

## Seasonal Variations and the Prevalence of Malaria in Imo State, Nigeria.

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**Abstract:** Malaria is a serious public health problem in Sub-saharan Africa including Nigeria, with the potential to increase significantly in response to seasonal changes. The aim of the study was to determine the influence of seasonal variations on the prevalence of malaria in Imo state, Nigeria. The study was a retrospective descriptive cross-sectional study using a self- designed pro-form to collect secondary data from hospitals in the three zones in Imo State (Owerri, Orlu and Okigwe) and analyzed using descriptive statistical analysis. The relationships between variables were determined using Spearman correlation test and the findings showed a relationship between weather (Rainfall) and Prevalence of malaria in Imo State. The prevalence of malaria was highest in Orlu zone (900 cases in 2017, 955 cases in 2016 and 1,088 cases in 2015) followed by Okigwe zone (854 cases in 2017, 1,116 cases in 2016 and 951 cases in 2015) and Owerri zone (538 cases in 2017, 689 cases in 2016 and 773 cases in 2015). The prevalence of positive malaria was highest among subjects aged 21-30 years in 2015 and 31-40 years in 2016 and 2017 and the burden was higher in females. The relationship between rainfall and prevalence of malaria in 2015 showed a moderate association ( $r= 0.659$  at  $0.02$ ). In 2016, the relationship was strong ( $r= 0.760$  at  $0.04$ ) and moderate in 2017 ( $r= 0.571$  at  $0.052$ ). Overall, the meteorological variation of weather to malaria occurrence showed the prevalence of malaria was highest in rainy seasons than in the dry seasons (from the months of May to September) every year in the three zones. Malaria parasitemia is highest in the rainy season amongst young female adults, thus adequate public health measures need to be undertaken to mitigate the endemicity of the disease within the region.

**Keywords:** Seasonal Variations, Prevalence, Malaria, Imo State, Nigeria.

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### I. Introduction

Malaria is a serious public health problem in Sub-Saharan Africa including Nigeria, with the potential to increase significantly in response to seasonal changes [1]. It is a life-threatening parasitic disease caused by the genus *Plasmodium* transmitted through the bite of female anopheles mosquitoes [2]. Malaria accounts for about 60 percent of outpatient visits to hospitals, 30 percent cause of child mortality and 10 percent cause of maternal mortality [3]. According to the World Health Organization report [4], Nigeria has the greatest burden of malaria in the world with approximately 51 million cases and 207,000 deaths reported annually (approximately 30 percent of the total malaria burden in Africa), while about 173 million persons are at risk of infection.

Malaria affects the health and wealth of nations and individuals alike. In Nigeria, malaria is understood to be both a disease of poverty and a cause of poverty [4][5]. The disease indirectly impairs the ability of individuals to be effectively productive by loss of time during care-giving activities, as their capacity to earn and save for their families is reduced. Furthermore, malaria in children, especially cerebral malaria has a tendency to damage the brain and affect the child's cognitive development and compromise future productive capacity due to truancy from school [6].

The knowledge of some malaria endemic communities is far from perfect, and misconceptions are common about the seasonality of malaria transmission and associated prevalence between the rainy and dry seasons. Thus, the aim of this research is to determine the influence of season on the burden of malaria infection in parts of Imo State Nigeria, study the difference in disease manifestations according to age and gender and correlate this to rainfall patterns within the study area. This will guide public health policies aimed at the effective prevention and control of malaria parasitemia.

## **II. Materials And Methods**

This study employed a retrospective design since it examined malaria cases collected from the medical records of some secondary and tertiary hospitals in parts of Imo State, Nigeria between 2015 and 2017. In addition, information on seasonal variations was collected from the Nigerian Meteorological Agency (NIMET) and compared / matched with data on the prevalence of malaria.

**Study Design:** Retrospective descriptive cross-sectional study using a self- designed pro-form to collect secondary data from hospitals in the three zones in Imo State (Owerri, Orlu and Okigwe), Nigeria.

**Study Location:** The study was conducted in the three senatorial zones in Imo State, Nigeria. The state lies within latitudes  $4^{\circ} 45^1\text{N}$  and  $7^{\circ} 15^1\text{N}$  and longitude  $6^{\circ} 50^1\text{E}$  and  $7^{\circ} 25^1\text{E}$  with a total land mass of 5, 530km<sup>2</sup> [7]. Owerri is the capital and the 3 geopolitical zones are Owerri, Orlu and Okigwe. The state has an estimated population of 5.4 million people.

**Study Duration:** August 2018 to March 2019

**Subjects & selection method:** The study population was drawn from the hospital records of patients who presented themselves for malaria investigation and treatment in the selected hospitals across the three zones (Federal Medical Center Owerri for Owerri zone, Imo State University Teaching Hospital Orlu (IMSUTH) for Orlu zone and General Hospital for Okigwe zone). Also, climate variables (monthly rainfall, relative humidity and temperature) were obtained from the Nigerian Metrological Agency (NIMET), Imo Airport unit and used. The hospital and climate records were obtained for the period of three years spanning from 2015-2017.

### **Inclusion criteria:**

1. The gender of the patients who visited the selected health facilities (Federal Medical Center Owerri from Owerri zone, Imo State University Teaching Hospital Orlu (IMSUTH) from Orlu zone and General Hospital from Okigwe zone) for malaria investigation and treatment from 2015-2017.
2. The age of patients confirmed positive for malaria investigation.
3. Number of confirmed patients positive for malaria.
4. Climate variables (mean monthly relative humidity, total monthly rainfall and mean monthly temperatures) obtained from the Nigerian Metrological Agency (NIMET), Imo Airport unit from 2015-2017.

### **Exclusion criteria:**

1. Patients who treated themselves at home or those who treated themselves in other hospitals without visiting the hospitals used in this study.
2. Education of confirmed patients
3. Socio-economic status of confirmed patients positive for malaria.
4. Climate variables before 2015.

### **Procedure methodology**

The available hospital and climate data records covering the periods (2015 -2017) were obtained and used. A proform was used to collect secondary data from selected hospitals in the three zones in Imo State. The study used all the patients who presented themselves for malaria investigation and treatment from 2015-2017 in the selected hospitals in the three zones in Imo State.

The collected climatic data include; mean monthly relative humidity, total monthly rainfall and mean monthly temperatures. Also, data on the gender of the patients who visited the hospitals for malaria treatment, the age and number of confirmed positive patients with malaria cases were collected. The study had independent variables which were seasonal variations (monthly rainfall, relative humidity and temperature), age and gender of subjects while the dependent variable was prevalence rate of malaria.

### **Statistical analysis:**

The collected data was entered into the computer software; Statistical Package for Social Sciences (SPSS) Version 21.0 and analyzed using descriptive statistical analysis. The relationship between variables was determined using Spearman correlation test. P-value less than 0.05 were considered statistically significant.

### III. Results

#### Overall monthly prevalence of malaria in Imo State for the three zones

Table no 1 shows the overall monthly prevalence of malaria in Imo State across the three years of study. In Okigwe zone, the highest malaria prevalence was recorded in August with 316 cases while the lowest was January with 153 cases. In Orlu zone, the highest malaria prevalence was recorded in September with 328 cases while the lowest was in January with 90 cases. In Owerri zone, the highest malaria prevalence was recorded in July with 312 cases while the lowest was January with 23 cases.

Months	Okigwe Zone				Orlu Zone				Owerri Zone			
	2017	2016	2015	Total	2017	2016	2015	Total	2017	2016	2015	Total
	+ve	+ve	+ve		+ve	+ve	+ve		+ve	+ve	+ve	
Jan	55	56	42	153	44	40	6	90	3	9	11	23
Feb	61	85	53	199	27	53	126	206	1	12	25	38
Mar	90	83	70	243	79	58	90	227	50	60	60	170
Apr	64	94	87	245	60	90	109	259	87	81	54	222
May	79	78	104	261	102	68	140	310	52	92	85	229
Jun	106	80	50	236	75	108	143	326	61	84	102	247
July	80	115	113	308	105	93	114	312	64	116	132	312
Aug	100	101	115	316	95	96	115	306	69	54	109	232
Sept	51	114	100	265	102	113	113	328	30	57	72	159
Oct	63	94	64	221	64	96	95	255	42	64	67	173
Nov	42	115	74	231	97	44	25	166	37	37	34	108
Dec	63	101	79	243	50	96	12	158	42	30	22	94
<b>Total</b>	<b>854</b> (29.2%)	<b>1,116</b> (38.2%)	<b>951</b> (31.6%)	<b>2,921</b>	<b>900</b> (30.6%)	<b>955</b> (32.4%)	<b>1088</b> (37%)	<b>2,943</b>	<b>538</b> (26.8%)	<b>696</b> (34.7%)	<b>773</b> (38.5%)	<b>2,007</b>

#### Overall Seasonal Prevalence of Malaria in Imo State

The results in Table no 2 presents the seasonal prevalence of malaria in Imo State. In Okigwe zone, during the rainy season (March- October), the number of positive cases recorded in 2015 was 703 while 759 cases were recorded in 2016 and 633 in 2017. During the dry season (November- February), 2015 recorded 248 cases while 357 cases were recorded in 2016 and 221 cases was obtained in 2017. In Orlu zone, during the rainy season (March- October) malaria cases recorded was 919 in 2015, 722 in 2016 and 682 in 2017. During the dry season (November- February), 2015 recorded 169 while 233 cases were recorded in 2016 and 218 cases in 2017 respectively.

In Owerri zone, during the rainy season (March- October) positive malaria cases was 681 in 2015, 608 in 2016 and 455 in 2017. During the dry season (November- February), 2015 recorded 92 cases while 88 cases were obtained in 2016 and 83 cases in 2017 respectively.

Season	Okigwe Zone				Orlu Zone				Owerri Zone			
	2017 +ve	2016 +ve	2015 +ve	Total	2017 +ve	2016 +ve	2015 +ve	Total	2017 +ve	2016 +ve	2015 +ve	Total
Rainy Season (March- October)	633	759	703	2,095	682	722	919	2,323	455	608	681	1,744
Dry Season (November- February)	221	357	248	826	218	233	169	620	83	88	92	263
<b>Total</b>	<b>854</b>	<b>1,116</b>	<b>951</b>	<b>2,921</b>	<b>900</b>	<b>955</b>	<b>1,088</b>	<b>2,943</b>	<b>538</b>	<b>696</b>	<b>773</b>	<b>2,007</b>
<b>%</b>	<b>(29.2%)</b>	<b>(38.2%)</b>	<b>(32.6%)</b>		<b>(30.6%)</b>	<b>(32.4%)</b>	<b>(37%)</b>		<b>(26.8%)</b>	<b>(34.7%)</b>	<b>(38.5%)</b>	

#### Seasonal prevalence of positive malaria by gender in Okigwe Zone

The results in Table no 3: present the seasonal prevalence of malaria by gender in Okigwe zone. Out of 368 males who tested positive for malaria in 2017, 270 cases were obtained during the rainy season while 98 tested positive during the dry season. On the other hand, out of 486 females who tested positive for malaria, 363 tested positive during the rainy season while 123 cases were obtained during the dry season. Overall for 2017, of the total of 854 positive cases, females accounted for 486, representing 57% while males were 368 representing 43%.

In 2016, 366 positive cases obtained during the rainy season were males while females had 393 positive cases. During the dry season, males obtained 177 cases while females had 180 cases. Overall for 2016, of the total of 1,116 positive cases, females accounted for 573, representing 51.3% while males were 543 representing 48.3%.

In 2015, during the rainy season, males had 344 cases positive for malaria while females had 359 cases. Furthermore, during the dry season, males obtained 96 cases of infection while females had 152 cases. Overall for 2015, of the total of 951 positive cases, females accounted for 511, representing 53.7% while males were 440 representing 46.3%.

**Table no 3: Seasonal Prevalence of positive Malaria by gender in Okigwe Zone**

Season	2017			2016			2015		
	M	F	+ve	M	F	+ve	M	F	+ve
Rainy Season (March- October)	270	363	633	366	393	759	344	359	703
Dry Season (November- February)	98	123	221	177	180	357	96	152	248
<b>Total</b>	<b>368</b>	<b>486</b>	<b>854</b>	<b>543</b>	<b>573</b>	<b>1,116</b>	<b>440</b>	<b>511</b>	<b>951</b>
%	(43%)	(57%)		(48.7%)	(51.3%)		(46.3%)	(53.7%)	

**Seasonal prevalence of positive malaria by gender in Orlu Zone**

Table no 4: presents the seasonal prevalence of malaria by gender in Orlu zone. Out of 417 males who tested positive for malaria in 2017, 304 cases were obtained during the rainy season while 113 tested positive during the dry season. On the other hand, out of 483 females who tested positive for malaria, 378 tested positive during the rainy season while 105 cases were obtained during the dry season. In 2016, 359 positive cases obtained during the rainy season were males while females had 363 positive cases. During the dry season, males obtained 122 cases while females had 111 cases. In 2015, during the rainy season, males had 416 cases positive for malaria while females had 503 cases. Furthermore, during the dry season, males obtained 86 cases of infection while females had 83 cases.

**Table 4: Seasonal Prevalence of positive Malaria by gender in Orlu Zone**

Season	2017			2016			2015		
	M	F	+ve	M	F	+ve	M	F	+ve
Rainy Season (March- October)	304	378	682	359	363	722	416	503	919
Dry Season (November- February)	113	105	218	122	111	233	86	83	169
<b>Total</b>	<b>417</b>	<b>483</b>	<b>900</b>	<b>481</b>	<b>474</b>	<b>955</b>	<b>502</b>	<b>586</b>	<b>1,088</b>
%	(46%)	(54%)		(50.3%)	(46.7%)		(44%)	(56%)	

**Seasonal prevalence of positive malaria by gender in Owerri Zone**

Table no 5 presents the seasonal prevalence of malaria by gender in Owerri zone. Out of 204 males who tested positive for malaria in 2017, 162 cases were obtained during the rainy season while 42 tested positive during the dry season. On the other hand, out of 334 females who tested positive for malaria, 293 tested positive during the rainy season while 41 cases were obtained during the dry season.

In 2016, 251 positive cases obtained during the rainy season were males while females had 357 positive cases. During the dry season, males obtained 43 cases while females had 45 cases.

In 2015, during the rainy season, males had 298 cases positive for malaria while females had 383 cases. Furthermore, during the dry season, males obtained 33 cases of infection while females had 59 cases.

**Table no 5: Seasonal Prevalence of positive Malaria by gender in Owerri Zone**

Season	2017			2016			2015		
	M	F	+ve	M	F	+ve	M	F	+ve
Rainy Season (March- October)	162	293	455	251	357	608	298	383	681
Dry Season (November- February)	42	41	83	43	45	88	33	59	92
<b>Total</b>	<b>204</b>	<b>334</b>	<b>538</b>	<b>294</b>	<b>402</b>	<b>696</b>	<b>331</b>	<b>442</b>	<b>773</b>
%	(38%)	(62%)		(46%)	(54%)		(43%)	(57%)	

**Malaria prevalence based on age**

Table no 6: shows the burden of malaria parasitemia based on the age of patients. For Okigwe zone, in 2017, people aged 31-40 had the highest prevalence of malaria with 229 cases followed by 225 cases between 21-30 years while the least was 48 cases among less than 10 years of age. In 2016, 21-30 had the highest prevalence of malaria with 255 cases followed by 254 cases between 31-40 years while the least was 64 cases among less than 10 years of age. In 2015, 21-30 had the highest prevalence of malaria with 239 cases followed by 236 cases between 11-20 years while the least was 49 cases among less than 10 years of age.

For Orlu zone, in 2017, subjects aged 21-30 years had the highest prevalence of malaria with 249 cases followed by 198 cases among 31-40 years while the least was 70 cases among those aged 51 years and above. In 2016, subjects aged 21-30 years obtained the highest prevalence of malaria with 255 cases followed by 229 cases among 31-40 years while the least was 60 cases among those less than 10 years of age. In 2015, the

highest prevalence of malaria was 300 cases among those between 21-30 years followed by 276 cases among 31-40 years while the least was 58 cases among those aged 51 years and above.

For Owerri zone, in 2017, subjects less than 10 years had the highest prevalence of malaria with 213 cases followed by 120 cases among 51 years and above, while the least was 32 cases among 41-50 years. In 2016, subjects less than 10 years recorded the highest prevalence of malaria with 250 cases followed by 126 cases among 51 years and above while the least was 50 cases among those aged 21-30. The highest prevalence of malaria in 2015 was shown among those less than 10 years (304 cases) followed by those aged 51 years and above (125 cases) while the least was among 21-30 years (71 cases).

**Table no 6: Malaria prevalence based on age**

Zone	Age of individuals in 2017							Age of individuals in 2016							Age of individuals in 2015						
	<10 yrs	10-20 yrs	21-30 yrs	31-40 yrs	41-50 yrs	51+ yrs	Total	<10 yrs	11-20 yrs	21-30 yrs	31-40 yrs	41-50 yrs	51+ yrs	Total	<10 yrs	11-20 yrs	21-30 yrs	31-40 yrs	41-50 yrs	51+ yrs	Total
Okigwe	48	126	225	229	171	55	854	64	180	255	254	155	94	1,116	49	236	239	170	167	89	951
Orlu	76	167	249	198	140	70	900	60	164	255	229	148	99	955	104	219	300	276	131	58	1,088
Owemi	213	41	77	55	32	120	538	250	103	50	92	75	126	696	304	89	71	82	102	125	773

**Metrological variation of weather relative to malaria prevalence**

Table no 7: Summarizes the variation of weather to malaria prevalence in Imo State. In 2015, rainfall was highest from the months of May (236.6), June (364.7), July (325.8), August (359.2), September (352.9) and October (324.3) and lowest for the months of January (12.4) and December (0.0). The relative humidity in 2015 was highest in the months of August (89), July (87), June (86) and October (82) and lowest for the months of December (39). The highest prevalence of positive malaria was shown in the months of July (359 cases), August (339 cases) and May (329 cases) while the lowest prevalence was in the months of December (113 cases) and January (59 cases).

In 2016, rainfall was highest from July (378.1), August (409.4) and September (423.8) and lowest for the month of November (12.2). The relative humidity in 2016 was highest in the months of July (87), and August (87), September (86) and June (84) and lowest for the month of January (56). Positive malaria prevalence was highest in the months of July (324 cases), September (284 cases) and June (272 cases) while the lowest prevalence was in the months of January (105 cases) and February (150 cases).

In 2017, rainfall was highest from June (213.4), July (367.5), August (391.3) and September (609.5) and lowest for the months of January (8.8) and February (0.0).

The relative humidity in 2017 was highest in the months of August (88), July and September (87) and respectively while the lowest for the month of February (67). Positive malaria prevalence was highest in the months of August (264 cases), July (249 cases), June (242 cases) while the lowest was in the month of February (89 cases).

**Table 7: Metrological variation of weather to prevalence of malaria in Imo State**

Months of the year	2015					2016					2017				
	Temp (°C)	Temp (°C)	Rainfall (mm)	Relative humidity (%)	+ve Cases	Temp (°C)	Temp (°C)	Rainfall (mm)	Relative humidity (%)	+ve Cases	Temp (°C)	Temp (°C)	Rainfall (mm)	Relative humidity (%)	+ve Cases
Jan	33.5	19.8	12.4	58	59	34.6	20.2	0.0	56	105	34.4	21.4	8.8	70	102
Feb	34.2	23.9	72.2	82	204	36.8	23.1	29.4	70	150	36.4	22.5	0.0	67	89
Mar	33.5	23.2	61.0	80	220	33.9	24.1	192.5	82	201	34.5	23.4	80.1	79	219
Apr	33.6	23.6	61.4	78	250	33.5	24.1	143.9	77	265	33.6	23.7	226.1	78	211
May	32.6	23.1	236.6	81	329	32.6	23.7	157.4	81	238	31.8	23.1	198.4	81	233
Jun	29.9	22.4	364.7	86	295	31.0	22.9	272.6	84	272	31.4	23.1	213.4	84	242
Jul	29.3	23.1	325.8	87	359	29.6	22.8	378.1	87	324	29.6	22.8	367.5	87	249
Aug	29.0	22.2	359.2	89	339	29.3	22.8	409.4	87	251	28.5	22.4	391.3	88	264
Sept	30.3	22.6	352.9	86	285	30.2	22.9	423.8	86	284	29.5	22.7	609.5	87	183
Oct	31.2	22.6	324.3	82	226	31.8	22.8	144.7	82	254	31.2	22.8	97.4	84	169
Nov	33.1	22.9	78.1	80	133	33.5	23.3	12.2	79	196	31.1	22.2	29.1	81	176
Dec	33.7	18.3	0.0	39	113	34.1	21.5	TR	69	227	32.3	21.4	30.1	72	155
					2,812					2,767					2,292

Source: Nigerian Metrological Agency (NIMET) Imo Airport Unit and hospital records.

#### **IV. Discussions**

The results obtained showed that malaria prevalence was higher among females compared to males across the three zones within the study period (2015-2017). However, this contrasts with a previous work [8] in which the prevalence of *Plasmodium falciparum* was higher among males than females in Kaduna Metropolis, Nigeria.

The age-related prevalence shows that malaria was highest among subjects aged 21-30 years in 2015 and 31-40 years in 2016 and 2017 respectively. This finding agrees with previous studies [9] [10] [11] which stated that age-groups less than 30 had the greatest burden of malaria infection. The higher positive results obtained among these age groups might be due to their occupational and socio-cultural settings. Those who expose themselves either as a result of their work or schooling are more likely to be subjected to mosquito bites compared to those who mostly stay indoors. This is in agreement with the position of [12] which opines that human behavior is influenced by cultural, social and economic factors which directly or indirectly affects health outcomes, including the risk for infectious diseases like malaria.

With regards to the possible impact of weather variables on malaria prevalence, this study showed that the prevalence of malaria tends to be on an increase during the rainy season (from May to October) across the three years. Malaria was at its peak in the month of July and minimal in October. Furthermore, the trend of malaria prevalence and temperature revealed it is seasonal. The findings of this study is in agreement with a previous work [13] which opined that the rainy season presents favorable environmental conditions that enhance mosquito breeding, survival and biting rates. Additionally, the results confirm that malaria transmission in Imo State is characterized by substantial inter-monthly variations. More so, this study showed that malaria prevalence increases as relative humidity increases as stated by the International Institute for Sustainable Development [14] and the previous research that showed high relative humidity lengthens the life of mosquitoes and helps the parasite to complete the necessary life cycle [15].

Generally, comparing the overall prevalence of malaria in Imo State across the three years of study, there is an observed decline in the percentage of positive cases. With the exception of Okigwe zone, 2015 recorded the highest prevalence of 37% and 38.5% for the other zones. These percentages reduced to 29.2%, 30.6% and 26.8% in 2017. This is in line with a study on the decomposition of changes in malaria prevalence amongst under-five children in Nigeria [16] which recorded similar declines within 10 years of study. This decline may be as a result of the huge investments in the national malaria eradication programme (NMEP) [17]. Although the decline recorded in this study is a public health achievement, malaria remains prevalent in Nigeria, especially in the northern parts of the country where the burden of malaria has been recorded as high as 56.9% in Jos [18].

The variations obtained in the prevalence rate amongst the three zones of the state can be related to the different climatic conditions of the regions, disposition of surface waters and precipitation/rainfall as can be seen from the meteorological data. This is because the three zones of the state have almost the same hospital facilities, literacy rate and living conditions. Furthermore, the specific characteristics of population living in a particular region can influence contact between humans and mosquitoes that lead to a greater transmission of malaria [19]. This can be seen in a recent study undertaken in the Zambezia province of Mozambique [20] which studied childhood malaria and observed a variation in the prevalence rate among villages within the same province.

#### **V. Conclusions and Recommendations**

In conclusion, our result shows that the prevalence of malaria was influenced by weather variables with the highest incidence in the rainy seasons. It is therefore recommended that people in endemic areas should adopt preventive practices in all seasons with emphasis on the rainy seasons in order to prevent the scourge of malaria. Furthermore, there was a variation in the prevalence rate amongst the zones studied, indicating that human and ecological factors may play a role in prevalence rates. Finally, it was observed that there was a gradual decline in malaria prevalence in the three years of study, showing that malaria intervention programmes in the state is making progress.

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