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DETERMINATION OF SEASONAL CLIMATIC ELEMENTS INFLUENCING THE PREVALENCE OF MEASLES AND MALARIA IN URBAN KATSINA, KATSINA STATE, NIGERIA

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ABSTRACT
The study examines the critical climatic elements that influence the prevalence of malaria and measles in Urban Katsina. The data used for this study were from secondary sources, including climatic variables obtained from NiMet at Umar Musa Yar'adua Airport, Katsina, malaria and measles data obtained from General Hospital Katsina and Federal Medical Center (FMC) Katsina, spanning 2012 to 2022. The data were analysed using the Stepwise Regression Model (SRM) to determine the key climatic elements that affect the occurrence of measles and malaria in each season. The findings indicate that the January maximum temperature (p-value = 0.056) significantly influences measles during the cold and dry season. April humidity (p-value = 0.046) significantly influences malaria during the hot and dry Season. June and August maximum temperature, September minimum temperature, September wind speed, and rainfall significantly influence malaria during the warm and wet season, with the following values: p-value = 0.017, 0.004, 0.003, 0.003, and 0.031, respectively, and August humidity and wind speed significantly influence measles prevalence during the warm and wet season with p-values of 0.010 and 0.013, respectively. The study concludes that temperature is the most critical climatic factor influencing disease prevalence across all four seasons. The findings recommend educating the public about the climatic factors that influence malaria and measles in each season to support prevention and control.

Keywords: Disease, Humidity, Rainfall, Season, Temperature, Wind speed

1 INTRODUCTION

Climatic variability and seasonality play a significant role in the spatiotemporal distribution of diseases. Malaria and measles are diseases that are sensitive to climate variability. They spread through vectors and cause diseases sensitive to climate variables, especially temperature, relative humidity, and wind speed. The distribution of malaria is determined by climatic and other geographic factors that affect vector mosquitoes and *Plasmodium* reproduction (Brooker *et al.,* 2015). Measles is a contagious disease caused by the measles virus with a prodromal illness characterized by fever, fatigue, coryza, and cough before the onset of rash (Alhaji & Nasir, 2019). Measles is transmitted through direct contact with an infected person or droplet exposure, and is only reactive to humans. Measles is a prevalent acute respiratory infectious disease in children caused by the measles virus, which is transmitted through respiratory droplets and through direct and indirect contact between individuals (Kutter, Spronken, Fraaij, Fouchier, & Herfst, 2018).

Moss & Griffin (2012) found that climatic factors partly underlie the seasonality of measles virus infections. Yang (2014) also found that, in temperate climates, measles outbreaks typically occur in the late winter and early spring each year. In contrast, in the tropics, measles outbreaks are irregularly associated with rainy seasons. Jia (2023) notes that meteorological conditions vary across regions, and multiple weather factors influence the measles virus.

The virulence and survival of the measles virus in the air are mainly influenced by temperature and relative humidity (Yang, 2014). De (1965) found that high temperature influences the survival of measles virus, and measles virus might survive slightly better at low temperature, while its activity might decrease. De & Winkler (1964) revealed that the survival of the measles virus is remarkably dependent on relative humidity, and the virus survives well at low relative humidity. According to the Federal Ministry of Health [FMH] (2001), in Nigeria, malaria remains a pervasive health issue, affecting over 50% of the population annually and accounting for 45% of outpatient visits.

Malaria is a significant public health problem in Nigeria (Akinbobola & Hamisu 2022). Malaria is the most prevalent disease in Katsina state (Dauda *et al.,* 2011). Malaria is endemic in Katsina state with all-year-round transmission. Katsina State Ministry of Health (2013) reported that, within 28 days, malaria killed 401 people out of 50,311 cases recorded during the 2012 flood.

Measles disease remains one of the leading causes of death among young children. In 2017, an estimated 110,000 measles deaths occurred globally, mostly among children under the age of five (Faruk, *et al*., 2020). Many children have died as a result of the measles outbreak in Katsina urban in recent years. Based on the above, this study seeks to investigate the climatic factors influencing the prevalence of malaria and measles in urban Katsina.

2 MATERIALS AND METHODS

2.1 Study Area

Urban Katsina is located between Latitude 12°58′ 0″N and 13° 4′00″N and Longitude 7°34′ 0″E and 7° 40′ 0″. It shares borders with Batagarawa LGA to the South, Jibia LGA to the West, and Kaita LGA to the North Figure 1, (Abaje and Ogoh, 2018).

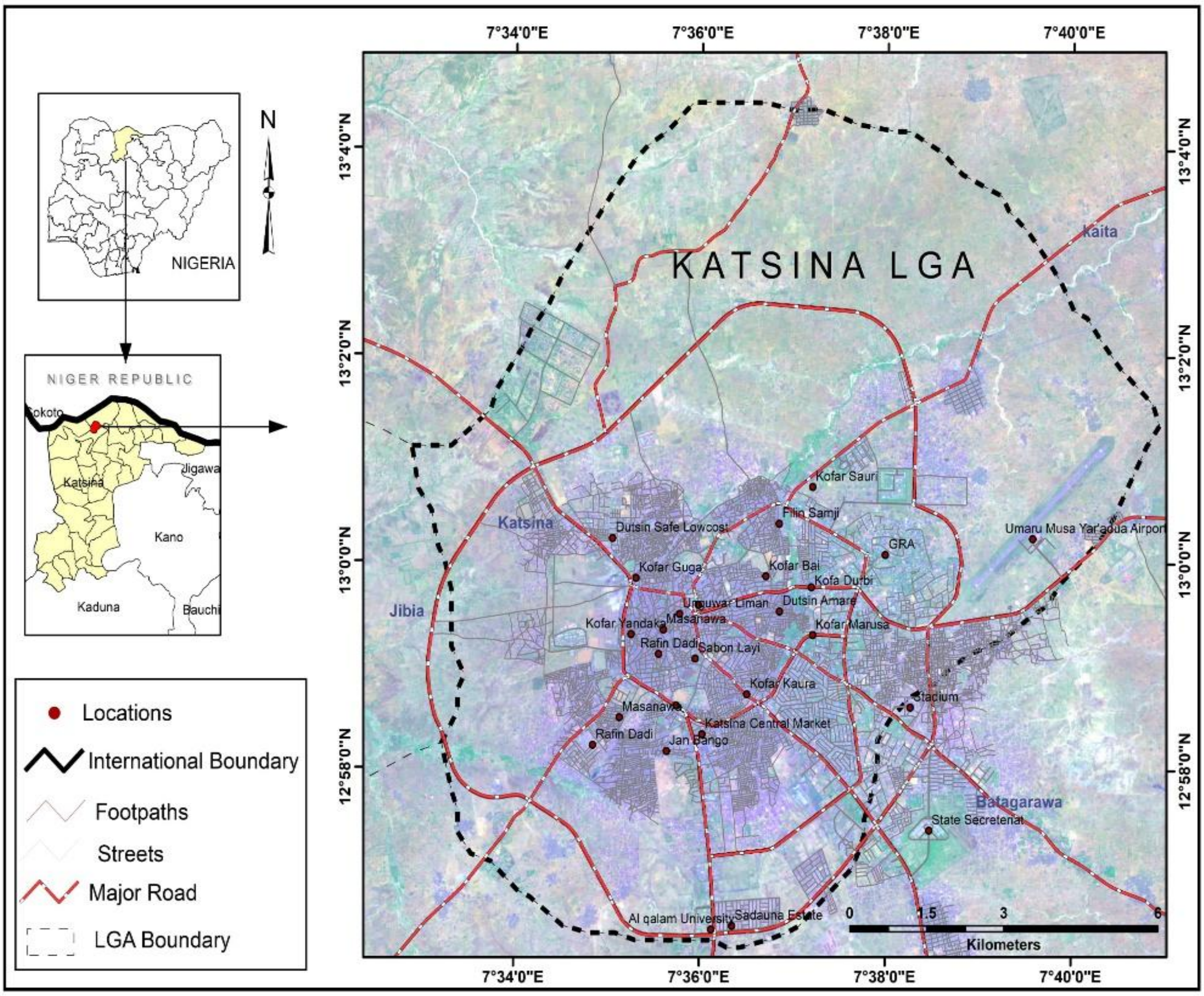

Figure 1: Study Area
Source: Katsina State Ministry of Land and Survey (2024).

The climate of this area is tropical wet/dry, classified as Köppen Aw (Köppen 1936). It has an annual rainfall of about 550-700mm (Abaje et al., 2017). Seasonal variation in rainfall is directly influenced by the interaction of two air masses: the relative warm and moist tropical maritime (mT) air mass, which originates from the Atlantic Ocean associated with southwest winds in Nigeria; and the relatively cold, dry and stable tropical continental (cT) air mass that originates from the Sahara Desert and is associated with the dry, cold and dusty North-East Trades known as the Harmattan (Abaje, 2023). The temperatures are always high. The highest air temperature is about 38 °C - 40 °C in some areas and typically occurs in April/May, while the lowest temperature occurs in December through February. Evapotranspiration is generally high throughout the year. The highest evaporation occurs during the dry season (Abaje et al., 2017; Abaje, 2023).

Katsina town lies within the Sudan savannah zone, but Sahel encroachment occurs in small pockets across some areas of the State. The trees have long taproots and thick bark, which enable them to withstand the long dry season and bushfire incidents, which are generally short, ranging from 3 – 8 meters high, with narrow leaves; some leaves are broader, while others are smaller. The trees include various acacias, neem trees, and eucalypts, among the exotic species found in the State. It is essential to consider the role of humans and their animals in modifying vegetation in this area (Abaje, 2007; Tukur & Abdulkarim, 2013).

The inhabitants of the study area are predominantly Hausa, but a considerable number of Fulanis have also settled there. Most of the people who settled were cultivators and traders. A sizeable number of migrants from villages and other States are found there, and they also dwell there (El-Ladan, 2017).

2.2 Data Collection

Secondary data were used for the study; the required data include climatic and disease data, including malaria and measles. The data were sourced from the Nigerian Meteorological Agency (NiMet) at Umaru Musa Yar'adua International Airport Katsina where climatic data (maximum and minimum temperature, humidity, wind and rainfall) for urban Katsina was collected on monthly basis from the year 2012 to 2022, and Federal Medical Center (FMC) Katsina and General Hospital Katsina (GHK) where the data on malaria from 2014 to 2021, and measles from year 2012 to 2022 where obtained.

2.3 Data Analysis

Stepwise regression analysis was used to determine the critical climatic variable that influences the occurrence of diseases in the four (4) distinct seasons (dry and cool season, dry and hot season, wet and warm season, and dry and warm season). The stepwise regression equation having more than two explanatory factors is given below:

$$Y = \beta o + \beta_1 Rain + \beta_2\ Min.Temp. + \beta_3\ Max.\ Temp + \beta_4\ Rel.\ Hum + \beta_5\ Wind\ speed \ldots + \beta_n X_n$$

where: Y = Malaria and measles
β_1= Rainfall
β_2 = Minimum temperature
β_3 = Maximum temperature
β_4 = Relative humidity
β_5 = Wind Speed

3 RESULTS AND DISCUSSION

3.1 Climatic Variables Influencing Malaria and Measles during Cold and Dry Seasons

The critical climatic variables that influence malaria during the cold and dry seasons are presented in Table 1. About 92% change in malaria was attributed to the critical climatic variable identified during the season in the study area. The climatic variables that were critical to malaria incidence were December Maximum Temperature (DMT), January Maximum Temperature (JMT), and December Wind Speed (DWS). These climatic variables were positive and not significant at 95% confidence level. A unit increase in any of the climatic parameters will lead to an increase in malaria prevalence during the cold and dry seasons in Katsina town.

Table 1: Climatic Variables Influencing Malaria and Measles during Cold and Dry Season

R^2 = 0.92				R^2 = 0.57
Diseases	**Climatic Variable**	**β**	**T**	**Sig.**
	December Maximum Temperature	0.201	0.486	0.097
Malaria	January Maximum Temperature	0.088	0.397	0.075
	December Wind Speed	0.523	0.141	0.078
Measles	December Maximum Temperature	0.766	0.499	0.077
	January Maximum Temperature	0.098	0.011	0.056**

**Significant at 95% confidence level

The climatic variables that were most strongly associated with measles prevalence were DMT and JMT (Table 1). About 57% change in measles was attributed to the critical climatic variable identified during the season in the study area. The variable was all positive, DMT was not significant at 95% confidence level, and JMT was significant at 5% (Table 1). A unit increase in any of these variables will increase the prevalence of measles during the cold and dry seasons in urban Katsina.

During the cold and dry seasons, the maximum temperatures in December and January, and the December wind speed, were the critical climatic elements that influenced the prevalence of malaria in urban Katsina. This does not mean that other climatic elements were not effective in determining malaria prevalence during the season; the three (3) mentioned were the key elements. The maximum temperature determines the temperature required for mosquito development, transmission intensity, mosquito biting rate, and the survival of the malaria parasite. The effect of wind speed on malaria transmission reduced malaria incidence by killing many mosquitoes and displacing them. High temperature influences the survival of the measles virus and its transmission. This result contradicts the fact that temperature is inversely associated with measles (Yan, 2023).

3.2 Climatic Variables Influencing Malaria and Measles during Hot and Dry Seasons

The climatic variable that is critical to malaria and measles during Hot and Dry Seasons (HDS) is presented in Table 2. About 97% change in malaria was attributed to the critical climatic variable identified during the season in the study area. The climatic variable critical to malaria during the HDS was April Humidity, which showed a positive relationship and was significant at the 95% confidence level. This result contradicts the findings of Yang et al. (2014), who found out that humidity inversely associated with measles incidence, while Gobak, (2025) observed measles is prevalence from January to May.

Table 2: Critical Climatic Influencing Malaria and Measles during the Hot and Dry Season

R^2 = 0.97				**R^2** = 0.93
Diseases	**Climatic Variable**	**β**	**t**	**Sig.**
Malaria	April Humidity	0.219	0.422	0.046**
Measles	March Maximum Temperature	1.760	7.440	0.085
	March Wind Speed	2.039	6.748	0.094

**Significant at 95% confidence level

The climatic variables that influence the prevalence of measles in Katsina town during the HDS were March Maximum Temperature (MMT) and March Wind Speed (MWS). About 93% change in measles was attributed to the critical climatic variable identified during the season in the study area (Table 2). Any unit increase in MMT and MWS is associated with an increased prevalence of measles in the study area. April humidity helps maintain the status of the malaria parasite. The March maximum temperature influences the survival of the measles virus in the study area. Akinbobola & Hamisu (2018) reported that measles incidence is more prevalent in the hot and dry season and the dry and cool season, while Alhaji and Nasir (2019) reported that measles occurred more during the hot and dry seasons.

3.3 Climatic Factors Influencing Malaria and Measles during Warm and Wet Seasons

During Warm Wet Seasons (WMS), the climatic parameters that were critical to malaria prevalence were: June Maximum Temperature (JMT), August Maximum Temperature (AMT), September Minimum Temperature (SMT), September Wind Speed (SWS), and September Rainfall (SR) (Table 3). About 97% of the change in malaria can be attributed to the critical climatic variable identified in the study. The parameters that were significant at 1% were JMT, AMT, SMT, SWS, and SR. An increase in any of the five (5) climatic parameters will lead to a rise in malaria prevalence in Katsina town during the warm, wet season. This result agrees with the findings of Dahiru, Abaje & Ati (2025) that any increase in the mean temperature will increase measles cases in Urban Katsina.

During the warm and wet season, many factors influenced the prevalence of malaria. The maximum temperature maintained parasite survival, which was supported by humidity and rainfall; wind speed aided the movement of mosquitoes from one location to another. The maximum temperatures observed in July and August support the virus's survival; August humidity helps conserve the virus's natural state; and August wind speed aids its transmission. The mentioned climatic variables facilitate the spread of measles fever in urban Katsina during the warm and wet season. This result is inline with Alhaji & Nasir (2019) and Dahiru *et al.* (2025), who reported that rainfall influenced the prevalence of measles.

Table 3: Critical Climatic Influencing Malaria and Measles during Warm Wet Season

R^2 = 0.976				**R^2** = 0.71
Diseases	**Climatic Variable**	**β**	**t**	**Sig.**
Malaria	June Maximum Temperature	0.086	0.383	0.017**
	July Humidity	0.095	0.390	0.063
	August Maximum Temperature	0.468	2.439	0.004**
	September Minimum Temperature	1.020	7.680	0.003**
	August Humidity	1.255	8.821	0.005
	September Wind Speed	1.954	3.983	0.003**
	September Rainfall			
		0.033	0.091	0.031**
Measles	July Maximum Temperature	0.636	1.025	0.094
	August Minimum Temperature	0.743	1.113	0.061
	August Humidity	0.783	1.333	0.010**
	August Wind Speed	0.936	1.864	0.013**

**Significant at 95% confidence level

The climatic variables that were critical during warm wet seasons for measles were August Humidity (AH) and August Wind Speed (AWS). The AH and AWS were significant at 5%, about 71% change in measles can be attributed to the critical climatic variable identified in the study (Table 3). A unit increase in either of the two (2) climatic parameters will lead to an increase in measles prevalence in Katsina town during the warm, wet season. This results is in related Gobak (2025) who found that a unit increase in relative humidity was associated with a higher malaria incidence and Kama, Marcus, Hembe, & Yisa (2024) also reported that malaria incidence was notably higher during the rainy season.

The minimum temperature in the month of October maintained the survival of the malaria parasite because, around October, cloud cover is lower; therefore, the minimum temperature can provide the required temperature. This finding is in accordance with Gobak (2025) who observed an increase in minimum temperatures, suggesting a possible rise in malaria incidence, especially during the warm and wet season. The October rainfall provides available moisture for mosquito breeding in urban Katsina. This result implies that the identified weather variables support the virulence and survival of the measles virus in the air during the warm and wet season. Because of the high temperatures in Katsina town during the season, the measles virus survives better than in seasons with lower temperatures.

3.4 Climatic Factors Influencing Malaria and Measles during Warm and Dry Season

During the warm and dry seasons, October Minimum Temperature (OMT) and October Rainfall (OR) were the critical climatic elements that influenced the prevalence of malaria in the urban Katsina (Table 4). About 91% of the change in malaria can be attributed to the critical climatic factor identified during the study seasons. Neither of the two (2) elements was significant at 95% confidence level; a unit increase in these variables will lead to a rise in the occurrence of malaria in the study area. Both the October minimum temperature and October rainfall were nonlinearly associated with malaria incidence in urban Katsina. The dangerous temperature range was 31 °C to 40 ºC. This result contradict the findings of Ali & Hagos (2025) whom reported that minimum temperature patterns revealed a statistically significant positive association with malaria prevalence, every unit increase in minimum temperature, the risk of malaria increases by 7.9%. Warmer minimum temperatures accelerate the life cycle of Plasmodium parasites within the mosquito vector, leading to increased transmission probability in urban highland Ethiopia. The outcome of this study relate with Duque et al., (2022) rainfall did not significantly contribute to malaria prevalence in in Zambia.

Table 4: Critical Climatic Influencing Malaria and Measles during Warm Dry Seasons

R^2 = 0.914				**R^2** = 0.844
Diseases	**Climatic Variable**	**β**	**t**	**Sig.**
Malaria	October Minimum Temperature	0.834	7.274	0.087
	October Rainfall	1.831	9.222	0.069
Measles	November Minimum Temperature	3.015	1.467	0.081

**Significant at 95% confidence level

The critical climatic factor influencing measles prevalence during the warm, dry season is minimum temperature, which was not significant at the 95% confidence level (Table 4). About 84% change in measles can be attributed to the critical climatic element identified during the seasons in the study. A unit increase in the climatic element will lead to measles outbreaks in the study area.

These climatic variables (October and November minimum temperatures) provide the temperatures required for the parasite to survive, and rainfall provides the moisture for it to propagate within the area during the season. Increases in maximum temperature indicate possible increases in measles cases (Gobak, 2025).

4 CONCLUSION

Temperature is the most critical climatic factor influencing disease prevalence throughout the year. Both hot and cold temperatures affect the occurrence of both measles and malaria. Humidity is a risk factor for measles, and it is most prevalent before and after cold spells. Wind speed influences disease occurrence only during warm and wet seasons.

5 RECOMMENDATIONS

The study recommends minimizing activities that raise temperatures and enforcing measures to regulate them. The public should be educated about the climatic factors that influence malaria and measles in each season to support prevention and control.

REFERENCES

Abaje I.B., Onu V., Abashiya M., Oyatayo K.K., Ibrahim A.A., Ati O.F., & Sawa, B.A., (2017). Climate Change Vulnerability Assessment in the Northern Part of Katsina

State, Nigeria: A Quantitative Approach. *Dutse Journal of Pure and Applied Sciences (DUJOPAS) 3* (1), 23-32.

Abaje, I.B. (2007). *Introduction to Soils and Vegetation*. Kafanchan: Personal Touch Productions, ISBN: 978-073-102-4

Abaje, I.B. (2023). Geo-Statistical Analysis of Meteorological Drought and Recurrence Intervals in the Context of Climate Change Over Extreme Northeastern Region of Nigeria. *Tanzania Journal of Science,* 49 (1), 152–166. DOI: https://dx.doi.org/10.4314/tjs.v49i1.14

Abaje, I.B. & Ogoh, A.O. (2018). Rainfall Trends and Occurrence of Floods in Katsina State: Implications for Infrastructural Development. *Osun Geographical Review,* 1, 78-89

Akinbobola, A., & Hamisu, A.S. (2018). Predicting Measles Occurrence Using Some Weather Variables in Kano, North-western Nigeria. *American Journal of Public Health Research*, 6 (4), 95-202.

Alhaji, M. & Nasir, A. (2019). Impact of Climatic Variables on the Prevalence of Measles in Wudil Local Government, Kano State, Nigeria. Iconic *Research and Engineering Journals 3*(4), 113-115.

Ali, M. S., & Hagos, Z. (2025). Climatic and environmental determinants of malaria prevalence in urban highland Ethiopia (2019 - 2023). *The Intergovernmental Research and Policy Journal(IRPJ),*10(10),1-13. https://doi.org/10.5281/zenodo.17357946

Brooker, S. L.T., Kolaczinski, K., Mohsen, E., Mehboob, N., Saleheen, S., Khudonazarov, J., Freeman, T., Clements, A., Rowland, M., & Kolaczinski, J. (2015). Spatial Epidemiology of Plasmodium vivax, Afghanistan. *Emer Infect Dis*, ;12(10), 600-2.

Dahiru, S., Abaje, I.B. & Ati, O.F. (2025). Relationship between Climatic Parameters and the Occurrence of Malaria and Measles in Urban Katsina, Katsina State, Nigeria. *Bima Journal of Science and Technology,* 8 (4B), 260-270. Published by the Faculty of Science, Gombe State University (GSU), Gombe, Nigeria. Available online at https://journals.gjbeacademia.com/index.php/bimajst/article/view/1202/1038. DOI: https://doi.org/10.56892/bima.v8i4B.1202

Dauda, U., Gulumbe, S.U., Yakubu, M. & Ibrahim, L.K. (2011). Monitoring of Infectious Diseases in Katsina and Daura Zones of Katsina State: A Clustering Analysis *Nigerian Journal of Basic and Applied Science* 19 (1),b31- 42.

De, J.G. (1965). *The survival of measles virus in air, in relation to the epidemiology of measles.* Arch Gesamte Virusforsch 1965; 16:97-102; PMID:14322937; http://dx.doi.org/10.1007/BF01253797

De, Jong, J.G., & Winkler, K.C., (1965). Survival of measles virus in air. Nature 1964; 201,1054-5; PMID:14191599; http://dx.doi.org/10.1038/2011054a0

Duque,C.Lubinda,M., Matoba,J., Sing'anga,C., Stevenson,J. Shields,T. and Shiff,C.J.(2022). Impact of aerial humidity on seasonal malaria: an ecological study in Zambia. *Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations*.1-12

El-Ladan, I.Y. (2017). Peasant Farmers Adaptation Strategies to Coping with Climate change in Jibia Northwest Katsina, Nigeria. *British Jouurnal of Applied Scienc and Technology* 20(2), 1-10..

Federal Ministry of Health FMH, (2009). *Strategic plan 2009-2013 "A road map for malaria control in Nigeria.* Nigeria and national malaria control programme (NMCP), Abuja, Nigeria.17

Gobak,K.H., (2025). Influence of Climatic Elements on the Incidence of Malaria, Measles, Meningitis, and Pneumonia in the Federal Capital Territory (FCT). *African Journal of Geographical Sciences (AJGS)* 6(1 & 2), (ISSN: 2786-9741; EISSN: 3043-6656):79 – 85.

Jia,Y., Xu,Q., Zhu, Y., Li,C., Qi,C., She, K., Liu,T., Zhang,Y., & Li,X.(2023). *Estimation of the relationship between meteorological factors and measles using spatiotemporal Bayesian model in Shandong Province, China*. BMC Public Health https://doi.org/10.1186/s12889-023-16350-96.

Katsina State Ministry of Health (2013*). Report on Diseases Prevalence in the Year 2012. Disease control Unit*.; 17-23.

Köppen, W. (1936). *Das Geographische System der Klimate, Handbuch der Klimatologie (The Geographical System of the Climate, Handbook of Climatology).* Borntraeger, Berlin, Bd. 1, Teil. C.

Kutter,J.S., Spronken, M.I., Fraaij, P.L., Fouchier, R., & Herfst, S. (2018).Transmis sion routes of respiratory viruses among humans. Curr Opin Virol.;28:142-51

Moss, W.J., & Griffin, D.E., (2012). Measles. Lancet; 379:153-64; PMID:21855993; org/10.1016/S0140-6736(10)62352-5 1110 http://dx.doi 19 - 23.

Tukur, R. (2010). *An Assessment of Domestic the Access, the use and the management of trees and shrubs in the Semi-urban fringe of Dutsin-Ma Area Katsina State*. Unpublished MSc. Thesis, Department of Geography Bayero University Kano 37-42

Yang,Q., Fu,C. Wang,N., Dong,Z., Hu,W., & Wang,M., (2014). The effects of weather conditions on measles incidence in Guangzhou, Southern China, Human Vaccines and *Immunotherapeutics*, 10:4, 1104-1110, DOI: 10.4161/hv.27826