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ORIGINAL RESEARCH ARTICLE

Influence of Weather Variability on Lower Respiratory Tract Infection Incidences in Yola North Local Government Area, Adamawa State

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ABSTRACT

The study examines the influence of weather variability on lower respiratory tract infection incidences in Yola North Local Government Area, Adamawa State. Meteorological data (rainfall, relative humidity, minimum and maximum temperature and sunshine duration) from 2015 to 2024 were downloaded from National Aeronautics and Space Administration [NASA] website. Reported cases of lower respiratory tract infection (LRTIs) were collected from Federal Medical Center Yola, which include; bronchitis, cold, pneumonia, catarrh and Tuberculosis (TB) from 2015-2024. Microsoft excel 2013 was employed to run the seasonal patterns of all the weather variables as well as LRTIs variables. SPSS Version 16 was used to run the correlation between weather elements and LRTIs parameters. Results showed that the pattern of rainfall depicted two seasons (wet and dry); April to September for wet and October to March for dry seasons. The results further revealed that the rainfall pattern and relative humidity influence bronchitis, cold, pneumonia and TB., Maximum and minimum temperature patterns tend to have less influence on those infections, while sunshine duration does not seem to influence LRTI cases incidences in the study area.. The Correlation Analysis results showed negative correlations (r) between rainfall and bronchitis (-0.513), cold (-0.610) and TB (-0.509) but a positive relationship (0.754) with pneumonia. Relative humidity portrayed negative relationship with all the LRTIs. Maximum temperature has (-0.704) strong negative correlation with pneumonia only. Minimum temperature and sunshine duration shows very weak relationship with all the LRTIs. Based on the seasonal pattern of weather elements and LRTIs parameters and also their relationships, weather variability tends to influences LRTIs incidences in the area. Therefore, it is paramount that government should reinforced environmental hygiene safeguard in the area. The use of nose mask should be encouraged among the populace during dusty weather conditions.

Introduction

Weather is one of the basic components that constitute the environments, affecting the living and non-living things in their surroundings directly. Variability in weather refers to temporal or spatial variation in weather parameters observed over a given area. It is best described as deviation of weather phenomenon from day to day changes or normal change as pointed by Ragurman *et al* (2018). These abnormal changes in weather could be due to extreme weather events that occur ones in a while. Weather parameters such as temperature, precipitation, humidity and sunshine hours create conditions that favors the life cycle of many disease pathogens and vectors which enhances their proliferation. These weather conditions may also manifest as extreme events causing flooding, drought, storms and heat/cold waves – impacting directly and indirectly on vector transmission dynamics. The direct impacts of climate on disease vectors are via adult survival and reproduction rates, the creation of breeding sites, and the development rates of the juvenile stage of the vector according to Ojo *et al* (2001). Pathogens transmitted to humans by insects and ticks spend part of their life cycle in their cold-blooded secondary (non-human) host where they are effective at the temperature of the local micro-climate, (Thomson *et al* 2018). Here the development rate of the pathogen (called the extrinsic incubation period) will slow down at lower temperatures increasing the probability that the insect/tick will not survive long enough for disease transmission to occur.

Variability in weather and climate has been shown to have an impact on infectious disease occurrence and spread. For example, increase in cases of diarrhea is often associated with extreme flooding events. The occurrences of diseases such as cholera, measles, malaria, pneumonia, meningitis, and asthma in various places have all been associated with variability in weather parameters (Sawa and Buhari 2011). These also show that weather anomalies have a demonstrated impact on increased disease transmission (Adebayo 2000).

Weather parameters influence human health directly or indirectly through changes in ranges of disease vectors, water borne pathogens, water quality and food availability and quality. Weather factors are important determinant of various vector borne diseases and many infectious diseases (WHO, 2000). Relationship between year to year variation in weather and infectious diseases are more evident where weather variations are marked and in vulnerable populations (WHO, 2014). Variation in weather and climate affects the human body significantly (WHO, 2016). The physiological function of human body responds to changes in weather condition. Several specific body disorders such as heat stroke occur only under particular weather conditions. Likewise the outbreak of several illness and diseases such as malaria, meningitis and avian influenza are known to be induced by weather variability.

Most likely, the periodic or seasonal nature of outbreaks of some human disease suggests that weather conditions play an important role in their seasonal variation (Adebayo, 2000).These include common disease such as malaria, asthma, cough, meningitis and other respiratory diseases as well as other major killer such as malnutrition and diarrhea (WHO, 2017). The temporal and spatial changes in temperature, precipitation and humidity expected to occur under different climatic scenarios could affect the biology and ecology of vectors and intermediate hosts and consequently the risk of disease transmission (WHO, 2016). Respiratory tract infectious diseases are among many of the world's most common and serious health problems. It is responsible for at least more than a million deaths every year in the world majority of which occurs in the most resource poor countries (Laah and Zubairu, 2007).

Tuberculosis and Pneumonia are partly a weather stress disease and it shows a markedly a seasonal character they invariably begin with drier and cold weather towards the end of November and reach its peak (Doney, 2017). Variations in weather parameters have promoted the occurrence of some diseases which affect some societies today. Weather variability has led to breeding conditions for disease vectors, (Kometa, *et al.,* 2013). Abnormal change in weather increases the frequency and strength of extreme weather events such as flood, drought and storms that threaten human safety and health. Weather variability is not just an environmental issue; it is also a healthcare issue. The major health threats due to change in weather are influenced by changing patterns of disease, death, water and food insecurity, vulnerable shelter and human settlement, extreme climate events, population growth and migration, (Commonwealth Secretariat 2009).

Weather and Climate variables influence diseases, and their mode of propagation, depending on three components which are; essential host, transmission environment and pathogen (Epstein, 2014). Some pathogens are carried by host to complete their life cycle. Appropriate climate and weather condition are necessary for their survival, reproduction, distribution and transmission of disease pathogen, (Bukhari 2009).

Variations in weather parameters have greatly influenced the biotic and abiotic components of an environment. The weather conditions of a place also have the propensity to influence the proliferation of some weather-related diseases. Yola North weather conditions have predisposing factors for disease infections like LRTI. Thus, the study objectively examines the influence of weather variability on Lower respiratory tract infections (LRTI) in the study area, so as to proffer mitigation measures against incidences of LRTI among the populace.

Materials and Methods

The Study Area

Yola North is one of the 21 Local Government Areas and the administrative capital of Adamawa State, North Eastern Nigeria as shown in (Figure.1), it is located between latitudes 90 14^1 and 9^0 17^1 N of the Equator and between longitudes 12^0 24^1 and 12^0 26^1 E of the Prime Meridian with an approximate land area of 109km^2 (Zemba 2010).

The study area is in boundary with Yola South to the south and west, it is also bounded by Girei local government area to the North and east, demarcated by river Benue. The weather condition of the study area varies significantly due to urbanization, because it is characterized with urban climate, while Yola South and Girei local government areas have urban fringes which modify the weather condition of those areas.

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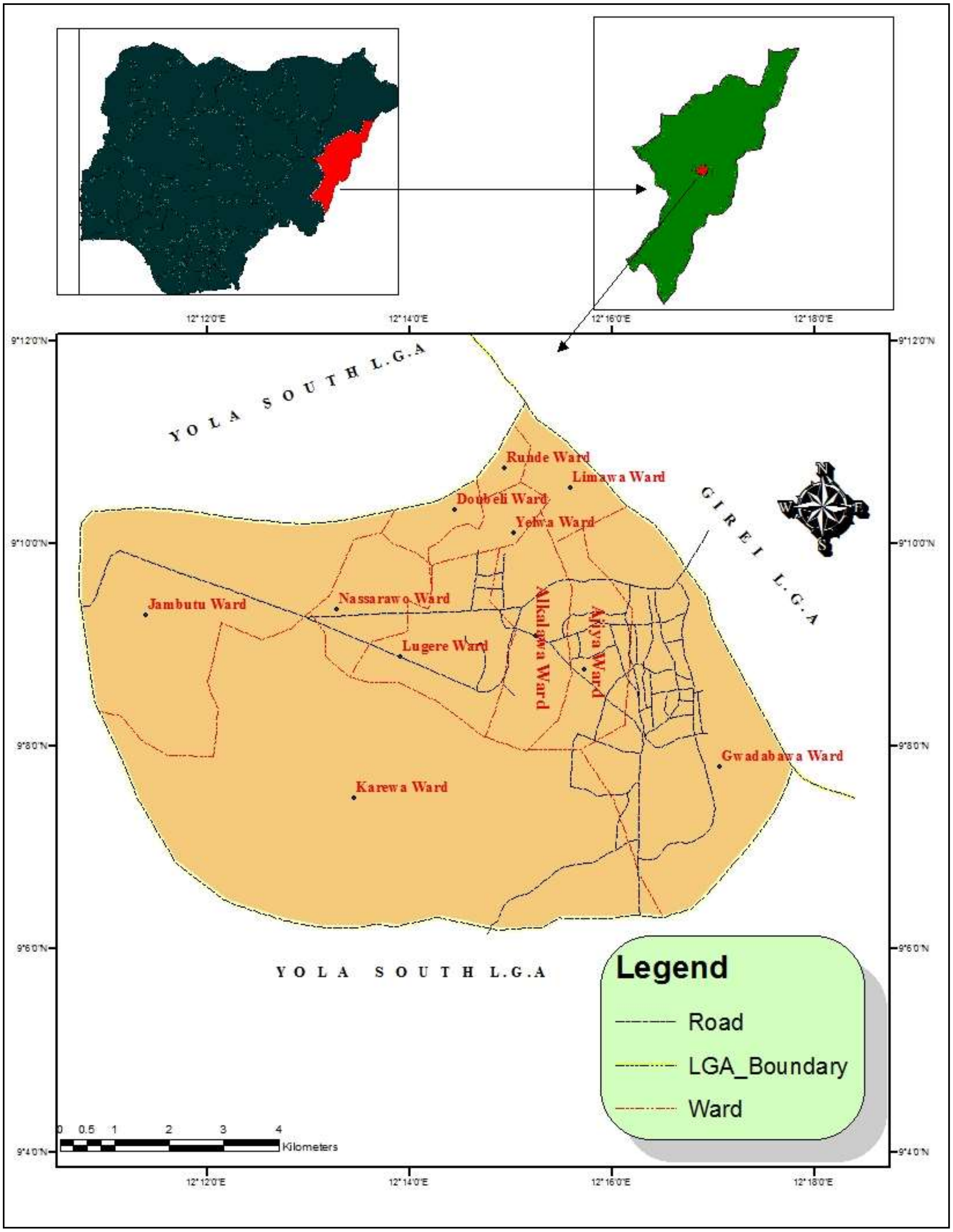

Figure 1: The Study Area

Method of Data Analysis

The seasonal means of five weather parameters consisting; rainfall, minimum and maximum temperature, relative humidity and sunshine duration, were computed in tables in order to assess seasonal pattern of the weather variables using SPSS Version 16. Records of the weather elements for ten years (2015 to 2024) were obtained from NIMET, Yola Airport, (Table:1). Ten years seasonal mean of respiratory tract infection variables consisting of pneumonia, tuberculosis, cold, bronchitis and catarrh were also computed using same software. The respiratory tract infection consist of; these data were collected from specialist Hospital Yola, through medical records department, for ten years. These data were also condensed in Table: 2 where seasonal mean were displayed.

Table 1: Seasonal Mean of Weather Parameters

Parameters	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Rainfall	0	0	2	42	44	94	132	162	198	187	0	0
Max/Tem	34	38	40	40	36	33	31	30	31	33	36	35
Min/Tem	18	22	24	27	24	23	23	23	23	23	20	17
Humidity	33	28	30	46	63	75	80	83	82	76	54	39
Sunshine	8	7	7	7	7	7	6	5	5	6	8	9

Table 2: Seasonal Mean of Respiratory Tract Infection Incidences

Parameters	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Bronchitis	76	63	30	9	7	7	21	32	11	38	34	58
Cold	202	88	33	41	46	43	33	32	40	89	159	196
Pneumonia	199	100	55	86	153	164	185	245	133	159	148	227
Catarrh	62	22	12	11	29	30	25	33	22	34	38	56
Tuberculos	68	55	26	7	3	5	18	27	10	34	31	44

The two data sets (Weather parameters and LRTI parameters) were further subjected to inferential statistics to examine the relationship between weather parameters and LRTI parameters. This process could only be achieved through Pearson Product Moment Correlation.

$$r = \frac{\sum xy/n - \bar{x}\bar{y}}{\sqrt{(\sum x2/n - \bar{x}2)(\sum y2/n - \bar{y}2)}} \qquad (1)$$

Where:
r = Correlation coefficient.

X_1= Weather parameters: (Mini., and Max. Temperature, rainfall, humidity and sunshine duration).

Y_1=Respiratory tract infection: (Bronchitis, Cold, Pneumonia, Catarrh and Tuberculosis). Correlation was used to determine the relationship between weather parameters and reported cases of LRTIs. All the values were correlated at (0.05) and (0.01) level of significance. Seasonal mean values of weather parameters are the independent variables (temperature, precipitation, humidity and sunshine duration), while mean seasonal values of the reported cases of LRTI (bronchitis, cold, pneumonia, Catarrh and Tuberculosis) are the dependent variables. Each of the weather parameter was computed against each case of reported LRTIs incidence.

Results and Discussion

Seasonal pattern of climate variables in the study area

The seasonal patterns of climatic variables illustrated in Figures below, depict the nature, pattern and characteristics of each variable in order to establish their respective influences on the prevalence's of lower LRTIs in the study area.

The seasonal analysis of rainfall values in the study area portrayed in Figure 2; shows that rainfall pattern reaches its peak with the value of almost 200mm in August and then records a sharp fall in amount between September and October, to a value of 57.2mm. This period of wet season creates favorable conditions for disease pathogen and vectors to proliferate, more of temperature tend to drop due to cloud cover that absorbs solar radiation from the sun. Then it denotes continues decline up to onset period which is in March with negligible amount of 4.8mm value. The month of October marks the cessation of rainfall in the study area. This explains the prevailing of Tropical continental air mass over the Maritime air mass which blows from the ocean, leading to change in season, (Iloeje, 2003).

Figure 3 reveals the seasonal pattern of Relative humidity of the study area with the lowest value of (27.2%) recorded in February, thus indicating the driest month with low temperature. This may also be connected with the occurrence of harmattan dusts which blows from Sahara desert with various dust particles which obstruct visibility and other health challenges related to respiratory tract infections. There is a steady increase in humidity from March to August, and then decline from August to December. The month of July, August and September have high relative humidity, with the peak in August with value of 83.4%. Here, relative humidity exhibit similar pattern with rainfall.

Maximum and minimum temperature of the study area show almost similar seasonal pattern as reflected in Figure: 4.The highest value of 38.7 ^{O}C is recorded in April and the lowest value in August with 29.8 ^{O}C. This may be due to the fact that August is the month with highest value of rainfall, and relative humidity that moderates temperature regime, through cloud cover which obstruct amount of solar radiation on reaching the surface. Minimum temperature has the highest value in April with 27.3 ^{O}C which later drops to 17.7 ^{O}C in December. Therefore, both maximum and minimum temperatures tend to maintain steady increase from January to April, and then begin to fall from May to October. Temperature is one of the climate variables that mostly influence lower RTIs, due to inactive of some bacteria's in low temperature.

Sunshine duration as illustrated in Figure 5; show some fluctuations, in that, it decreases from February to August, then increases from September to November. The longest duration in terms of sunshine hours is in December with 9 hours which can be attributed to the absence of cloud cover; while the shortest duration in sunshine hours is in August with 5.0 hours, which coincides with the occurrence of much cloud cover associated with the month of August.

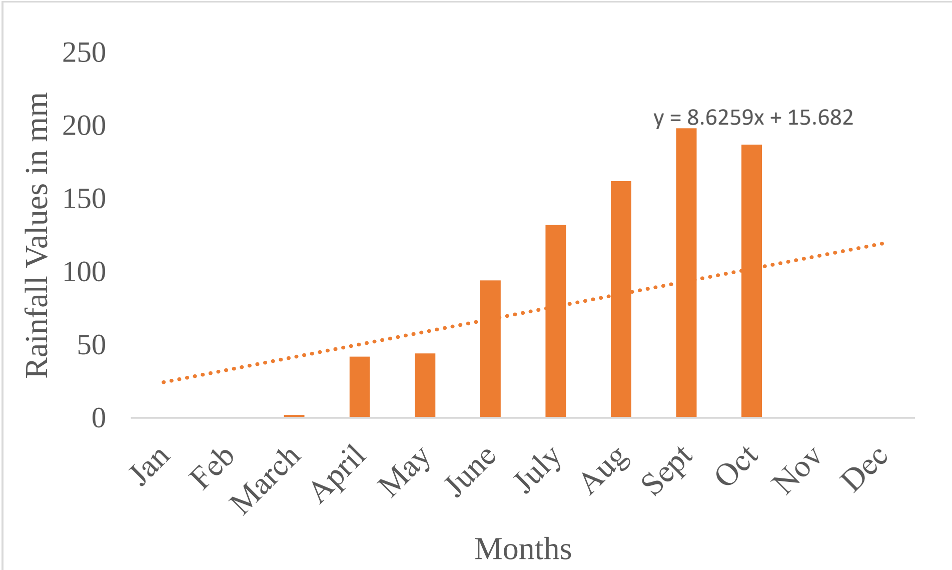

Figure 2: Seasonal pattern of Rainfall in the Study Area

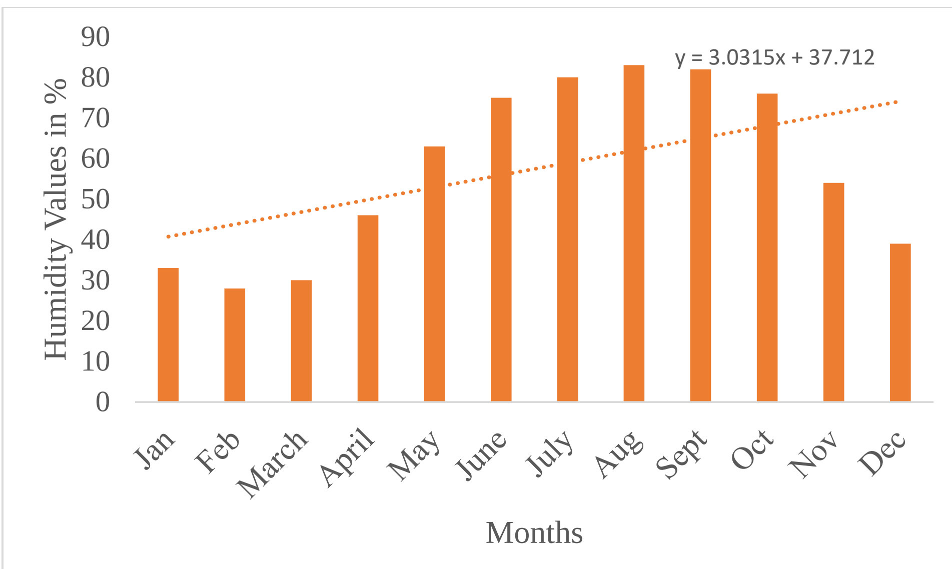

Figure 3: Seasonal pattern of Relative humidity in the Study Area

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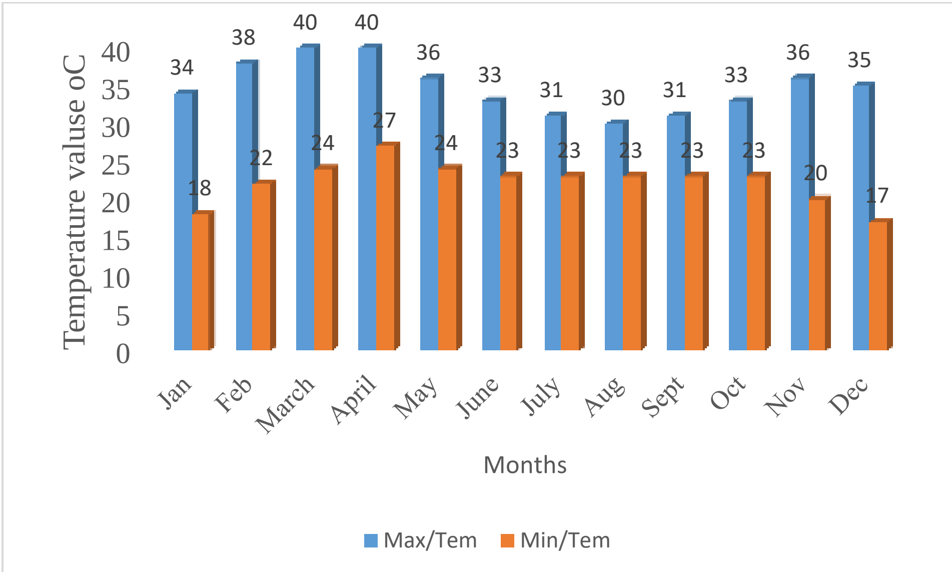

Figure 4: Seasonal pattern of Maximum and Minimum Temperature in the Study

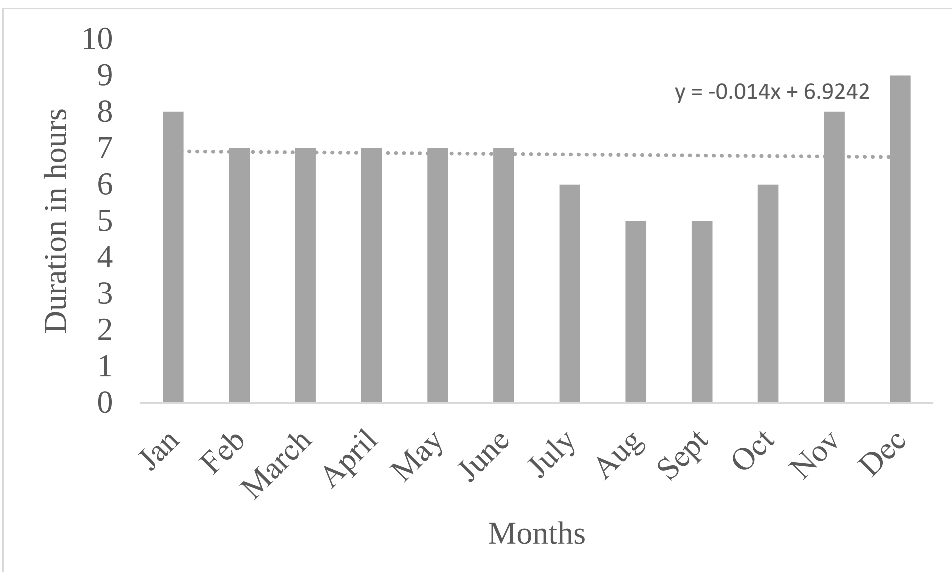

Figure 5: Seasonal pattern of sunshine hours in the Study Area

Seasonal pattern of Lower RTI in the study area

The seasonal patterns of lower RTIs are displayed in the Figures below. These illustrations of seasonal pattern are aimed at describing the characteristics and seasonal pattern of lower RTIs prevalence in the study area in order to see whether climatic variables of the study area have correlation with RTIs.

Figure 6 portrayed seasonal pattern of Catarrh where we have high cases in January with 62 and in December, we have 56. These two months have low temperature without rainfall, it also marked harmattan period, which causes difficulties in breathing due to air pollution by the harmattan dust. The figure also reveals low case in April with 11 patience and 12 in March. March and April record the highest temperature value, therefore, high temperature does not influence occurrence of Catarrh. By this pattern, the rise in prevalence of Catarrh and pneumonia in the month of August indicates that climatic variables such rainfall and temperature are sufficient enough to contribute to subsistence of LRTI disease vector in the study area.

Figure 7 explain the seasonal pattern of Pneumonia in the study area. The prevalence of pneumonia has lowest cases in March with 55 patience, while in August is raised to 225 cases which marked the zenith prevalence in the study area. This pattern of pneumonia is in consonant with rainfall pattern of the study, therefore, it stand to reason that rainfall pattern of the study area influences pneumonia prevalence's. Figure 8 displayed the seasonal pattern of cold in the study area which shows a rise of about 202 reported cases in the month of January and 196 in December. The fewest cases occurred in August with 32, then we have 33 cases in March and July respectively. The seasonal pattern also reveals sharp fall in the month of February with less than 100 reported cases and gradually declining from March to September with reported cases of less than 50, then began to rise from month of September to January. This seasonal pattern is in harmony with temperature seasonal pattern which buttress the prevalence of LRTIs in the study area.

Seasonal pattern of bronchitis was displayed in Figure 9 showing characteristic and pattern of occurrence in the study area. It reveals high occurrence in January with 76 cases and 58 in February. The lowest values were recorded in May and June having similar value of 7 cases. The seasonal pattern of cold and bronchitis exhibit similar pattern and characteristics, however, cold seasonal pattern indicate sharp fall from January to April then gradual maintain the transition and start to rise again reaching its peak in the month of January. This result reveals that there is strong relationship between bronchitis and rainfall of the study area as shown in Fig 2.

Figure 10 depict the seasonal pattern of Tuberculosis in the study area where by, January is the month with highest number of reported cases of about 68 patients and 55 cases in February. In the month of May, it shows less than 5 cases of Tuberculosis were recorded, this shows that, Tuberculosis pattern fluctuate proportional to weather variability, however, low cases were reported in the month of April to June. Finally, the seasonal pattern of tuberculosis shows increase from December through February, thus the weather condition of this period may account for the prevalence of LRTIs in the study area.

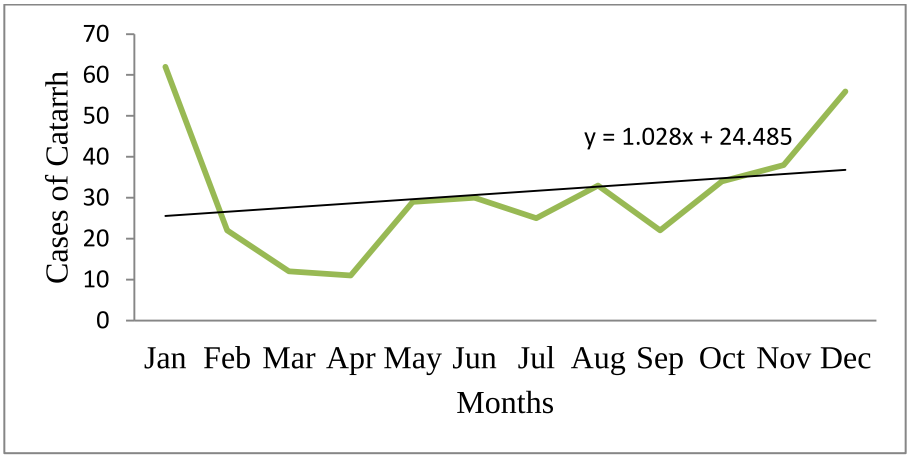

Figure 6: Seasonal pattern of Catarrh in the Study Area

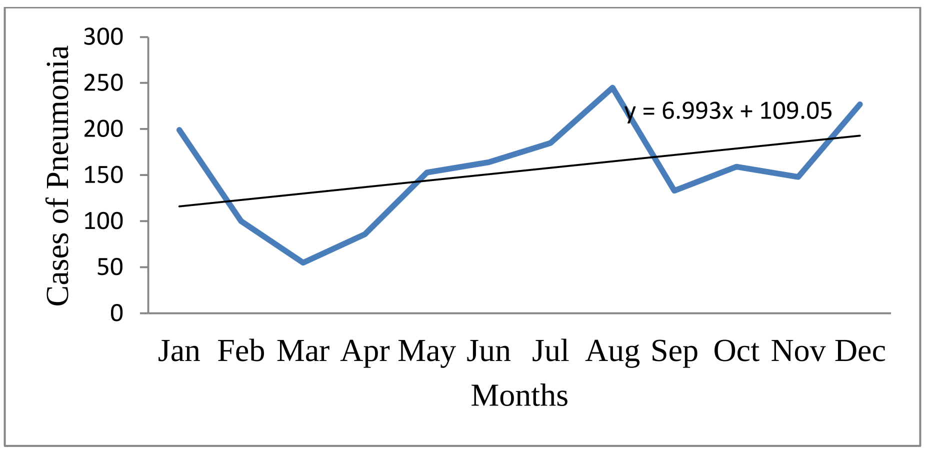

Figure 7: Seasonal pattern of pneumonia in the Study Area

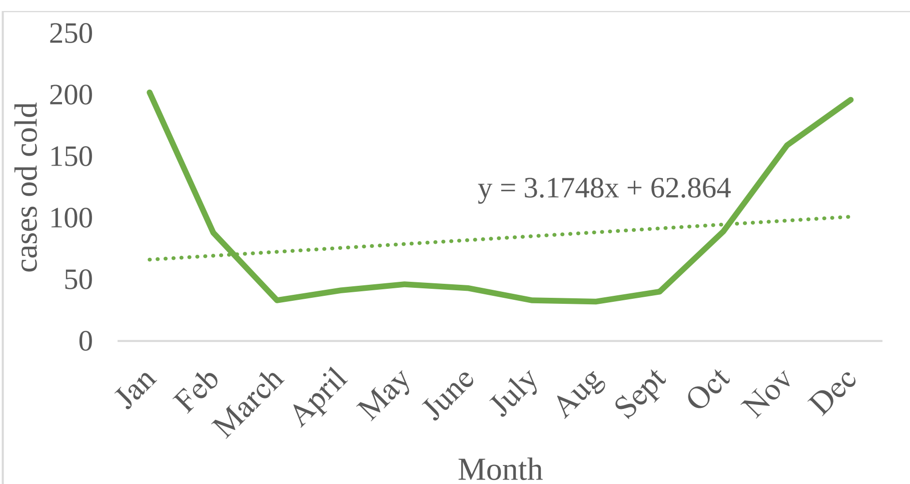

Figure 8: Seasonal pattern of cold in the Study Area

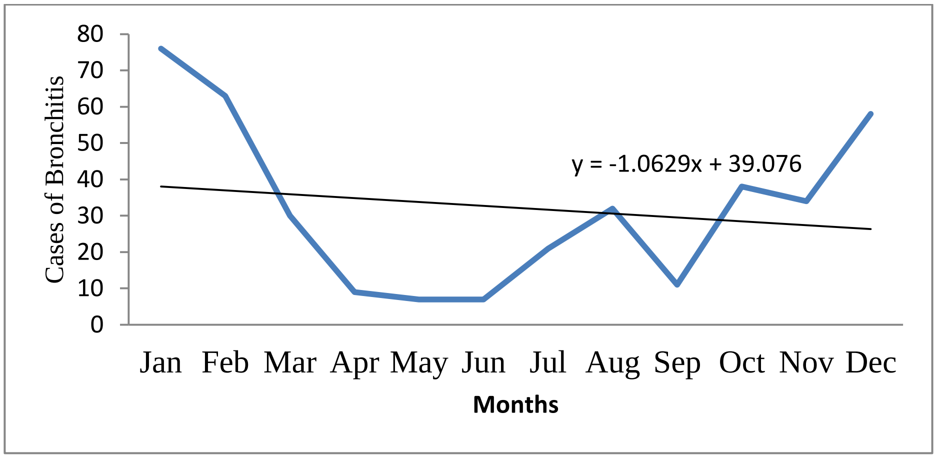

Figure 9: Seasonal pattern of bronchitis in the Study Area

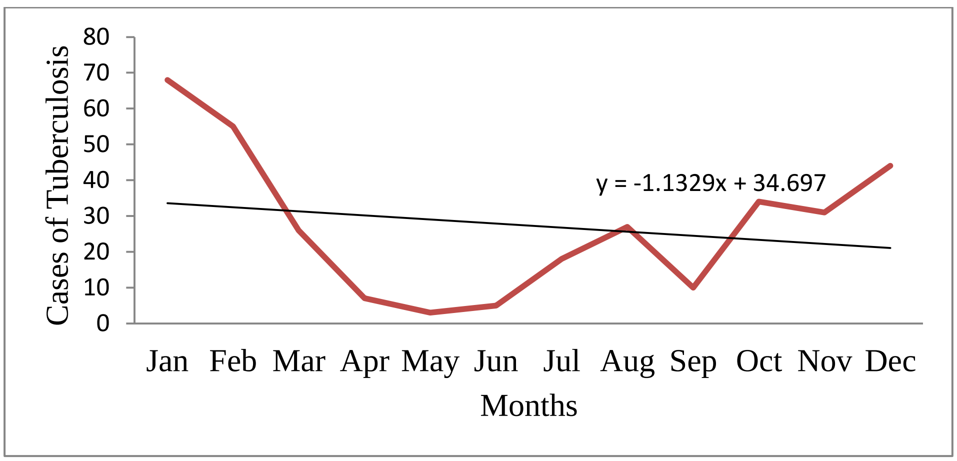

Figure 10: Seasonal pattern of Tuberculosis in the Study Area

Correlation between weather variables and lower RTIs prevalence

Table 3 displayed the correlation coefficients of weather variables and lower respiratory tract infections prevalence at 1% and 5% significant levels. The coefficients values explain strength of relationship among the variables of weather and lower respiratory tract infection.

Table 3: Correlation Coefficients of the Weather Variables and LRTIs Cases

L.R.T.Is	Rainfall	R/Humidity	Max/Temp	Min/Temp	Sun D.
Bronchitis.,	-0.513*	-0.762**	0.042	-0.445	0.362
Cold	-0.610*	-0.675*	0.265	-0.490	0.103
Pneumonia.,	0.754**	-0.519*	-0.704**	0.413	0.018
Catarrh	-0.255	-0.761**	-0.362	0.063	0.428
T/B	-0.509*	-0.774**	0.028	-0.441	0.361

* Correlation is significant at 0.05 (5%) levels two-tail
**Correlation is significant at 0.01 (1%) levels two-tail

The correlation coefficient between bronchitis and rainfall shows strong inverse relationship (-0.513). This value further explains that, increase in rainfall account for decrease in bronchitis prevalence. Absence of rainfall create favorable for pathogen responsible for the proliferation of bronchitis, however, infections have multiple factors responsible for its occurrence. Relative humidity also have inverse relationship with bronchitis, since rainfall and humidity exhibit similar pattern and characteristics. Minimum temperature has weak relationship with bronchitis (-0.445) prevalence. The relationship is not strong but negative, depicting that decrease in minimum temperature does not account for any change in the occurrence of bronchitis. Sunshine duration and maximum temperature have no influence on lower respiratory tract infection in the study area.

The correlation coefficient between cold and rainfall is (-0.610), this denote that rainfall influences cold prevalence inversely. The cases of cold tend to increase after rainfall cessation, which agree with seasonal pattern of cold in figure 8. Relative humidity show strong negative correlation with cold. If rainfall influences cold negatively, it also stand to reason that relative humidity will also influence cold negatively since both show similar pattern as shown in figure 3. Sunshine duration shows weak correlation with cold as portrayed in table 3. Correlation coefficient between cold and minimum temperature show weak negative correlation, the relationship here is not inversely proportional. Other weather variable like maximum temperature has no influence on cold in the study area.

Pneumonia cases shows r- value of (0.754), which implies that rainfall influences pneumonia cases with strong positive correlation. This assertion confirms with the seasonal pattern of pneumonia in figure 6, where we have consecutive cases from July through August. Relative humidity also show (-0.519) negative correlation with pneumonia. This connote the inverse relationship between pneumonia and relative humidity, where we have low humidity from December to February, the cases of pneumonia are prevalence in the study area, as depicted in figure 6. Maximum temperature has strong negative influence on the prevalence of pneumonia in the study area. Other weather variables like minimum temperature have weak relationship with pneumonia, and finally sunshine duration does not influence Pneumonia occurrence.

Relative humidity shows strong negative correlation (-0.761) with catarrh. Relative humidity is very low between January and February where we have high cases of catarrh within that period. Other weather variables underscore here have no influence on catarrh prevalence in the study area. Tuberculosis has strong negative correlation with rainfall (-0.509) and relative humidity (-0.774). These weather relationships buttress the pathogen or bacteria in propagation in their hosts with contribution of other environmental factors. Maximum temperature does not influence TB prevalence as well as sunshine duration. Minimum temperature has weak negative correlation (-0.441) on TB, this reveals that minimum temperature does not influence BT occurrence.

Conclusion

The study concludes the influence of weather on the prevalence of lower respiratory tract infection in the study area. The weather seasonal pattern typically portrayed tropical hinter land, depicting two seasons (wet and dry). Rainfall pattern influences the prevalence of bronchitis, cold, pneumonia, and tuberculosis creating favorable conditions for their proliferations. The pattern of relative humidity exhibit similar characteristics with rainfall, which at the same time influences the occurrence of bronchitis, cold, pneumonia, catarrh and tuberculosis. Maximum and minimum temperature tends to increase from March through May and later drop from July through September and December to January. These pattern influences pneumonia inversely with less influence on bronchitis, cold, catarrh and TB. In epidemiology, there are multiple causes of LRTIs apart from weather conditions, however, some weather conditions do not influence some infections, this is due to other factors, like body immunity, primary healthcare interventions and sanity among others. In the same vein, these underscore conditions determine the relationship between weather condition and lower respiratory tract infection in the study area.

Recommendations

Through the findings of this study, the researcher examined critically to offer the following recommendations:

1. Government should prioritize environmental sanitation by law enforcement agents, where every household should participate making environment clean and safe. Pollution should be avoided at all cost, either, land pollution, water pollution and air pollution.
2. Traditional ways of treating LRTIs should be discouraged through enlightenment campaign during routine immunization programs by primary healthcare workers, and ensure medical checkup on regular basis.
3. Free distributions of face mask in strategic areas like parks, banks, restaurants, lodges and public offices by the owners. More enlightenment on the use of those masks in season of harmattan or in activities that produces dust or related dangerous particles that should not be inhale.
4. People should avoid exposing themselves to harsh weather and other activities that can trigger some lower respiratory infections.

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