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RESEARCH ARTICLE

SEASONAL TIMING, MALARIA MORBIDITY AND CONTROL IN TARABA STATE, NIGERIA

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ABSTRACT

This study investigated the effects of season on malaria parasite prevalence, morbidity in Taraba state, Nigeria. Using a retrospective study design, the study relied on secondary data obtained from Meteorological Station Taraba State and Health facilities from 2005 2014. The research findings showed that season greatly influence malaria transmission. Rainfall plays an important role in the distribution and maintenance of breeding sites for the mosquito vector. The mean rainfall from 2005-2014 were 1885.80mm, per 1000 mean malaria morbidity was 228.90. Years with peak malaria morbidities (years 2006, 2011 and 2014) had least annual rainfalls (1488.20-1677.00mm). Monthly malaria morbidity had a significantly negative linear relationship with rainfall (r = - 0.827, p 0.001). Malaria morbidity for the decade increased at rates 0.298%.This study provide information on the malaria situation in Taraba State which will be useful to the National Malaria Control Programs and publichealth service providers in formulating policies that may promote the mitigation of malaria in Taraba State, Nigeria.

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INTRODUCTION

Malaria is the leading cause of morbidity in Nigeria; Four *Plasmodium* species have been well known to cause human malaria namely, *P. falciparum, P. vivax, P. ovale, and P. malariae.* A fifth one, *P. knowlesi,* has been recently documented to cause human infections in many countries of South East Asia (Danesver *et al*., 2009). With the new move towards malaria eradication (Roberts and Enserink, 2007) and the scaling-up of malaria control interventions, there is a renewed energy and drive to maximize the impact of control tools in each epidemiological context. Where malaria transmission is seasonal, optimal timing of control becomes particularly important. Knowing the duration, start and end of the malaria transmission season is important in terms of planning control strategies. To date, several attempts have been made to describe the seasonality of malaria endemic areas such as the Climate and Malaria Resource Room (CMRR) (2009) and Mapping Malaria Risk for Africa (MARA) collaboration (2007). This Research aims to present a simple method for describing the seasonality of malaria disease in a given site, to assist policy makers in deciding when and where malaria interventions should be delivered.

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MATERIALS AND METHODS

Study area

The study area is Taraba State; Taraba is located in north- east geopolitical zone of Nigeria; Taraba state covers an area of 60,291.8 square kilometers and lies at latitude 8° 00' north and longitude 10° 30' east. It has a population of approximately 2,300,736 (2006 census) and a population density of 27 people per square kilometer. The state accounts for 1.6% of Nigeria's population (Harper, 2006).

Research Design

This study used retrospective design to investigate the relationship between rainfall on patterns of malaria transmission, morbidity in Taraba State from 2005-2014. Health data was obtained from the health facilities. While historical rainfall, records was obtained from Taraba State Meteorological Station in Jalingo. Both were obtained for the periods of 10 years.

Sampling Procedure and Sample Size

This study utilized data on malaria morbidity from all health facilities in Taraba States across the periods of Ten years in consideration. It has a population of approximately 2,300,736 (2006 census) and a population density of 27 people per square kilometer. The state accounts for 1.6% of Nigeria's population (Harper, 2006). In terms of rainfall variability data from Jalingo Meteorological Station is conveniently selected in order to give a central position in the study area covering 60,291.8 km^2 Distance estimated from Taraba Southern which boundary with Cameroon Republic and Northern Taraba boundary with Adamawa.

Data Analysis

Data collected from the field were cleaned and a dataset developed. The data were subject to both descriptive and inferential statistics. The descriptive statistical results were presented in graphs and tables. Inferential statistics used is ANOVA to determine the variation of rainfall on malaria morbidity within and over the years. Regression was used to give the various trends to test the strength of the relationship between malaria morbidity and the selected climatic elements using the SPSS version 20.

RESULTS

The table below (Table 1) compared morbidity cases with the annual total population. During the ten - year period it was established that on average, for every 1000, people 228.9 (22.89%) suffered from malaria morbidity every year. The year 2014 had the highest value of 357/1000 (35.7%) followed by the year 2006 which had 318/1000 (31.8%).

Table 1. Malaria morbidity per thousand and percent (2005-2014)

Year	Population	Total Morbidity	Per/1000	%
2005	85545	19923	232.89	23.29
2006	99557	31706	318.47	31.85
2007	97763	19591	200.39	20.04
2008	95753	17545	183.23	18.32
2009	94992	17053	179.52	17.95
2010	103767	16279	156.88	15.69
2011	106744	29429	275.70	27.57
2012	105636	19343	183.11	18.31
2013	99019	19977	201.75	20.18
2014	101438	36218	357.05	35.71
Mean	99021.40	22706.40	228.90	22.89

Source: Department of Statistics, Taraba State Ministry of Health, Jalingo (2014)

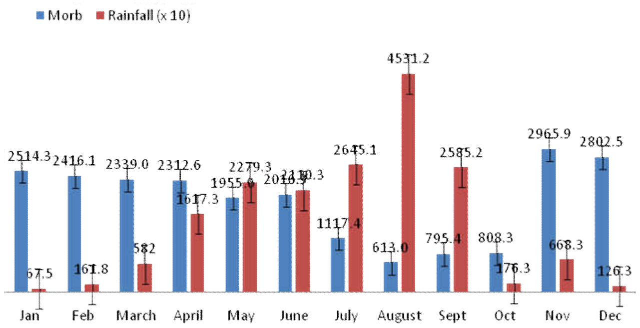

Figure 1. Seasonal patterns of mean monthly rainfall and malaria morbidity inTaraba State (2005 - 2014)

Annual and seasonal malaria morbidity

The table 2 shows both annual and monthly means of malaria morbidity over the surveillance period. When analysis of variation in morbidity was carried out, the result established that there was a significant variation in morbidity within the years of study with F = 3.642 while P = 0.001. As can be observed, each year showed different values which also showed variations as the years progressed from 2005 to 2014.

Seasonal patterns of rainfall and malaria morbidity

The pattern however, divided a year into two rainy seasons of October – March and April – September (Figure 1). Rainfall declined consistently from October to December and from January to March. Based on the ten year surveillance period, the mean monthly results showed that there was no month without malaria morbidity, the months of November – December, and January-April registered higher cases than the rest of the months. The result also showed that morbidity rose steadily from the month of April to July after which it declined steadily towards October. The month of November registered a sharp rise again steadily declining towards July. Comparing the monthly malaria patterns with the monthly rainfall patterns, two seasons per year was established. However, it should be noted that while rainfall peaks in the months of July, August and September, malaria peaks in the months of November-December and January, which is about one month after the rains reduce in the months of October. The months of Nov-Dec and January-March which registered the least amount of rainfall on the other hand registered the highest morbidity. However, from the above observation, although there is periodicity in both malaria and rainfall, the periodicity of malaria is not as sharp as that of rainfall.

It can be noted that while rainfall has more defined seasons, malaria remains high throughout the year, an indication that the impact of variability of rainfall on malaria is not that great. This clearly indicates that there could be other factors promoting the occurrence of malaria morbidity in the study area. The researcher observe that there exist insignificant negative correlation between rainfall and malaria morbidity (r = -0.598, p = 0.068) during the surveillance period. This means that rainfall does not significantly prevent malaria prevalence, as it provide suitable larval habitat in Study Area. Mean monthly trends of rainfall during this period (2005-2014) of time, showed a positive trend (Fig.2).

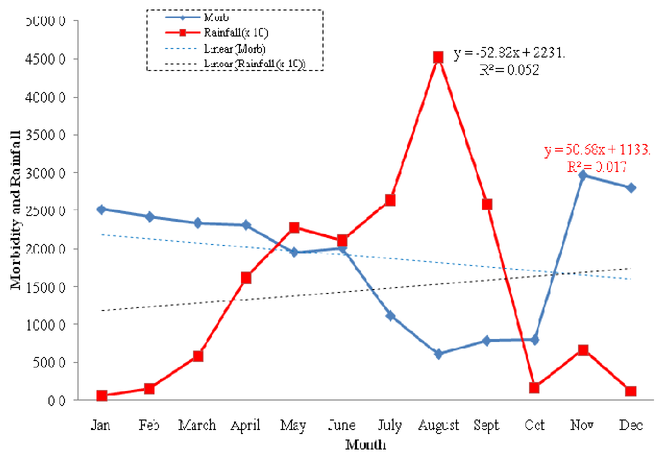

Fig. 2. Trends of mean monthly rainfall and malaria morbidity (2005- 2014)

At y = 50.683x + 1133.1, rainfall increased at the rate of 50.683% per month within the years. With a co-efficient of determination (R^2) = 0.017, the implication is that on average, one year accounted for about 1.7% of the changes observed. The seasonal trend was insignificant at a P value of 0.452.

Table 2. Annual Malaria Morbidity (2005-2014)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Mean
2005	2246	2301	2915	2811	2118	1169	879	401	878	984	2810	411	1660
2006	3816	2427	3811	3411	1224	2451	1711	1088	1440	2939	3781	3607	2642
2007	2160	2020	1614	3211	2412	601	786	198	620	676	2412	2881	1633
2008	2025	2269	2101	1609	2412	1001	206	208	243	179	2691	2101	1420
2009	2440	3614	1001	1012	2261	108	451	304	460	480	2921	2001	1421
2010	2009	1503	1001	1981	1210	2101	353	659	301	308	2411	2442	1356
2011	3016	2604	3011	2073	2166	3916	2056	1019	1488	1008	2661	4411	2452
2012	2110	1004	2001	1995	1151	3499	370	368	318	306	3111	3110	1611
2013	1010	2451	2124	1982	1201	2881	301	519	391	202	3801	3114	1664
2014	4311	3968	3811	3041	3395	2442	4061	1366	1815	1001	3060	3947	3018
Mean	2514	2416	233	2313	1955	2016	1117	613	795	808	2966	2802	1888

Source: Department of Statistics, Taraba State Ministry of Health, Jalingo (2014)

Table 3. Relationships between malaria, morbidity and rainfall within individualyear

Years		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Rainfall	r-value	-0.353	-0.795	-0.403	-0.755	-0.773	-0.353	-0.351	-0.644	-0.258	-0.697
	p-value	0.261	0.002*	0.193	0.005*	0.003*	0.260	0.263	0.024*	0.418	0.012*

NB: * indicates significant difference at $p \leq 0.05$. r- Values (-) indicates a negative relationship

In establishing the trend of malaria morbidity within a year, the results based on the ten-year period was used as a predictive model using mean morbidity for each month within the surveillance period. The trend showed that malaria cases decreased but not significant (P = 0.475) towards the end of the year at the rate of -52.82% per month during the surveillance period (y = -52.83x + 2231.4). During the same period, a co-efficient of determination (R^2) = 0.0521 implied that the period of twelve months every year during the surveillance period accounted for 5.21% of the temporal variations observed (Fig.2). While, rainfall had a positive trend towards the end of the year, malaria morbidity had a negative trend. Increases in rainfall therefore, lead to a decrease in malaria morbidity and because the increase in rainfall was not significant, there could be other factors contributing to the negative trend in morbidity towards the end of the year. The researcher observe that there exist significant negative correlation between rainfall and malaria morbidity (r = -0.827, p = 0.001).

DISCUSSION

Changes in malaria morbidity in relation to rainfall are complicated. Lindsay *et al*. (2000) from study on El Niño effect on malaria morbidity observed a 2.4 times increase in rainfall than normal was associated with a striking decline in malaria morbidity. Malaria morbidity has also widely reported to have a positive relationship with rainfall (Patz *et al.,* 2003; Odongo-Aginya *et al.,* 2005). While the positive association between malaria morbidity and rainfall is hinged on the creation of breeding site, tolerable atmospheric humidity and suitable soil moisture for *Anopheles* mosquitoes by rainfall, the negative association results from the destruction of mosquito breeding sites by excessive rain. The negative relationship between malaria morbidity and rainfall from this study is probably attributable to destruction of breeding sites of *Anopheles* mosquitoes resulting in death of mosquito larvae and subsequent drop in malaria transmission (IISD 2013). The rainy season in Taraba State is characterized by mean annual rainfallvarying between 1058 and 1300mm (Bako *et al.,* 2016). During this period standing water bodies suitable for *Anopheles* mosquitoes breeding are created; relative humidity due to increased rainfall and atmospheric temperature enhance mosquito survival and reproduction (Bi *et al.,* 2013; Govoetchan *et al*., 2014). Where malaria transmission is seasonal, optimal timing of control becomes particularly important. Knowing the duration, start and end of the malaria transmission season is important in terms of planning control strategies.

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