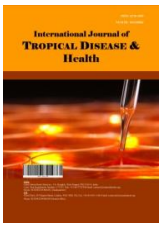

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Malaria Prevalence in Rice Farm Settlements South East Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Authors EIN and OCA designed the study. Authors EIN, OCA, FJU, SIE, IOA, OPO, CED, LOA and SIO collected all data and handled all laboratory analyses. Authors EIN and IOA handled the statistical analysis. Author EIN drafted the first manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aim: Agrarian settlements in Nigeria possess a lot of factors that predisposes the populace to malaria. The present study focused on the evaluation of three-year prevalence of malaria in rice farm settlements, South-East Nigeria.
Study Design: The study was a retrospective descriptive survey designed to evaluate the prevalence of malaria infection between January 2015 and December 2017. A total of 29, 458 records were examined, 21, 559 and 7, 899 from Ebonyi and Enugu States respectively for three years (2015 – 2017). Male comprises 11, 453 of the records while the female was 18, 005.
Place and Duration: Southeastern Nigeria \ three years

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Methodology: Preparation of thick films blood smears for microscopy following standard methods.
Results: Overall, 12, 746 (43.3%) were positive for malaria parasites, 7, 651 (35.4%) and 5, 115 (64.8%) from Ebonyi and Enugu respectively. Prevalence of the infection was similar between male and female in Ebonyi State (35.5% vs. 35.3%, $\chi^2 = 0.044$, df = 1, p = 0.834); but significantly higher in female compared to male in Enugu State (69.7% vs. 55.7%, $\chi^2 = 154.808$, df = 1, p = 0.0001).
Conclusion: There was high prevalence of malaria infection in rice farm settlements, south-east Nigeria.

Keywords: Malaria; prevalence; rice farms; farmers; South-east Nigeria.

1. INTRODUCTION

Fifteen countries in sub-Saharan Africa and India carry almost 80% of the global malaria burden; five of these countries - Nigeria (25%), the Democratic Republic of the Congo (11%), Mozambique (5%), India (4%) and Uganda (4%), accounted for nearly half of all malaria cases worldwide [1].

Some anthropological activities especially some agricultural practices predispose people to malaria. It has been reported that agrarian settlements possesse a lot of factors that predispose the populace to malaria [2]. Specifically, management of irrigation in rice farming has contributed to environmental problems, including water adoption, water quality reduction and waterlogging and some of these problems encourage the breeding of mosquitoes which is the vector of *Plasmodium* parasite that causes malaria infection [3]. Similarly, grown bushes around the residence, involvement in much farming, residing close to water bodies, staying late night outdoors and poor health care system were major factors that predispose the residents of agrarian settlements to malaria in south-east Nigeria [2].

There is a dearth in the literature of malaria prevalence in rice farm settlements in Nigeria especially southeastern Nigeria. Because of the alarming scourge of malaria in sub-Saharan Africa especially Nigeria and the high level of malaria predisposing factors available in agrarian settlements in our study area, the present study was designed to evaluate three years prevalence of malaria in rice farm settlements, South-East Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

Anambra, Ebonyi and Enugu states are the states in south-east Nigeria known for commercial rice farming. This study selected Ebonyi state (Abakaliki and Ishiagu) and Enugu state (Adani and Eha-Amufu) as a specific study area.

Abakaliki is designated by the following coordinates 6°20'N 8°06'E / 6.333°N 8.100°E. It has 1750-2500 mm rainfall per annum with an average atmospheric temperature of 27°C (Range 26°C - 29.6°C) (Nigeria Meteoroloagical Agency). It is 117 meters elevation above the sea level.

Ishiagu has coordinates of 5°56'32.99" N 7°33'59.99" E. The climate of Ishi-Agu is classified as Aw by the Köppen-Geiger system. In Ishiagu, the average annual temperature is 27.1°C. Precipitation here averages 1961 mm.

Adani is in Uzo-Uwani local government area of Enugu State. It is located between latitudes 6° 03'N and 6° 44'N and longitudes 7° 01'E and 7° 03'E bounded north by Nsukka LGA, east by Udi LGA and south by Ayamelum LGA in Anambra State. The soil is predominantly impervious clay as well as hydromorphic especially during the rainy season; hence waterlogged conditions tend to prevail [4]. It is usually well-drained by the south-flowing tributaries of the Amansea River that form the eastern boundary of Uzo-Uwani communities. It has a tropical wet-and-dry climate or Aw climate of Koppen's climate classification. It records an average of eight months rainfall between March and October (rainfall amounts between 1800 metres and 2000 metres) and four months of the dry season between November and February [5]. The inhabitants are mainly farmers [6].

Eha-Amufu has a geographic location of latitude 6.65° north, longitude 7.77° East and 140 meters elevation above sea level. Two distinct seasons is experienced in the area: the dry and wet seasons. The dry season stretches from November to April or May while the rainy season begins around May and ends in October [7].

2.2 Study Design and Population

The study is a retrospective descriptive survey designed to evaluate the prevalence of malaria infection between January 2015 and December 2017 among inhabitants of rice farm settlements in Ebonyi State (Abakiliki and Ishi-Agu) and Enugu State (Adani and Eha-Amufu). All the inhabitants of the four agrarian locations constitute the population of the study. Hospitals, primary healthcare and diagnostic laboratories that partnered in this study were purposely selected. The personnel of these health facilities and community leaders were involved in the study also. Consent was obtained from them to use anonymous data extracted from their database on a monthly interval for the study.

2.3 Data Collection and Quality Control

Three years (2015–2017) data on malaria prevalence was sourced from purposely selected hospitals, health care centres and medical diagnostic laboratories in different locations of our study area (Adani and Eha-Amufu; Abakiliki and Ishi-Agu). Data were taken from the primary record book at the health facilities. Three selected trained health workers collected the data individually and cross cheeked each other and were confirmed by the study team.

2.4 Preparation of Thick Films Blood Smears for Microscopy as Reported by the Collaborated Hospitals and Laboratories

Thick film blood smears preparation and confirmation of the presence or absence of malaria parasite followed the methods of [8] and [9]. A large drop of blood samples was deposited at one end of the slide and was spread out evenly with the corner of another slide to a diameter of about 20mm, thereafter, they were put in distilled water for 10 minutes for dehaemoglobinisation, dried in a flat position to ensure even distribution of blood and stained with Giemsa`s stain for 20 minutes. The stain was washed out with buffered water of pH 6.8 and stood upright to dry in the air, and viewed under x 100 objective (oil immersion) lens.

The smears were used to confirm the presence or absence of malaria parasite. The asexual forms of the parasite were counted in 200 leucocytes. The degree of parasitaemia was graded according to the number of parasites per microlitre thus, 1-999 (+), 1000-9999 (++) and >100000 (+++).

2.5 Statistical Analysis

Statistical Package for Social Sciences SPSS® version 20.0 (IBM Corporation, Armonk, USA) was used for analysis. Data collected was analyzed using Chi-square (χ^2) test. A probability value of 95% ($p < 0.05$) was regarded as significant.

3. RESULTS

3.1 The Overall Prevalence of Malaria in the Study Areas

A total of 29, 458 records were examined, 21, 559 and 7, 899 from Ebonyi and Enugu States respectively for three years (2015 – 2017). Male comprises 11, 453 of the records while the female was 18, 005. Overall, 12, 746 (43.3%) were positive for malaria parasites, 7, 651 (35.4%) and 5, 115 (64.8%) from Ebonyi and Enugu respectively. Prevalence of the infection was similar between male and female in Ebonyi State (35.5% vs. 35.3%, $\chi^2 = 0.044$, df = 1, p = 0.834); but significantly higher in female compared to male in Enugu State (69.7% vs. 55.7%, $\chi^2 = 154.808$, df = 1, p = 0.0001) (Table 1).

Table 1. Prevalence of malaria in Ebonyi and Enugu States according to sex

State	Sex	Infection status		Total (%)
		Positive (%)	Negative (%)	
Ebonyi	Male	3081 (35.5)	5603 (64.5)	8684 (40.3)
	Female	4550 (35.3)	8325 (64.7)	1287 (59.7)
	Total	7631 (35.4)	13928 (64.6)	21559 (100.0)
			$\chi^2 = 0.044$, df = 1, p = 0.834	
Enugu	Male	1541 (55.7)	1228 (44.3)	2769 (35.1)
	Female	3574 (69.7)	1556 (30.3)	5130 (64.9)
	Total	5115 (64.8)	2784 (35.2)	7899 (100.0)
			$\chi^2 = 154.808$, df = 1, p = 0.0001	

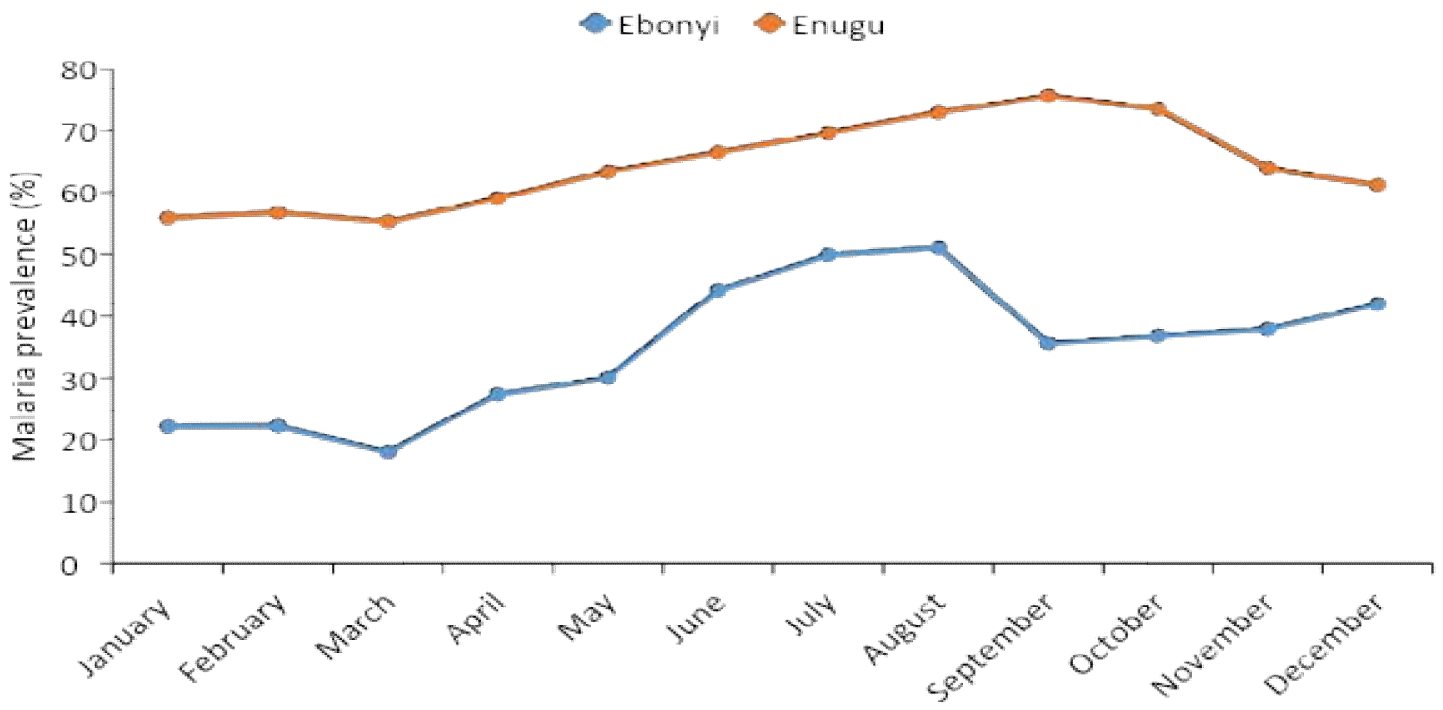

Fig. 1. Three-year (2015 - 2017) overall monthly prevalence of malaria in Ebonyi and Enugu states rice farming communities

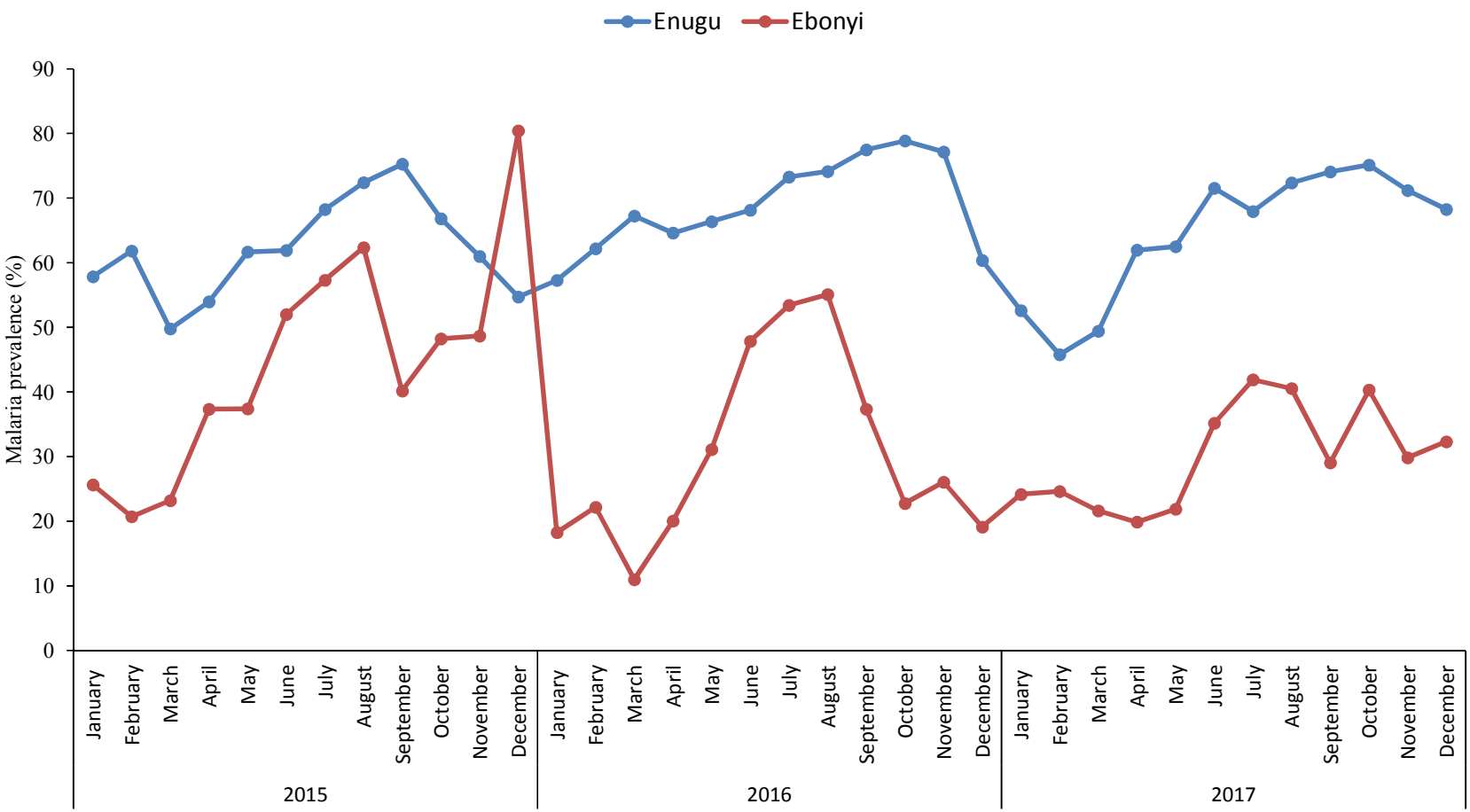

Fig. 2. Monthly prevalence of malaria in Ebonyi and Enugu States disaggregated by years 2015, 2016 and 2017

For the three years covered by the study, the prevalence of malaria in Ebonyi State rice farming communities showed a progressive decline with a sharp drop between 2015 and 2016. It dropped from 43.0% prevalence in 2015 to 31.6% in 2016, and 31.6% in 2017. The yearly difference in malaria prevalence in the two rice farming communities of Ishiagu and Abakaliki, marked by a sharp drop between 2015 and the years 2016 and 2017 was significant statistically (χ^2 = 277.007, df = 2, p = 0.0001).

Among the rice farming communities of Enugu State, the overall prevalence of malaria during this time interval was almost twofold compared to Ebonyi. This level of disparity in malaria prevalence between Ebonyi and Enugu was maintained for three years. However, the prevalence of malaria in Enugu State rice farming communities was different significantly on a yearly scale; the highest prevalence occurred in 2016 and the least in 2015 (Table 2).

Overall monthly pattern of malaria prevalence in Ebonyi and Enugu States for the three years 2015 – 2017 is presented as Fig. 1. Prevalence in both states usually peaked in the rainy months of between June and September. In the rice farming communities of Enugu, peak incidence appears to lag by one to two months compared to Ebonyi. In Ebonyi, peak prevalence which was obviously lower compared to Enugu, occurred in July and August, after which incidence dropped in September. In Enugu State rice farming communities, there was a steady rise from March till September when the peak was reached.

When disaggregated by years, the rise in prevalence of malaria between April and September in both Enugu and Ebonyi was consistent. However, peak incidence was not always in the rainy months of May, June, July, August and September (Fig. 2). In some year peak incidence lagged into the drier months October, November and December (e.g. 2015 Ebonyi and 2016 Enugu).

3.2 Stratified Prevalence of Malaria in the Study Areas

The prevalence of malaria in the sampled states and communities stratified according to sex are presented on Tables 3 and 4 respectively. The result shows that for both male and female participants, malaria prevalence was significantly ($p < 0.05$) higher among Enugu residents (male: 55.7%; female: 69.7%) than their Ebonyi counterparts (male: 35.5%; female: 35.3%), with an overall prevalence of 64.8% and 35.4% respectively (Table 3). When compared among the sampled communities, Eha-Amufu had significantly ($p < 0.05$) higher malaria prevalence among participants for both sexes (male: 943, 71.9%; female: 2123, 82.4%) than the rest communities (Table 4). The least in prevalence was Abakaliki with a prevalence of 16.5% and 20.0% for males and females respectively. On the overall, the community with the most malaria prevalence was Eha-Amufu (78.8%), followed by Ishiagu (65.9%), while the least was Abakaliki (18.6%) ($p = 0.0001$; Table 4).

Tables 5 and 6 show the prevalence of malaria in the sampled states and communities stratified according to years of study. In all the three years of study, malaria prevalence was significantly ($p < 0.05$) higher among Enugu residents (2015: 62.8%; 2016: 67.7%; 2017: 64.1%) than their Ebonyi counterparts (2015: 43.0%; 2016: 31.6%; 2017: 31.5%), with an overall prevalence of

Table 2. Prevalence of malaria in Ebonyi and Enugu States according to years of study

State	Year	Infection status		Total (%)
		Positive (%)	Negative (%)	
Ebonyi	2015	3141 (43.0)	4170 (57.0)	7311 (33.9)
	2016	2324 (31.6)	5038 (68.4)	7362 (34.1)
	2017	2166 (31.5)	4720 (68.5)	6886 (31.9)
	Total	7631 (35.4)	13928 (64.6)	21559 (100.0)
			χ^2 = 277.007, df = 2, p = 0.0001	
Enugu	2015	1843 (62.8)	1093 (37.2)	2936 (37.2)
	2016	1684 (67.7)	802 (32.3)	2486 (31.5)
	2017	1588 (64.1)	889 (35.9)	2477 (31.4)
	Total	5115 (64.8)	2784 (35.2)	7899 (100.0)
			χ^2 = 15.209, df = 2, p = 0.0001	

64.8% and 35.4% respectively (p = 0.0001; Table 5). When compared among the sampled communities, Eha-Amufu had significantly (p < 0.05) higher malaria prevalence among participants in the three years (2015: 1014, 78.4%; 2016: 1136, 81.7%; 2017: 916, 76.0%) than the rest communities (Table 6). The least in prevalence was Abakaliki with a prevalence of 29.8%, 14.1% and 12.1% for 2015, 2016 and 2017 respectively. On the overall, the community with the most malaria prevalence was Eha-Amufu (78.8%), followed by Ishiagu (65.9%), while the least is Abakaliki (18.6%) (p = 0.0001; Table 6).

Table 7 shows the sex-related prevalence of malaria stratified according to the sampled communities. Significant differences exist between sexes for malaria prevalence with respect to all the sampled communities but one (Ishiagu: p = 0.799). While in Abakaliki, Eha-Amufu and Adani communities, the females had significantly (p<0.05) higher prevalence of malaria than male. On the overall, the females had higher malaria prevalence than the males with a prevalence of 45.1% and 40.4% respectively (p = 0.0001; Table 7).

4. DISCUSSION

Overall positive for malaria parasites in the two states under review was high (43.3%). This was in contrast with the report of [10] who reported an overall prevalence of 14.2% of *P. falciparum* malaria infection among rice farming communities in Kilangali village, Kilosa district, central Tanzania based on microscopic examination. Also, [11] reported that the majority (78.1%) of the individuals in rice – irrigation and high levels of water-shaded areas had the highest malaria.

The higher prevalence observed may be associated with the availability of wetland in the rice farming communities and none adherence to the use of mosquito bite preventive measures such as Insecticide Treated Bed Nets (ITNs). The relationship between the use of mosquito nets and the prevalence of malaria in rice farms in Sahel of Mali was acknowledged by [12]. According to the work of [13] cited in a discussion paper of the [14] rice cultivation in West Africa and the Americas has a deep-rooted relationship with malaria transmission.

The difference in prevalence between the two states may be attributed to the location of the communities. The two sampled communities in Enugu State (Adani and Eha – Amufu) are in the rural areas while Ishiagu and Abakaliki are part of developed communities in Ebonyi State. The inhabitants of the urban area may have more access to the health facilities and malaria preventive measures such as ITNs than their rural counterparts. These assertions have been supported by the works of [15] and [16] cited in [14] who reported that urban communities in Sub - Sahara Africa have far better health indicators than their rural counterparts, reflecting better socioeconomic and physical access to preventive and curative services. Also, [17] suggested that the risk factors for the higher prevalence of malaria in rural communities may be small population and closeness of the inhabitants to their farms and differences in the housing structure. Similarly, overgrown bushes around residence, much farming, staying late night outdoors and poor health care facilities\system

Table 3. Prevalence of malaria in the sampled states stratified according to sex

Sex	State	Infection Status		Total (%)
		Positive (%)	Negative (%)	
Male	Ebonyi	3081 (35.5)	5603 (64.5	8684 (75.8)
	Enugu	1541 (55.7)	1228 (44.3)	2769 (24.2)
	Total	4622 (40.4)	6831 (59.6)	11453 (100.0)
			χ^2 = 354.961, df = 1, p = 0.0001	
Female	Ebonyi	4550 (35.3)	8325 (64.7)	12875 (71.5)
	Enugu	3574 (69.7)	1556 (30.3)	5130 (28.5)
	Total	8124 (45.1)	9881 (54.9)	18005 (100.0)
			χ^2 = 1745.840, df = 1, p = 0.0001	
Overall	Ebonyi	7631 (35.4)	13928 (64.6)	21559 (73.2)
	Enugu	5115 (64.8)	2784 (35.2)	7899 (26.8)
	Total	12746 (43.3)	16712 (56.7)	29458 (100.0)
			χ^2 = 2029.964, df = 1, p = 0.0001	

were major factors that predispose the residents of agrarian settlements to a high prevalence of malaria [2].

Sex-dependent prevalence of malaria infections has always been reported especially in communities where domestic roles are gender-based. Similar sex-dependent prevalence significant difference in malaria was reported by [10] in rice farming communities in Central Tanzania with males having a higher prevalence. This may be that females sleep under insecticide-treated bed nets more than the males.

Table 4. Prevalence of malaria in the sampled communities stratified according to sex

Sex	Community	Infection Status		Total (%)
		Positive (%)	Negative (%)	
Male	Ishiagu	2201 (65.8)	1146 (34.20	3347 (29.2)
	Abakaliki	880 (16.5)	4457 (83.5)	5337 (46.6)
	Eha-Amufu	943 (71.9)	369 (28.1)	1312 (11.5)
	Adani	598 (41.0)	859 (59.0)	1457 (12.7)
	Total	4622 (40.4)	6831 (59.6)	11453 (100.0)
		χ^2 = 2702.290, df = 3, p = 0.0001		
Female	Ishiagu	2839 (66.0)	1460 (34.0)	4299 (23.9)
	Abakaliki	1711 (20.0)	6865 (80.0)	8576 (47.6)
	Eha-Amufu	2123 (82.4)	455 (17.6)	2578 (14.3)
	Adani	1451 (56.9)	1101 (43.1)	2552 (14.2)
	Total	8124 (45.1)	9881 (54.9)	18005 (100.0)
		χ^2 = 4538.779, df = 3, p = 0.0001		
Overall	Ishiagu	5040 (65.9)	2606 (34.1)	7646 (26.0)
	Abakaliki	2591 (18.6)	11322 (81.4)	13913 (47.2)
	Eha-Amufu	3066 (78.8)	824 (21.2)	3890 (13.2)
	Adani	2049 (51.1)	1960 (48.9)	4009 (13.6)
	Total	12746 (43.3)	16712 (56.7)	29458 (100.0)
		χ^2 = 7143.589, df = 3, p = 0.0001		

Table 5. Prevalence of malaria in the sampled states stratified according to years of study

Year	State	Infection Status		Total (%)
		Positive (%)	Negative (%)	
2015	Ebonyi	3141 (43.0)	4170 (57.0)	7311 (71.3)
	Enugu	1843 (62.8)	1093 (37.2)	2936 (28.7)
	Total	4984 (48.6)	5263 (51.4)	10247 (100.0)
			χ^2 = 329.063, df = 1, p = 0.0001	
2016	Ebonyi	2324 (31.6)	5038 (68.4)	7362 (74.8)
	Enugu	1684 (67.7)	802 (32.3)	2486 (25.2)
	Total	4008 (40.7)	5840 (59.3)	9848 (100.0)
			χ^2 = 1007.501, df = 1, p = 0.0001	
2017	Ebonyi	2166 (31.5)	4720 (68.5)	6886 (73.5)
	Enugu	1588 (64.1)	889 (35.9)	2477 (26.5)
	Total	3754 (40.1)	5609 (59.9)	9363 (100.0)
			χ^2 = 808.759, df = 1, p = 0.0001	
Overall	Ebonyi	7631 (35.4)	13928 (64.6)	21559 (73.2)
	Enugu	5115 (64.8)	2784 (35.2)	7899 (26.8)
	Total	12746 (43.3)	16712 (56.7)	29458 (100.0)
			χ^2 = 2029.964, df = 1, p = 0.0001	

Table 6. Prevalence of malaria in the sampled communities stratified according to years of study

Sex	Community	Infection Status		Total (%)
		Positive (%)	Negative (%)	
2015	Ishiagu	1773 (65.0)	954 (35.0)	2727 (26.6)
	Abakaliki	1368 (29.8)	3216 (70.2)	4584 (44.7)
	Eha-Amufu	1014 (78.4)	274 (21.6)	1293 (12.6)
	Adani	829 (50.5)	814 (49.5)	1643 (16.0)
	Total	4984 (48.6)	5263 (51.4)	10247 (100.0)
		χ^2 = 1402.363, df = 3, p = 0.0001		
2016	Ishiagu	1673 (60.8)	1077 (39.2)	2750 (27.9)
	Abakaliki	651 (14.1)	3961 (85.9)	4612 (46.8)
	Eha-Amufu	1136 (81.7)	255 (18.3)	1391 (14.1)
	Adani	548 (50.0)	547 (50.0)	1095 (11.1)
	Total	4008 (40.7)	5840 (59.3)	9848 (100.0)
		χ^2 = 2819.491, df = 3, p = 0.0001		
2017	Ishiagu	1594 (73.5)	575 (26.5)	2169 (23.2)
	Abakaliki	572 (12.1)	414 (87.9)	4717 (50.4)
	Eha-Amufu	916 (76.0)	290 (24.0)	1206 (12.9)
	Adani	672 (52.9)	599 (47.1)	1271 (13.6)
	Total	3754 (40.1)	5609 (59.9)	9363 (100.0)
		χ^2 = 3275.360, df = 3, p = 0.0001		
Overall	Ishiagu	5040 (65.9)	2606 (34.1)	7646 (26.0)
	Abakaliki	2591 (18.6)	11322 (81.4)	13913 (47.2)
	Eha-Amufu	3066 (78.8)	824 (21.2)	3890 (13.2)
	Adani	2049 (51.1)	1960 (48.9)	4009 (13.6)
	Total	12746 (43.3)	16712 (56.7)	29458 (100.0)
		χ^2 = 7143.589, df = 3, p = 0.0001		

Table 7. Sex-related prevalence of malaria stratified according to sampled communities

Community	Sex	Infection	Status	Total (%)
		Positive (%)	Negative (%)	
Ishiagu	Male	2201 (65.8)	1146 (34.2)	3347 (43.8)
	Female	2839 (66.0)	1460 (34.0)	4299 (56.2)
	Total	5040 (65.9)	2606 (34.1)	7646 (100.0)
		χ^2 = 0.065, df = 1, p = 0.799		
Abakaliki	Male	880 (16.5)	4457 (83.5)	5337 (38.4)
	Female	1711 (20.0)	6865 (80.0)	8576 (61.6)
	Total	2591 (18.6)	11322 (81.4)	13913 (100.0)
		χ^2 = 26.023, df = 1, p = 0.0001		
Eha-Amufu	Male	943 (71.9)	369 (28.1)	1312 (33.7)
	Female	2123 (82.4)	455 (17.6)	2578 (66.3)
	Total	3066 (78.8)	824 (21.2)	3890 (100.0)
		χ^2 = 57.152, df = 1, p = 0.0001		
Adani	Male	598 (41.0)	859 (59.0)	1457 (36.3)
	Female	1451 (56.9)	1101 (43.1)	2552 (63.7)
	Total	2049 (51.1)	1960 (48.9)	4009 (100.0)
		χ^2 = 92.826, df = 1, p = 0.0001		
Overall	Male	4622 (40.4)	6831 (59.6)	11453 (100.0)
	Female	8124 (45.1)	9881 (54.9)	18005 (100.0)
	Total	12746 (43.3)	16712 (56.7)	29458 (100.0)
		χ^2 = 64.738, df = 1, p = 0.0001		

In all the three years of study, malaria prevalence was significantly ($p < 0.05$) higher among Enugu residents than their Ebonyi counterparts in 2015. Also, the three years retrospective study showed that the prevalence of malaria in Ebonyi state rice farming communities showed a progressive ascending decline with a sharp drop between 2015 and 2016. At the community level, the yearly difference in malaria prevalence in the two rice farming communities of Ishiagu and Abakaliki showed a sharp drop between 2015 and the years 2016 and 2017 which was statistically significant. Similarly, the prevalence of malaria in Enugu State rice farming communities was different significant on a yearly scale. On the overall, the community with the most malaria prevalence was Eha-Amufu followed by Ishiagu while the least is Abakaliki. There was evidence that malaria transmission risk varies even between neighbouring villages and is influenced by agroecosystems [2,18].

In Ebonyi, peak prevalence occurred in July and August, after which incidence dropped in September while in Enugu State rice farming communities, there was a steady rise from March till September when the peak was reached. The study also showed that when disaggregated by years, the rise in prevalence of malaria between April and September in both Enugu and Ebonyi was consistent. However, peak incidence was not always in the rainy months of May, June, July, August and September. This result is supported by [12] who reported that transmission of malaria was mostly below detection level during the dry season, whereas it was high toward the end of the rainy season growing villages in Bamako, Mali. Similarly, [19] reported that the incidence of clinical malaria in inland rice farming communities of the forest region of western Côte d'Ivoire was significantly higher in the rainy season than in the dry season.

5. CONCLUSION

There was a high prevalence of malaria infection in the purposely selected rice farming settlements in the two selected states of south-east Nigeria**.** The prevalence was sex-dependent and dropped progressively yearly probably due to the use of some latest WHO-approved intervention strategies such as ITNs and the improvement in health facilities in the regions. We therefore suggest that the fight against malaria should be intensified in agrarian settlements especially rice farm settlements.

CONSENT AND ETHICAL APPROVAL

As per university standard guideline, participant consent and ethical approval have been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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