Meningitis and Measles every year. A study of the relationship between the prevalence of malaria and temperature variation using data for Ondo in the delta region of Nigeria carried out by Omonijo *et al*. (2011) revealed that an increase of 1^0C each in the air and sea surface temperatures resulted in 56.4% and 15.4% increase in monthly malaria sickness at a confidence interval of 95%. Akinbobola and Bayo (2011) used data obtained at Akure in Nigeria to study the relationship of malaria with some atmospheric parameters. Their result shows that relative humidity and rainfall have almost the same trend of association with malaria, while the remaining parameters share almost similar trend, except minimum temperature. Rainfall and humidity have a positive association with malaria incidence at lag of one month, while others have an inverse association. According to Ojeh *et al*., (2016), climate variability worsened the incidences of malaria in Nigeria during the period under study. Malaria incidence varied from 76 % during the rainy season to 24 %

during the dry season. Ayanlade *et al*., (2020) observed a significant positive relationship between rainfall and malaria, especially during the wet season with correlation coefficient $R^2 \geq 60.0$ in almost all the ecological zones of Nigeria. In the Sahel, Sudan and Guinea savannah, a strong relationship between temperature and meningitis was observed with $R^2 > 60.0$. In all, the results further reveal that temperatures and aerosols have a strong relationship with meningitis. This exercise will be the first of its kind conducted using data from Ilorin in Nigeria. The prevalence of three diseases namely typhoid, meningitis and asthma have been studied in relation to five atmospheric weather parameters of minimum temperature, maximum temperature, rainfall, relative humidity and sunshine hour. This study utilized data covering a whole solar cycle.

2 Materials and Methods

2.1 Study Location

Figure 1 shows the location of Kwara state in the map of Nigeria, and the expanded map of kwara state showing the location of IIorin within the state. Ilorin is the capital city of Kwara State and it is located on latitude 8.5ºN and longitude 4.5ºE. The city covers a landmass of area 765 km^2. It is located in the wooded savannah part of Kwara state close to the equator. Its western part has an elevation of 350 m above sea level with its peak point in the Northern part on Sobi hill which is about 394 m above sea level. Ilorin is within the Guinea savannah vegetation zone. During dry seasons, it receives the north easterly wind called Harmattan, which brings the Sahara dust with it. The dust plumes generally come from the Bodel Depression in the Chad Basin, and they can reach up to 3 km thick, reducing visibility to around 1 km (Olanrewaju, 2009; Falaiye *et al*., 2021). Ilorin metropolis experiences two climatic seasons which are the rainy season and the dry season. The rainy season is between the month of March and November and the annual rainfall varies from 1000 mm to 1500 mm, with the peak between September and early October. The mean temperature is generally high throughout the year. Ilorin has an average temperature of 25ºC in January, 27.5ºC in May and 22.5ºC in September. During rainy season, moist monsoon known as the South-Westerly wind blows from the Gulf of Guinea into the area and this causes rains and clouds in the area. The major rivers in Ilorin are Asa, Agba, Alalubosa, Oyun, Osere and Aluko (Oyegun 1985).

2.2 Danger posed by the Three Selected Diseases

The three of the diseases that have been found to be prevalent in Ilorin city are meningitis, typhoid and asthma. Meningitis is a rare infection that affects the delicate membranes known as meninges. These membranes cover the brain and spinal cord. It is a life threatening disease. It can lead to brain damage if not quickly diagnosed and treated. Bacterial Meningitis is caused by bacteria called *Haemophilus influenza* type b (Hib). According to the World health Organisation (WHO, 2022) Neisseria meningitides bacteria has the potential to cause large scale epidemic. The meningitis belt in the sub-Saharan African according WHO covers the nineteen northern states of Nigeria and it has been reported to remain a major public health challenge. Over 1,160 deaths were recorded in 2016/2017 according to a 2021 report from the Nigerian Centre for Disease Control, NCDC (Nigerian Govt, 2021).

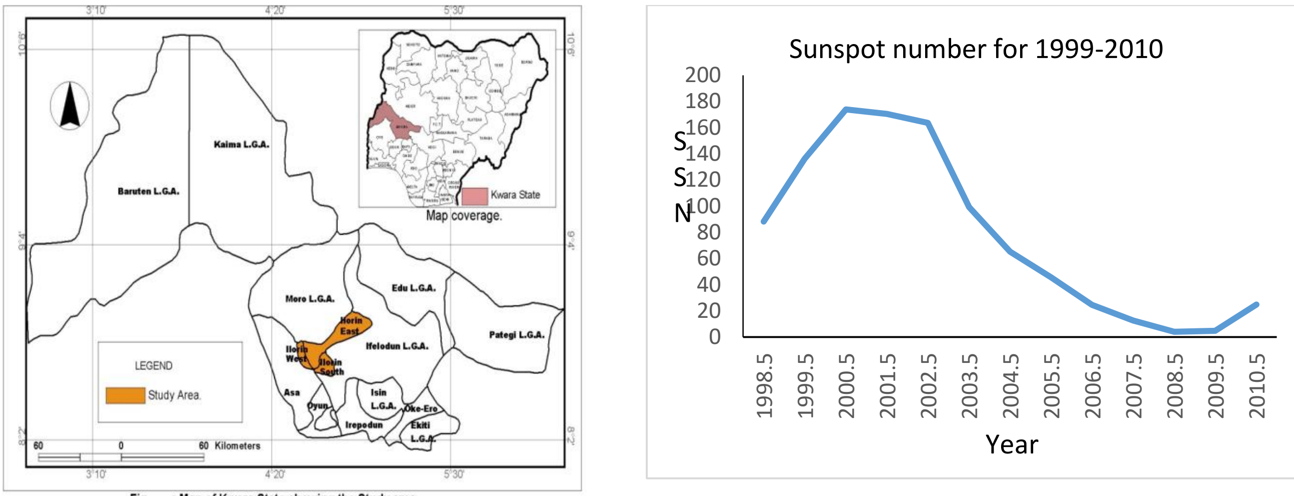

Fig. : Map of Kwara State showing the Study area.

Figure. 1: (a) Map showing the location of Kwara state and Ilorin, (b) a plot of the sunspot number for 1999 – 2010.

Typhoid fever is a bacterial infection that can spread throughout the body, affecting many organs. If not promptly treated, typhoid fever can cause serious complications and can be fatal. Over 7.2 million cases of typhoid fever are recorded annually in the sub-Saharan Africa and this is attributed to environmental factors such as rainy season, contaminated water bodies among others (Adesegun *et al.*, 2020). It is spread by the faecal-oral route and commonly presents with nonspecific clinical features such as fever, headache, rigors, joint pain, nausea etc. (Enabulele and Awunor, 2016).

Asthma is a long term disease of the lungs which causes the airways to get inflamed and narrow thereby making it hard to breathe. Severe asthma can cause trouble being active. Ozoh et al., 2021 reported the prevalence of asthma along with some other diseases in among children in Nigeria. According to the May, 2022 report of WHO, most asthma related deaths occur in low and lower-middle-income countries where under-diagnosis and under-treatment is a challenge.

The prevalence of asthma in Nigeria is high with approximately13 million cases ranking among the highest in Africa.

2.3 Data and Method of Analysis

Meningitis, asthma, and typhoid are three of the most prevalent diseases in Ilorin according to the records of the University of Ilorin Teaching Hospital (UITH). This is what informed the choice of these three diseases in this study which is aimed at providing supportive information to the medical/health providers and the health information unit of the ministry of health in the town. Data used were records of the patients infected with these diseases during the years between 1999 and 2010, a period of 11 years. The records were obtained from the records department of UITH. Having established the possible influence of solar radiation in weather/climatic variation, it was needful to examine the trend of solar radiation intensity during the period under study which falls into one solar cycle. There are different parameters which are used to represent solar radiation intensities among which includes the sunspot number (SSN), solar flux index (F10.7) etc. SSN data for the eleven year were obtained from the archive of the National Oceanic and Atmospheric Administration (NOAA) www.ngdc.noaa.gov.solar.ssndata. Five of the physical parameters which describe the state of the atmosphere (weather) at any point in time namely: minimum temperature, maximum temperature, rainfall, sunshine hour and wind speed. Data for these five parameters covering the elven years selected (1999-2010) were collected from the Nigeria Meteorological Agency (NIMET). Annual average values of these parameters were computed and graphs plotted to study their trends of variation over the eleven years under study. Graphs of climatic parameters and the health record data were plotted together using the Microsoft-Excel tool. Relationships between the individual disease and the five weather parameters were then examined using regression analysis and generalised linear model as given by equation (1) below. Forecast was made for the selected climatic parameters using auto regressive integrated moving average (ARIMA) model in equation (2). SPSS software was used for multiple regression analysis from which a predictive model was generated for the selected diseases and each weather parameter using equation (3).

The regression relation is as shown in Equation (1):

$$\mathrm{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + \mathrm{e} \qquad (1)$$

where: Y is disease, X_1 is rainfall, X_2 is relative humidity, X_3 is maximum temperature, X_4 is minimum temperature, X_5 is Sunshine hours and e is error.

The generalised linear model is given as:

$$\mathrm{E}\left(\frac{y_t}{X_t}\right) = \exp\left(b_0 + \sum b\, X_t\right) \quad (2)$$

where X_t is disease at time (t), $y_t$is climatic variable at a time (t), $b_0$and b are the regression coefficients. The probability of occurrence of a disease is given by equation (3),

$$prob\left(\frac{y_t}{\lambda}\right) = \frac{e-\lambda}{y_t} \quad (3)$$

where y_t is weather parameter at time t and λ isdisease at time t

3 Results

3.1 Pattern of Variations in the Solar and Weather Parameters

Figure 1(b) is a plot of SSN for solar cycle under study. The intensity of solar radiation increased from the moderate value of 80 in 1999 to 170 around 2000 before declining exponentially to 0 in 2009. Thus, the period under study falls within two solar epochs. While the period of 1999 – 2003 falls within the high solar activity, the period 2003 – 2010 falls within the low solar activity period. Figure 2(a-e) shows plots of annual variations in the weather parameters. Figure 2a is the plot of the variation in annual average rainfall over the years under study (i.e., 1999 – 2010). Amount of Rainfall reduced gradually during the period of rising intensity of solar radiation, reaching its minimum in 2001 when SSN was almost at a plateau. As the solar intensity dropped, the amount of rainfall rose rapidly from its minimum of 60 mm in 2001 to a maximum of 120 mm in 2004. The amount of rainfall then remained relatively stable (between 10 mm and 20 mm) during the low solar activity period between 2004 and 2008. As SSN began to rise again in 2009, rainfall began to drop again. This result showed indeed that solar radiation intensity have influence on the amount of rainfall. Thus rainfall increased between 2001 and 2004 (i.e. from the period of high solar activity to the period of moderate solar activity) at Ilorin, became relatively stable during the years within low solar activity (between 2004 and 2008), and began to decrease again towards the rising solar activity (2009 and 2010). Figure 2b presents the plot of minimum temperatures while Figure 2c shows the plot of the maximum temperatures at Ilorin during the period under study. The annual average maximum temperature shows a strong relationship with SSN. SSN has its greatest values between the years 2000 and 2003. Average maximum temperature was recorded in 2001. SSN then gradually decreased, reaching it minimum of almost zero between 2008 and 2009. This is also reflected in the annual variation in the maximum temperature. Maximum temperature rose from a low value of about 32.0^0 C in 1999 to a maximum of 33.18^0 in 2001and then decreased to 32.3^0 C in 2003. It thereafter reduced gradually reaching its minimum value of 32.09^{0}C in 2009, except for a sudden rise in 2007 (32.7^{0}C). SSN began an upward excursion in 2009; this is also reflected in the average annual maximum temperature as shown by the plot. Figure 2b shows the plot of the annual average minimum temperature at Ilorin during the eleven-year period. The minimum temperature, like the maximum temperature rose from a minimum value of 20.8^0 C in 1999 to a maximum of 22.2^0 C in the year 2000. Minimum temperature decreased thereafter to 21.6^0 C between 2000 and 2001. Minimum temperature rose again gradually from 21.6^{0}C in 2001 to attain the peak value of 22.25^{0}C in 2005 before dropping to all time low of 20.7^0 C in 2008 and thereafter began to rise, attaining a peak of 21.6^0 C in 2010. Although, it was obvious that other factors within the troposphere could have had influences on these two parameters, the two parameters show high tendency of being influenced by SSN. Figure 2d shows the graph of annual average relative humidity (%) at Ilorin during the eleven-year period of 1999 - 2010. Like rainfall, relative humidity at Ilorin during this period is anti-correlated with SSN. The annual average relative humidity decreased rapidly between 1999 and 2002 from 77% to 71%. It thereafter rose first rapidly between 2002 and 2003, and then gradually, attaining a peak (76.5%) in 2006 before dropping to its minimum value in 2007. It then increased from 71.5% in 2007 to 78% in 2009. Figure 2e shows the graph of annual average sunshine hours at Ilorin during the eleven-year period of 1999 - 2010. The graph shows that sunshine hour over Ilorin is not particularly dependent on SSN. Annual sunshine hour varied between 6.10 and 6.63 hours respectively during the solar cycle period. The maximum sunshine hour is observed in the year 2010 (6.62 hrs) and the minimum in the year 2005 (6.18 hrs.). Sunshine hour could possibly have been influenced by the amount of water vapour in the atmosphere as revealed by the level of de-similarity in the trends of the two parameters. The two parameters appear to be anti-correlated.

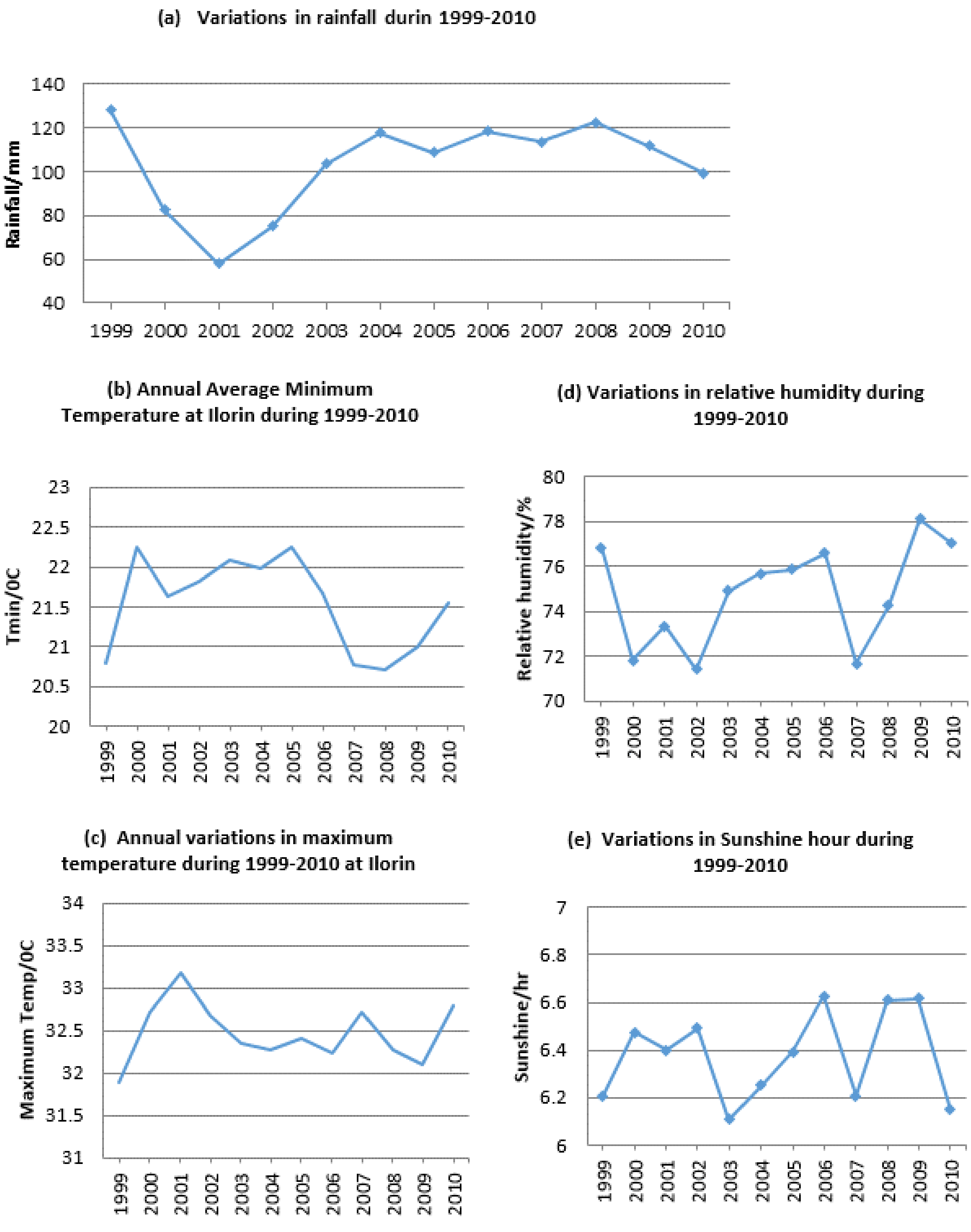

Figure 2: Plots of the annual average variations in the weather parameters at Ilorin during the period 1999-2010

3.2 Effect of climatic variation on the occurrences of the selected diseases

Figures 3-7 are graphs showing relationships among the occurrences of meningitis, typhoid, and Asthma respectively in relation to the meteorological parameters which include rainfall (mm), maximum temperature, minimum temperature, relative humidity (%) and sunshine hours (hrs.). Figure 3a shows that asthma occurrence followed the same pattern with the annual average rainfall throughout the years especially during low solar activity periods except for 2004 and 2006, when large drop in asthma occurrence is recorded. In Figure 3b, variations in the occurrence of typhoid show high degree of dependence on rainfall. The sharp drop in rainfall between 1999 and 2001 is reflected in typhoid occurrence between 2000 and 2001. Similarly, the rise in rainfall from 2001 to 2004 is reflected in typhoid occurrence which rose from 110 cases in 2001 to 135 in 2002. Figure 3c shows that meningitis occurrence shows dependency on rainfall only during years of high and moderate solar activities (1999-2005). Meningitis occurrences during the years of low solar activity tend to be inversely proportional to rainfall. While annual average rainfall rained on the high side between 2005 and 2008, the occurrence of meningitis was on a downward trend. Occurrence of meningitis increased again between 2008 and 2010 when average rainfall was decreasing.

The relationships among the minimum temperature and the diseases are presented in the plots in Figure 4 (a-c). While asthma show anti-correlation with the minimum temperature (Figure 4a,), typhoid and meningitis occurrences show some degree of dependence. A rise in Tmin between 1999 and 2000 is reflected in the equivalent rise in typhoid. Similarly, a drop in Tmn in the following year resulted in a drop in typhoid recorded. Positive relationship between the occurrence of meningitis and Tmin became noticeable only from 2005.

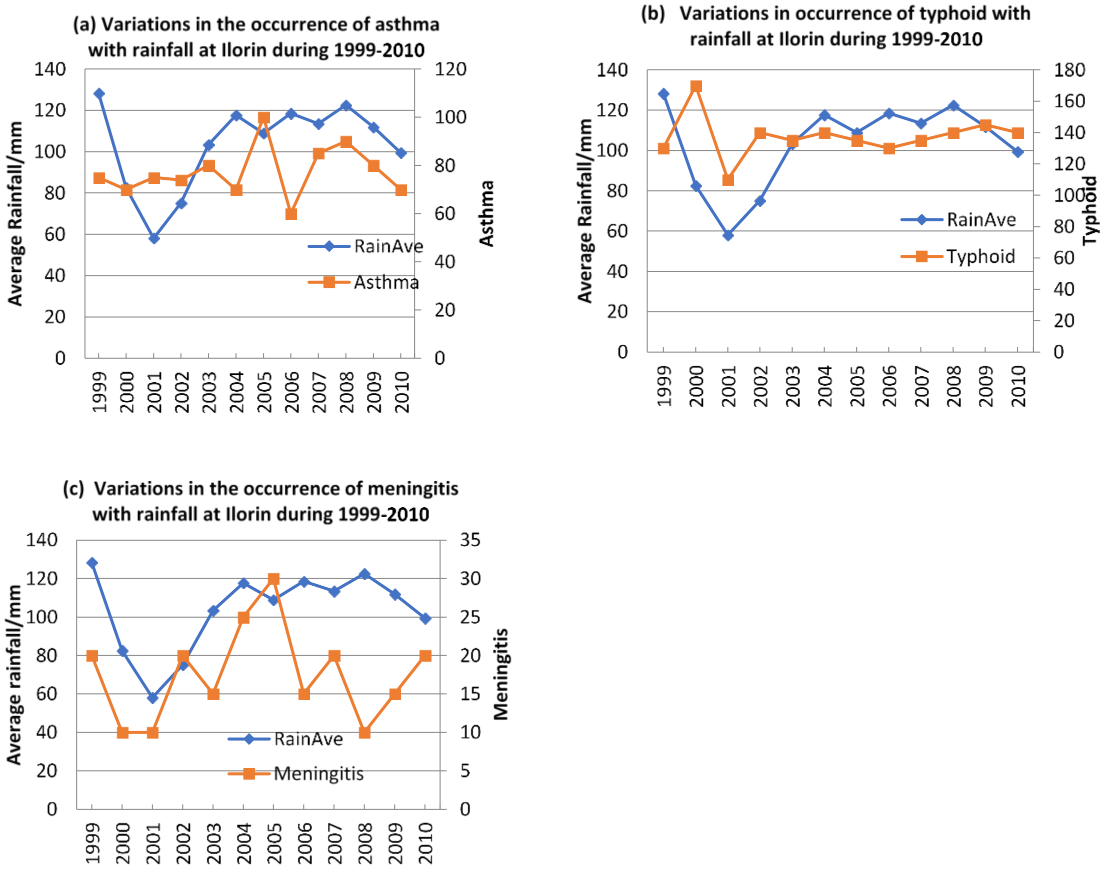

Figure 3: Plots of the variations in the occurrence of diseases with the annual average rainfall at Ilorin during 1999-2010

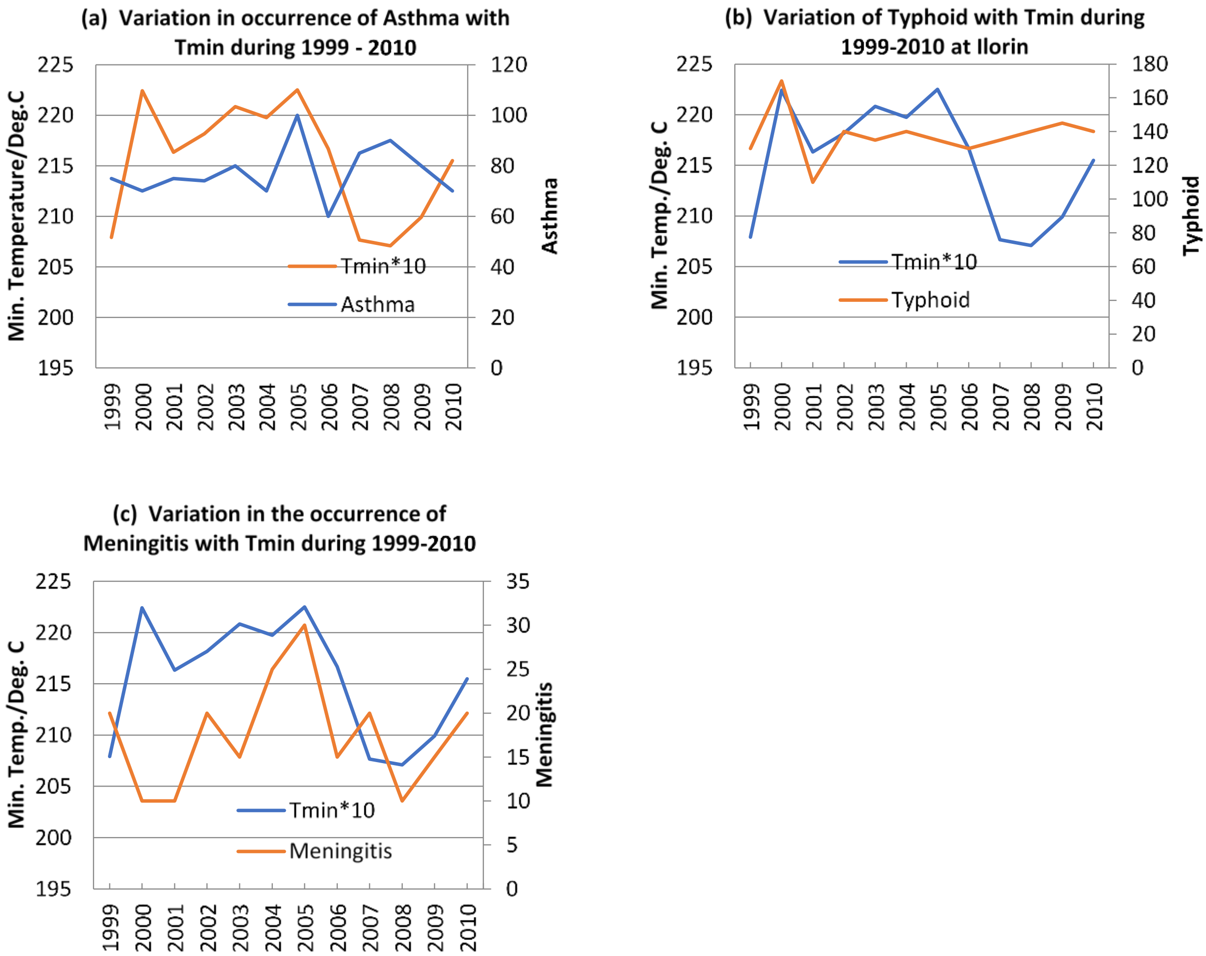

Figure 4: Plots of the variations in the occurrences of diseases with Minimum Temperature at Ilorin during 1999-2010

Relationships' existing among the diseases and Tmax is shown in Figure 5(a-c). While meningitis occurrence shows no positive correlation with Tmax, asthma and typhoid showed positive dependence during some years within the solar cycle. Figure 6(a-c) reveals that all the diseases have some degree of positive relationship or the other with relative humidity at Ilorn during the period under study. Figure 7(a-c) represent the relationships among the diseases and sunshine hour. The level of dependence of the diseases and the weather parameters were further investigated by obtaining the P-values and the coefficients of determination in the relationships using equations (1-3). For the determination of the p-values, the null hypothesis states that "there is no relationship between the occurrence of the disease with weather parameters b_i where i is 1,2,3,4 and 5 representing the five weather parameters of rainfall, Relative humidity, maximum temperature, minimum temperature and Sunshine hour respectively. The smaller the p-value ($p \leq 0.05$), the more significant the result i.e. the less randomness in the result and the null hypothesis is rejected. The values for P-values and coefficients of determination for each of the diseases are as shown in Tables 1-3. Table 1 show the P-values of b_1 - b_5, for typhoid are 0.019, 0.052, 0.059, 0.045, and 0.056 respectively. Since these values are much less than unity, we therefore reject the null hypothesis of b_1 and b_4. Thus, we conclude that a good relationship exists between typhoid and the three of the weather parameters (namely maximum temperature, relative humidity and sunshine hour). For asthma, the P-values of b_1 - b_5 are 0.057, 0.042, 0.037, 0.052, and 0.039 respectively. The null hypotheses of b_1, b_4 are thus accepted and the null hypotheses of b2, b3, b5 are rejected. This result implies that the occurrence of asthma is not dependent on rainfall and the minimum temperature. Asthma occurrence is related to Tmax, Relative humidity and Sunshine hour only. The P-values of b_1- b_5, for Meningitis are 0.022, 0.001, 0.035, 0.043, and 0.026 respectively. The null hypothesis is rejected for all the parameters in relation to meningitis.

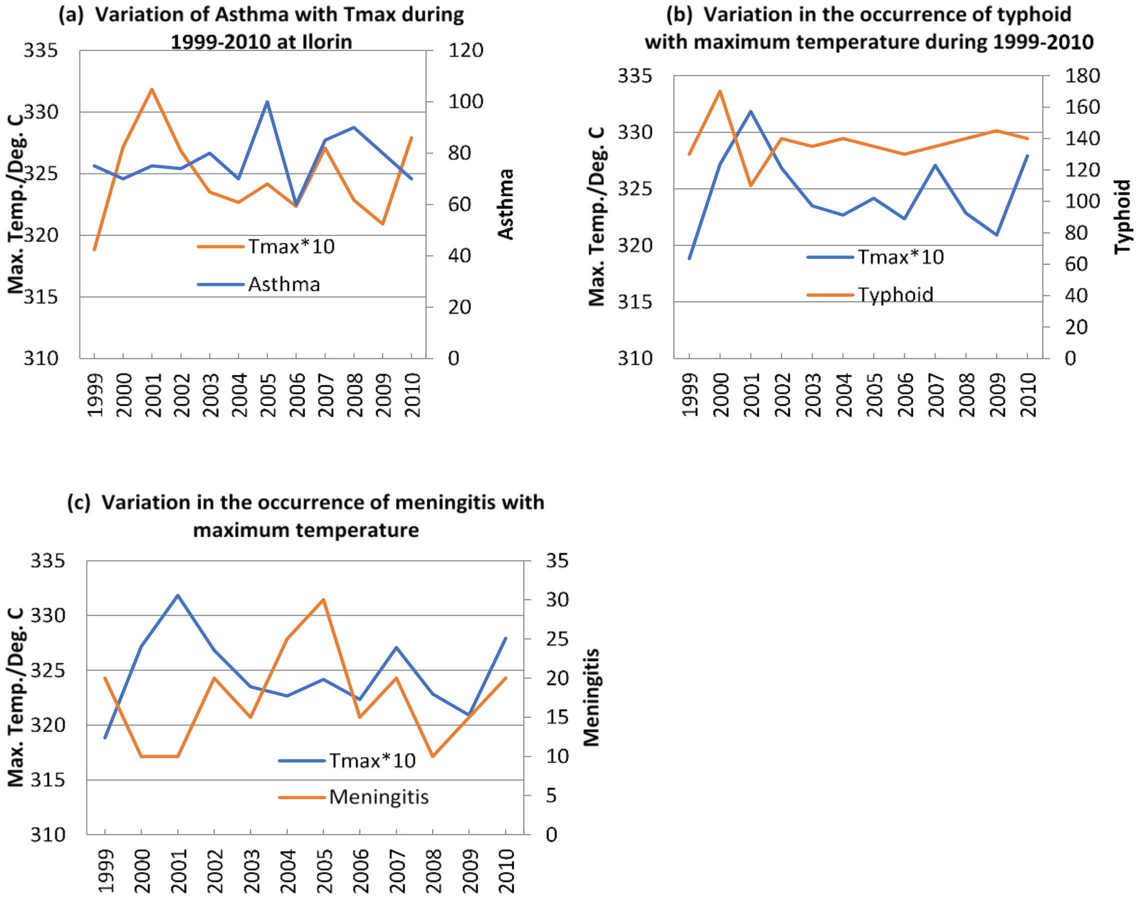

Figure 5: Plots of variations in the occurrences of diseases with Maximum Temperature at Ilorin during

1999-2010

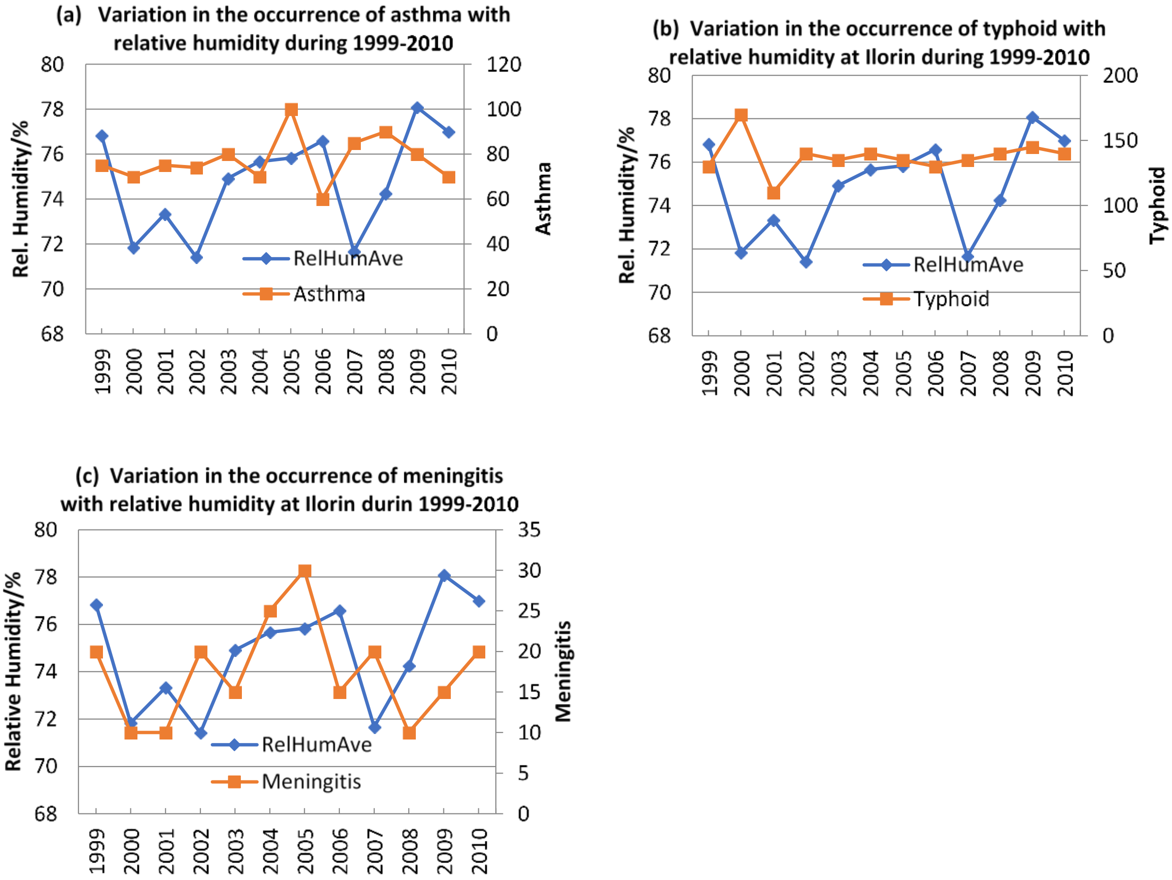

Figure 6: Plots showing the variations in the occurrences of diseases with respect to the annual average relative humidity at Ilorin during 1999-2010

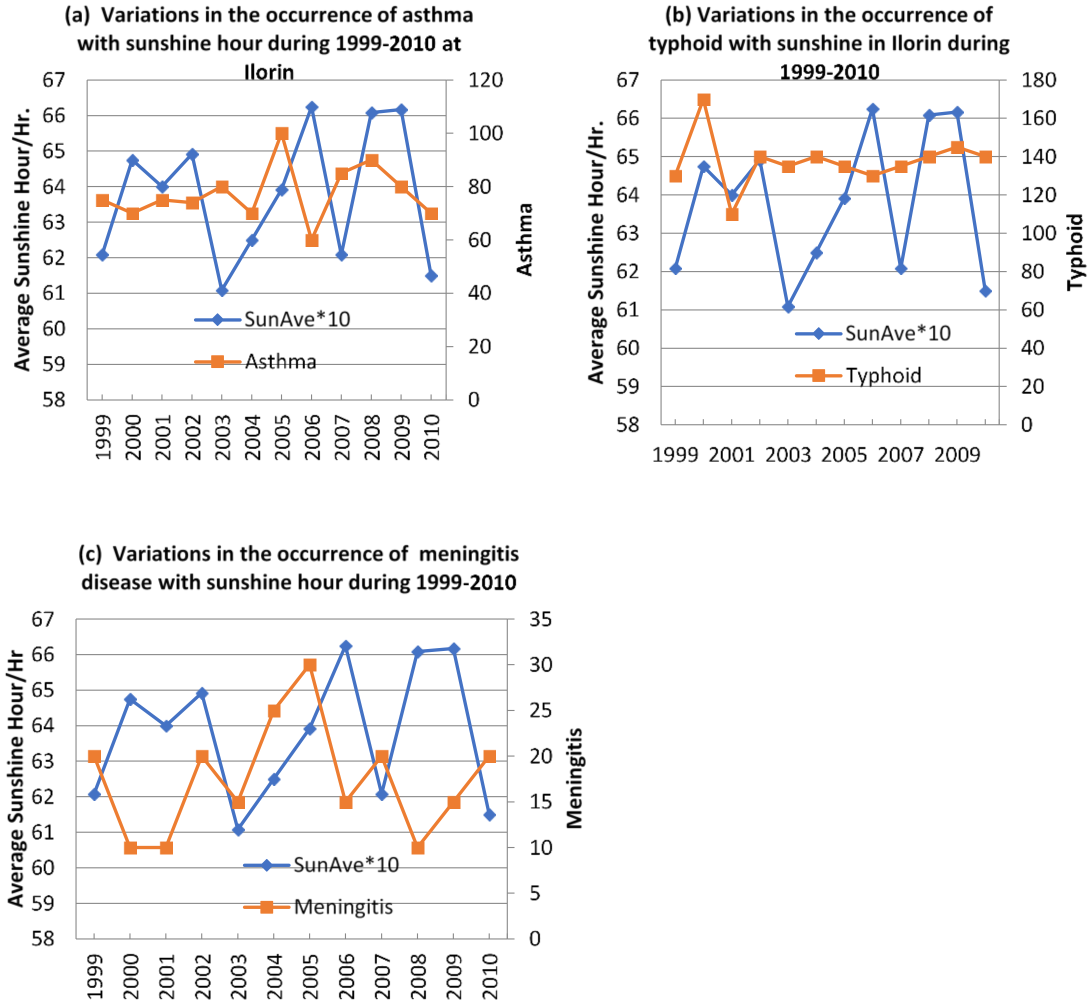

Figure 7: Plots showing the variations in the occurrences of diseases with respect to the sunshine hour during 1999-2010 at Ilorin.

Table 1: The P-values for the diseases

Disease name (Y)	b_0	b_1	b_2	b_3	b_4	b_5
Typhoid	0.447	0.019	0.052	0.059	0.045	0.056
Asthma	0.017	0.057	0.042	0.037	0.052	0.039
Meningitis	0.046	0.022	0.001	0.035	0.043	0.026

Table 2 shows the coefficients of b_1, b_2, b_3, b_4, b_5, gotten by regression analysis. In order to further examine the degree variability in the occurrence of each of these diseases as a result of their relationships with the weather parameters, we obtained the "goodness of fit" i.e. the coefficients of determination. Table 3 is the summary of the coefficient of determination for the generalised model (equation 2) used in this study. For Typhoid $R^2 = 0.972$, this means that 97% of information contained in the dependent variable can be explained by the independent variables. We can say categorically that the various weather parameters can influence typhoid by at least 97%. Similarly, for Asthma R^2 = 0.928 which means that 93% of information contained in the dependent variable can be explained by the independent variable, thus implying that asthma occurrence at Ilorin can be said to be 93% dependent on the weather parameters. Finally for Meningitis, R^2 = 0.945. This means that meningitis occurrence is 95% dependent on the weather parameters. These results therefore confirm that variations in the occurrences of the diseases under study are actually controlled by weather.

Table 2: Summary of the coefficients of the variables

Disease name (Y)	b_0	b_1	b_2	b_3	b_4	b_5
Typhoid	19.6	9.58	-4.6	7.88	5.75	2.0
Asthma	21.6	8.26	-2.75	-0.241	5.86	1.23
Meningitis	17.3	-3.80	4.29	7.81	-2.13	-1.6

Table 3: Summary of the coefficient of determination

Model	R	R^2	Adjusted R^2	Std. Error	Sig. F change
Typhoid	0.778	0.972	0.277	12.349	0.239
Asthma	0.963	0.928	-0.488	15.605	0.909
Meningitis	0.972	0.945	-0.568	9.037	0.949

4 Discussion

A study of the relationship among the five weather parameters, namely rainfall, minimum temperature, maximum temperature, relative humidity and sunshine hour, and the three prevalent diseases namely meningitis, typhoid and asthma have been carried out for Ilorin during they 11 year period of 1999 to 2010, a period that fell within two solar epochs; high (1999-2003) and low solar activities (2003-2010). Results from the study show that the weather over Ilorin experienced variations in response to the 11-year solar intensity (i.e. the solar cycle). While rainfall and relative humidity are observed to vary inversely as the solar intensity, maximum and minimum temperatures varied rather positively with solar cycle. Sunshine hour however did not show musch evidence of dependence on the solar cycle. These results are in line with the observation of Haigh, 2011 who stated that the intensity of solar radiation influences climate. According to Haigh, 2011, an overall increase in solar activity has contributed to global warming within the first century. Also Yamakaw et al. (2015) observed a significant relationship between Sea Surface temperatures and SSN. The results from the present study therefore confirms existing literature. The pattern of the average rainfall revealed that rainfall decreased within the first three years, thereafter increased rapidly and then fluctuated between 100 mm and 120 mm for the remaining years of the cycle. This results further confirms the results obtained by Oluwadare et al. (2021) in which rainfall at Ilorin was shown to have increasing trend with high degree of variability over a nine year period. For the temperature, bothe annual average rminimum and maximum temperatures followed the pattern of variation in SSN, being high during high solar activity and following a decreasing trend during the low solar activity perods. This result is contrary to the results obtained by Oluwadare et al. (2021), who observed an increasing trend in temperature with minimal variability during 2010-2018 period. This observations thus confirm the dependence of weather parameters (and climate) on solar intensity. These two studies were carried out within different solar cycles. Fries and Meyer (2009) opined that relationships exist between climate change and infectious diseses on both spatial and temporal scales. Changes in weather is a component of climate change, thus implying that changes in weather ultimately have influence on the prevalence of diseases depending on loaction and time. Results from this study confirms this opinion. Results of the study on the relationships among the diseases and the weather parameters show that the occurrences of the three diseases i.e. meningitis, typhoid, and asthma are influenced by changes in weather. Study by Grigorieva and Supruns (2018) showed that the prevalence of a type of asthma in children and teenagers was climate sensitive in Russia. Their study further showed that Bronchial asthma was seasonal dependent being prevalent during spring (March-April) and early winter (Nov-Dec) when temperature changes are large. Our results show significant relationships exist among the diseases and the weather parameters. Occurrences of the three diseases studied; meningitis, typhoid, and asthma show significant relationship with rainfall and relative humidity.

5. Conclusion

A study of the relationship between weather variations (represented by five parameters) and occurrences of some diseases namely typhoid, meningitis and asthma in Ilorin over a period of eleven year (1999 - 2010) have been carried out. This is the first time this type of study is conducted using data for Ilorin (to the best of the knowledge of authors). It is established from the results that the weather over Ilorin experienced variations during the period under study. The results further show that the disease respond to changes in weather as represented by the five parameters in Ilorin.

It is hereby concluded that (i) changes in weather are affected by the intensity of solar radiation; all the five parameters of weather show evidence of variation with radiation intensity of the sun; and (ii) occurrences of disease are weather/climate related. All the three diseases studied show one level of dependence or the other on changes in weather. Typhoid occurrence is significantly (positively) influenced by changes in all the weather parameters except rainfall. Occurrence of asthma increases with increase in rainfall and minimum temperature while meningitis occurrence is significantly dependent on maximum temperature and relative humidity.

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