

Temperature Variability and Outbreak of Meningitis and Measles in Zaria, Northern Nigeria

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Abstract: Monthly maximum and minimum temperature records and reported cases of Meningitis and Measles in Zaria, Kaduna State for 10 years (1999-2008) were used to determine the influence of temperature on the outbreak of these two diseases. The results show that the reported cases of Meningitis and Measles are highest between March and April when the temperatures are also high. Results of the correlation analysis indicate that the reported cases of these two diseases have positive and significant relationship with temperature. Regression analyses show that about 78.4 and 84.5% of the variations in the occurrence of Meningitis and Measles respectively are accounted for by variations in temperature. The study revealed that the cases of Meningitis and Measles would increase by 6 and 19 persons, respectively for every 1°C increase in temperature. It was found out that the traditional architectural setting of Zaria city also aggravates the effect of temperature in that part of Zaria.

Key words: Diseases, epidemic, measles, meningitis, temperature

INTRODUCTION

Variability in weather and climate has been shown to have an impact on infectious disease outbreak and spread. For example, increase in cases of diarrhea is often associated with extreme flooding events while recent researches link cholera outbreak with warmer temperatures. The outbreak and spread of diseases such as Murray Valley, Encephalitis, Blue Tongue, Rift Valley Fever, African Horse Sickness, Rose River Virus disease and Malaria in various parts of the world have all been associated with variability of climate. The seasonal nature of outbreaks of several human and animal diseases suggests that climate plays an important role in their occurrences. These show that climate anomalies have a demonstrated impact on increased disease transmission.

Proper physiological functioning of the human body is obtainable only within a range of favourable climatic conditions. The body responds to changes in climate. Four climatic elements (Ayoade, 1983) - Solar radiation, air temperature, humidity and wind directly influence the physiological functioning of the human body; but air temperature and humidity are the commonly discussed (Ojo, 1977). Climate in itself influences the incidences of diseases in two major ways. Firstly, it affects the resistance of the human body to some diseases. Secondly, climate influences the growth, propagation and spread of some disease organisms or their vectors.

Malaria, one of the World's most common and serious tropical diseases is responsible for at least one million deaths every year in the world (WHO, 2003)

stated that the burden of malaria is becoming even higher. About 515 million cases of malaria occurred by the end of 2002.

Despite the realization of the influence of climate on the physiological processes in the human body and the outbreak of diseases, Adebayo (2001) noted that very little attention has been directed at studying the actual health implications of climatic variability in Nigeria. Observations have revealed that the outbreak of some epidemic diseases (particularly Meningitis and Measles) in Zaria occur mostly during the hot dry season (February-May). However, the extent to which increase in temperature influences the outbreak of these two air borne diseases has not been investigated. Against this backdrop, this study aims at determining the relationship between the outbreak of Meningitis and Measles in Zaria, northern Nigeria.

Study area: Zaria lies between Latitude 11°03' N and 11°15' N; Longitude 7°30' E and 7°45' E in Kaduna State. Urban Zaria consists of six distinct settlements: Zaria City, Tudun Wada, Sabon Gari, Government Reservation Area, Palladan and Samaru (Fig. 1). It lies on the High Plains of Northern Nigeria at an altitude of about 670 m above sea level. It is situated within the northern Guinea Savanna. Like any other town in northern Nigeria, Zaria experiences distinct wet and dry seasons. The wet season (May-October) is characterized by convectional rainfall that is followed by intense thunderstorms and lightening. The mean annual rainfall is about 1000 mm. The average Maximum and Minimum temperature, Rainfall and

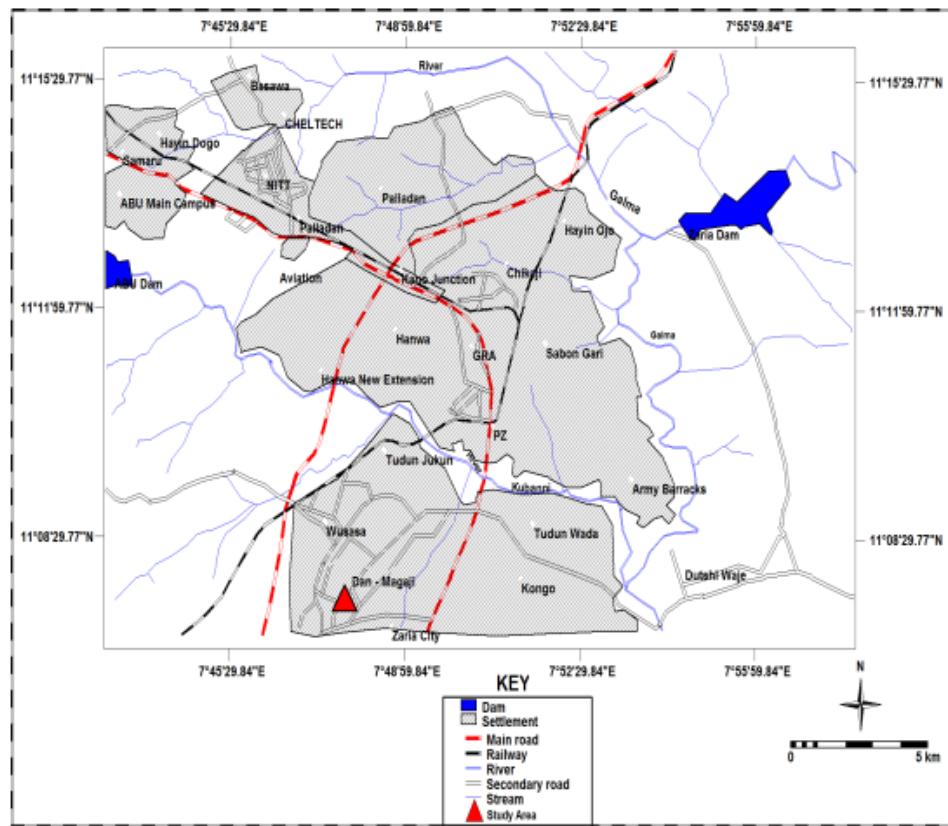


Fig.1: Part of Zaria showing location of study area

Table 1: Mean Climatic Conditions at Zaria (1999 – 2008)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max. Temp. °C	28.7	38.5	40.9	43.0	40.1	32.6	30.2	31.0	31.7	33.2	32.4	30.4
Min. Temp. °C	13.7	19.5	22.5	24.0	22.4	21.0	20.9	20.1	20.3	18.5	14.1	13.6
Rainfall (mm)	0.00	0.00	0.00	63.1	113.1	160.2	152.0	235.5	110.2	16.8	0.00	0.00
Humidity (%)	20	20.5	23.0	40.5	68	78.4	83.0	85.0	75.2	57.1	24.0	16.8

Relative Humidity during the period of study are given in Table 1. The dry season (November - April) is characterized by a period of low temperatures (December–February) - this is the harmattan season; and the hot dry season (March - April) where temperatures are as high as 32°C . Relative humidity is high only during the rainy season, but drops during the dry season.

MATERIALS AND METHODS

Monthly maximum and minimum temperature records for 10 years (1999-2008) were sourced from the Meteorological Unit of the Nigerian College of Aviation Technology (NCAT), Zaria. Records of patients (both inpatients and outpatients) treated for Meningitis and Measles from Zaria Local Government Area for 10 years (1999-2008) were obtained from two hospitals: Ahmadu Bello University Teaching Hospital (ABUTH) Shika, and

the Gambo Sawaba Hospital, Kofan Gayan, Zaria. The period 1999-2008 is used because this is the longest period with continuous record of patients treated for meningitis and measles the area.

Daily maximum and minimum temperature data were used to obtain the mean monthly maximum and minimum records. Daily number of both inpatients and outpatients treated for Meningitis and Measles within the study period were summed up to give the total number of patients treated for the two diseases for each month. Each month's record was expressed as a percentage of the total annual incidence of each disease. A linear graph of the two diseases and temperature were drawn to show disparities in the outbreak of the diseases. Finally, in order to determine the statistical relationship between temperature variability and outbreak of the two diseases, bivariate correlation analysis was used. Regression analysis was used to determine how much of the variation

Table 2: Monthly Distribution of Reported Cases of Meningitis and Measles in Zaria Local Government Area (1999 – 2008)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Meningitis	28 (3.3)	97 (11.4)	279 (32.8)	144 (16.9)	58 (6.8)	50 (5.9)	23 (2.7)	56 (6.6)	36 (4.2)	14 (1.6)	32 (3.8)	34 (4.0)
Measles	35 (2.0)	115 (6.6)	685 (39.3)	452 (25.9)	100 (5.7)	68 (3.9)	29 (1.7)	41 (2.4)	57 (3.3)	42 (2.4)	65 (3.7)	55 (3.2)

Table 3: Correlation and Regression of Temperature with Reported Cases of Meningitis and Measles in Zaria

Disease	Correlation coefficient (r)	Coefficient of determination (R^2)	Regression equation
Meningitis	0.784	0.67	$Y = 72.3 + 6.24x$
Measles	0.835	0.88	$Y = 38.5 + 18.55x$

$r \geq 0.65$ is significant at 0.05%

in the outbreak of the Meningitis and Measles is accounted for by temperature variability.

RESULTS AND DISCUSSION

The mean climatic conditions at Zaria for the 10 years are given in Table 1. From Table 1, it is seen that there is a gradual increase in maximum temperature from January and reaches a peak in April (40°C), then drops to a minimum again in January (28°C). November to March is the dry season at Zaria when there is virtually no rainfall. The rainy season starts in April and ends in October with mean peak rainfall in August of about 235.5 mm. Relative humidity is very low during the dry season (November-March) but increases gradually from April (40.5%) to a peak in August (85.0%) and drops again to 57.1% in October. This shows that the period of high humidity does not coincide with the period of high temperature at Zaria. A linear graph of Maximum temperature, Meningitis and Measles is presented in Fig. 2.

From Fig. 2, it is seen that the highest number of patients treated for Meningitis and Measles coincide with the period of peak maximum temperatures (February - April). The peak of all the three variables is in March. The reported cases drop sharply in May due to onset of the rainy season and consequent decrease in temperatures up to January. The monthly frequencies of reported cases of the two diseases are presented in Table 2.

From Table 2, it is observed that the distribution pattern of the outbreak of the two diseases is very similar. There is a drastic increase in the number of reported cases of Meningitis from January to April (period of dry season when temperatures are high). The month of March has the peak of outbreak of Meningitis then there is a gradual decrease in the number of cases from May to December (period of warm rainy season and cold dry harmattan). It is observed that about 60% of the total number of reported cases of Meningitis occurred between February and April (the hottest period). This finding corroborates the assertion by Barbour (1982) that two thirds of the reported cases of Meningitis in Nigeria occur within just three months (February, March and April).

Table 2 shows that the peak period of the outbreak of Measles in Zaria is also in the month of March when

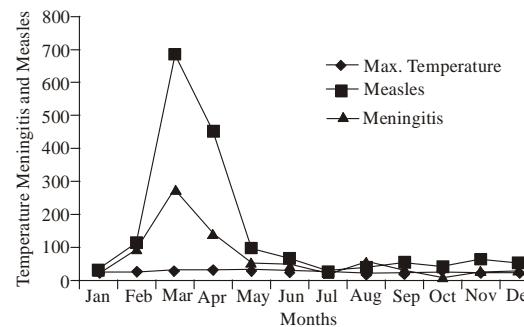


Fig. 2: Monthly variability of maximum temperature, meningitis and measles in Zaria

temperatures are high. However, Measles outbreak is more rampant during the hot dry season (February and May). There is, however a gradual decline in the number of reported cases from June to October. It is worthy to note here that Barbour's (1982) assertion is confirmed by this study since about 70% of the reported cases of Measles occurred within only three months (February - April). This observation points to the fact that the outbreak of Measles is very much influenced by high temperatures. The statistical relationship between the reported cases of outbreak of Meningitis and Measles is presented in Table 3.

Table 3 shows that both Meningitis and Measles have high positive and significant correlations with temperature (78.4%) and (83.5% respectively at 0.01 level of significance. This implies that the higher the temperature, the higher the incidence of Meningitis and Measles outbreak. This finding is in agreement with Adebayo (2001) for his similar study at Yola. Table 3 also shows that about 67% of the variations in the incidence of outbreak of Meningitis is accounted for by temperature variability. It is observed from Table 3 also that about 83.5% of the variations in the occurrence of Measles is due to temperature variability. This result suggests that high temperatures do trigger the outbreak of Meningitis and Measles in Zaria as the higher incidence of reported cases occur during periods of high temperatures (February - April) in the region.

The regression equations in the fourth column of Table 3 suggest that the cases of Meningitis and Measles

would increase by 6.24 and 18.55, respectively for every 1°C increase in temperature at Zaria. This further expatiates the earlier statement that increase in temperature greatly influences the incidence and increase in cases of Meningitis and Measles.

The outbreak of Meningitis and Measles could also be aggravated by some other observed conditions such as overcrowding in houses, poor ventilation, poor building and street layouts in the study area. The observations of Adebayo (2001) for Yola are also applicable to Zaria. The architectural plan of houses in Zaria reflects the religion and culture of the people. The need for security and privacy strongly determine the pattern and layout of buildings, especially among the Moslems who practice purdah (segregation and seclusion of married women). The basic structure is an enclosed compound divided into compartments of single rooms with individual accessibility and privacy but all open into a common courtyard. The individual rooms are poorly ventilated as they only have windows facing into the courtyard but not outside; and the walls are so high that they prevent proper ventilation. Moreover, in most the cities, the major streets are not laid parallel to the predominant wind (Adebayo, 1987). High occupancy ratio also prevails in the study area but particularly in Zaria City. This agrees with Makama (1997) that in a room, there are between 3 and 6 occupants. All these conditions tend to aggravate the effect of high temperature on outbreaks of Meningitis and Measles in Zaria.

CONCLUSION

Results of this analysis have shown that peak cases of Meningitis and Measles outbreak in Zaria is in March and that increase in temperature has a significant influence on the outbreak of these two air borne diseases. This is further aggravated by poor ventilation in the buildings as a result of inadequate window provisions for proper cross ventilation.

To minimize the effect high temperature, individuals who own houses, the Government and Non-governmental organizations should embark on greening of Zaria by planting more trees around the buildings and in open spaces.

Buildings should have standard window sizes to ensure proper cross ventilation. The Kaduna State Urban Planning Development Authority that approves building plans should discourage the traditional architecture with small undersize windows; also ensure that all buildings are properly oriented. High walled fences that are sometimes higher than the buildings themselves should be discouraged since the walls not only prevent proper wind flow but also store heat during the day and release it at night.

Finally, since street layout affects intra urban circulation of air, it is recommended that the direction of wind should be taken into consideration in the planning of new streets so that major streets are laid parallel to the direction of the prevailing wind.

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