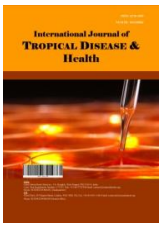

International Journal of TROPICAL DISEASE & Health

39(4): 1-12, 2019; Article no.IJTDH.53345
ISSN: 2278–1005, NLM ID: 101632866

Further Analyses of Trends in Malaria Diagnoses and Incidence Rates (2014-2018) in Edo State, Nigeria

A. Ebomwonyi[1], A. O. Omorogie[2], M. A. E. Noutcha[3], M. C. Abajue[3] and S. N. Okiwelu[3*]

[1]Department of Disease Control, Ministry of Health, Benin City, Edo State, Nigeria.
[2]Department of Animal and Environmental Biology, University of Benin, Benin City, Nigeria.
[3]Department of Animal and Environmental Biology, University of Port Harcourt, Port Harcourt, Nigeria.

Authors' contributions

The work was carried out in collaboration among all authors. Author AE Coordinated malaria data collection in Edo State. Author AOO did same for population data. Authors SNO and MAEN conceived the study and wrote the protocol. Author MCA managed the literature search. Author SNO wrote the final draft from the first draft of author MAEN. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJTDH/2019/v39i430212
Editor(s):
(1) Dr. Shankar Srinivasan, Associate Professor, Department of Health Informatics Rutgers - School of Health Professions, USA.
Reviewers:
(1) Mohammad Tahir Waheed , Quaid-i-Azam University, Pakistan.
(2) Mila Nu Nu Htay, Melaka-Manipal Medical College, Malaysia.
(3) Tabe Franklin Nyenty, University of Yaounde 1, Cameroon.
Complete Peer review History: http://www.sdiarticle4.com/review-history/53345

Original Research Article

Received 12 October 2019
Accepted 17 December 2019
Published 23 December 2019

ABSTRACT

Background: The United Nations Inter-Agency and Expert Group on Millennium Development Goals (MDGs), established incidence rate as one of the indicators for monitoring progress on Malaria control. Data on malaria incidence rates in Edo State, Nigeria, 2006-2013 were published in 2015. The current study focused on incidence rates, 2014-2018. In addition, trends in malaria diagnoses were also investigated.
Methods: Records of numbers of patients from the 18 Local Government Areas (LGAs) complaining of malaria, at LGA Health Centres, State Hospitals, etc. were obtained from the Department of Disease Control, State Ministry of Health, Benin City. Patients were placed in 3 categories: Fever, without malaria confirmation, confirmed uncomplicated, confirmed severe. Human population records over the 5-year period were obtained from the Nigeria Population

**Corresponding author: Email: okiwelu2003@yahoo.com;*

Commission, Benin City. Incidence rates were calculated and relative proportions of patients in the 3 categories determined.

Results: The numbers of fever cases, without malaria confirmation, varied across LGAs and constituted 58.00-68.00% of all fever cases annually. In confirmed cases of malaria, most were uncomplicated. The highest numbers of confirmed cases were in Egor and Oredo LGAs. The pattern was similar in uncomplicated and severe cases. The ratios of uncomplicated and severe cases of malaria varied significantly ($p<0.05$) annually. Malaria incidence rates varied among LGAs in each of the years: 2014 (0.75-5.48%), in 2015 (0.24-2.55%), in 2016 (1.44-5.21%), in 2017 (1.17-9.69%), in 2018 (0.63-4.03%). However, these differences were not significant ($p>0.05$). In the period 2014-2018, malaria incidence rates of 5.00% and above were recorded only 5times across LGAs: Egor, 2014 (5.48%); Esan Central, 2016 (5.14%; Ovia southwest, 2016 (5.21%), 2017 (9.69%); Uhunmwnde, 2017 (5.05%).

Conclusion: The decline in malaria incidence rates, 2014-2018, over the 2006-2013 data indicates progress. However, there are still daunting challenges which have been detailed in the text. These results also highlight the need for malaria test confirmation rather than utilizing fever as the exclusive symptom for malaria. All stakeholders must intensify efforts to ensure that this downward trend in malaria incidence rates is sustained.

Keywords: Malaria; confirmed cases; uncomplicated; severe; incidence rate; Edo State; Nigeria.

1. INTRODUCTION

On the eve of the 21st century, Nchinda of the World Health Organization (WHO) wrote: "Malaria, A reemerging disease in Africa". Sadly, Africa was never part of the eradication campaign of the 1950s and 1960s. He estimated deaths at 300- 500 million annually and 90% in children under 5years old. Malaria was estimated to cause 2.3% of global diseases [1], after pneumococcal acute respiratory infections (3.5%) and tuberculosis (2.8%). Malaria epidemics were reported in 14 African countries, 1994-1996, with many deaths [2] and in areas previously not known for malaria. Two main tools were recommended: drugs for early treatment of the most vulnerable and, vector control: Insecticide-treated nets (ITNs) and Indoor Residual Spray (IRS) [3].

By the turn of the century in 2000, the number of malaria deaths in young children in Sub-Saharan Africa was 803,000 (Precision estimate: 710,000-896,000) [4]. Malaria causes about 20% of all deaths in children under 5 in Africa; it is now the most important cause of deaths in the group [5]. In malaria endemic countries in Africa, 25-40% of all out-patient visits and 20-50% of hospital admissions are due to malaria [5]. There were malaria epidemics in fringe areas in 19 countries where inhabitants had low immunity, 1997-2002[4]. Multilateral Initiative on Malaria was established in 1997 in Dakar.

In 2005, the World Health Assembly (WHA) set 2010, to ensure that at least 80% of those at risk of malaria or suffering from it benefit from improved preventive and curative interventions, to reduce the burden by at least 50%, compared to 2000 levels [6]. In 2008, the UN Secretary General was even more ambitious to prevent malaria deaths by ensuring universal coverage of interventions by 2010[7]. In 2008, the Global Malaria Action Plan (GMAP) was launched by the Roll Back Malaria (RBM) to reduce malaria deaths to near zero by 2015. The UN inter-agency and Expert Group on Millennium Development Goal (MDG) indicators established the following indicators for malaria: Incidence and deaths rates associated with malaria, proportion of children under 5years sleeping under insecticide-treated nets, proportion of children under 5years with fever who are treated with anti-malaria medicines[8].

Malaria mortality rates have been reduced by 47% in all age groups worldwide between 2000 and 2003, leading to an estimated prevention of 4.3 million deaths. Fifty five countries were on track to meet RBM/WHO targets of reducing incidence rates by 75% in 2015 [9]. Empirical studies have shown that the use of Long Lasting Insecticide Nets (LLINs), Indoor Residual Spay (IRS) and Intermittent Preventive Therapy (IPT) have been the drivers of decline in transmission. As transmission declines, the proportion of individuals affected decreases and the geographical clustering of individuals better delineated; such clusters are often called "malaria hotspots". They can be detected by using different malaria indices: incidence rates, prevalence rates, sociological markers of exposure and mosquito density. Declines are being slowed by several factors. Silent sustainers

of infections include: low density chronic infections [10], in infants [11], children of school-going age [12], pregnant women [13] and non-pregnant adults [14]. Changing clinical epidemiology, reflected in increase in median age of admission to hospitals, resistance in mosquitoes acquired either through target site mutations or related to detoxification and sequestration of active ingredients and behavioural resistance [15]. Resistance to artemisinin and Artemisin Combined Therapy (ACT) in Africa and difficulty in access to treatment for most at risk and hard to reach populations are some of other factors stalling decline in transmission [9].

Although the prevalence of *Plasmodium falciparum*, the most virulent of the 4 human *Plasmodium* species declined by 40% (1900-1929) and 24% (2010-2015) in Sub-Saharan Africa, there have been periods of rapid increase and decrease. The cycles and trends over the past 115 years are inconsistent with simplistic explanations. However, there has been little change to the continued high transmission belt covering large parts of West and Central Africa [16].

Malaria is highly endemic in Nigeria [17,18], where it accounts for 60% of outpatient visits to health facilities, 30% childhood deaths, 11% maternal deaths(4,500 annually) [17]. The financial loss is estimated at approximately 132 billion naira in form of treatment costs, prevention and loss of man-hours. The National Malaria Control Programme (NMCP) delivered 17 million ITNs (2005-2007); 6.6 million LLINs to cover 23% of the population at risk [19]. The programme delivered 4.5 million single dose packages of ACTs in 2006, 9 million in 2007, far below total requirements. However, funding for malaria increased from US$17 million in 2005 to US$60 million in 2007, provided by the Government, Global Fund and World Bank, was unlikely to be sufficient to meet national needs [19].

Challenges to malaria control in Nigeria include: drug resistance, dearth of quality control of drugs, inadequate malaria epidemiological data, incorrect diagnoses, widespread intermittent presumptive treatment; dearth of effective drug distribution mechanisms. Insecticide resistance, residual and outdoor transmission, behavioural plasticity (early biting indoor versus outdoor, varying by species. Biting behavior may also vary with geographical location) [9,20]. As indicated earlier, knowledge of malaria incidence rates is vital for monitoring goals, targets, policies and strategies for malaria control and elimination, discovering malaria hotspots, etc. Data on incidence rates in the Local Government Areas (LGAs) of Edo State over an 8-year period, 2006-2013, is in the database. The current analyses are for the 5-year period, 2014-2018.

2. MATERIALS AND METHODS

2.1 Study Area

Detailed aspects of the study area were provided in 2015 [21]. Edo State has 18 Local Government Areas (LGAs), distributed among the three eco-vegetational zones as follows: Derived savanna (Akoko-Edo, Etsako East, Etsako Central, Etsako West, Owan West, Esan North-East, Esan Central, Esan South-east); lowland rainforest Ovia South-West, Ovia North-East, Igueben, Egor, Uhunmwonde, Oredo, Ikpoba-Okha, Orhionmwon); Freshwater Swamp Forest (Ovia South-West, Oredo, Ikpoba-Okha, Orhionmwon). The major urban centers are: Benin City, State Capital (Oredo LGA), Igarra (Akoko-Edo LGA), Agenebode (Etsako East LGA), Sakponba (Orhionmwon LGA) and Ehor (Uhunmwonde LGA). In 2006- 2013, incidence rates increased steadily over the period in all LGAs, although there was a significant drop in 2011 at Esan West. Highest incidence rates were recorded in 2012/2013 at Uhunmwonde (10.4512-11.4959%) and Esan (13.5873-13.6548%); lowest rates (0.9691-2.3828%) at Akoko Edo LGA. Incidence rates rose in derided savanna, lowland rainforest, rural and urban centers.

2.2 Methods

The State Ministry of Health was involved in the study and ensured that high ethical standards were maintained. Human population data over the period were compiled, based on the 3.2% estimated Annual Growth Rate by the National Population Commission (Table 1). Numbers of confirmed fever/malaria cases were obtained from the 3-tier health care referral system. There is the Primary Healthcare Centre at the Head Quarters of LGAs but they have limited facilities. Improvement in facilities and personnel occurs at the Secondary Healthcare level, with hospitals in State Headquarters. There is further improvement in facilities and personnel at the tertiary level, represented by Teaching and Specialist Hospitals, funded by the Federal Government

Table 1. Edo state population across lgas (2014-2018)

Edo state population (growth rate = 3.2%)						
LGAs	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Akoko-Edo	315847	325954	336385	347149	358258	369722
Egor	409584	422691	436217	450176	464581	479448
Esan Central	126900	130961	135152	139477	143940	148546
Esan North East	143814	148416	153165	158067	163125	168345
Esan South East	202107	208574	215248	222136	229245	236581
Esan West	151642	156494	161502	166670	172004	177508
Etsako Central	113964	117611	121375	125259	129267	133404
Etsako East	175928	181557	187367	193363	199551	205936
Etsako West	238122	245742	253606	261721	270096	278739
Igueben	83916	86601	89373	92233	95184	98230
Ikpoba-Okha	447189	461499	476267	491508	507236	523467
Oredo	451485	465932	480842	496229	512108	528496
Orhionmwon	220177	227223	234494	241998	249742	257733
Ovia North East	185391	191323	197445	203764	210284	217013
Ovia South West	163106	168326	173712	179271	185008	190928
Owan East	186037	191990	198133	204474	211017	217769
Owan West	117354	121110	124985	128985	133112	137372
Uhunmwonde	145582	150240	155048	160010	165130	170414
	3878144	**4002245**	**4130317**	**4262487**	**4398886**	**4539651**

Numbers of patients for malaria treatment were retrieved from the database of the Malaria Control Section, Ministry of Health, Benin City, Edo State. Incidence rates were calculated thus:

$$\frac{\text{Number of malaria cases}}{\text{Human population}} \times \frac{100}{1}$$

Patients were placed initially in 2 categories: Febrile (fever) cases, confirmed malaria cases by microscopy. The confirmed cases were further sub-divided into uncomplicated and severe [22]. In uncomplicated malaria, the interval from time of infection until parasites become detectable in blood is termed pre-patent period, while the term incubation period is the interval between infection and the onset of symptoms. Duration of incubation period is influenced by several factors: parasite species, immune status, etc. The first symptoms are non-specific and mimic flu-like syndrome. The hallmark is fever, but before the onset of fever are symptoms, such as malaise, anorexia, lassitude, dizziness and a sense of chillness [23]. Fever is usually irregular in the early stage. Most of the severe malaria complications occur in non-immune subjects with *falciparum* malaria and involve the central nervous system (Cerebral malaria), renal system (acute renal failure) and/or haematopoietic (severe anaemia). Progression of severity can be rapid and severe is a potentially fatal disease, so treatment must be rapid [24]. Computer programme Rafbadu T. designed was used for statistical analyses (Restriction semi groups, partial transformation, ANOVA, etc.

3. RESULTS

The highest numbers of confirmed malaria cases were in Egor (23,164) and Oredo (11,849) LGAs; the number in each of the other 16 LGAs was less than 7,000. This pattern was similar in the numbers of uncomplicated: Egor (15,159) and Oredo (10,235), while each of the other LGAs recorded less than 6,700; severe: Egor (8,005) and Oredo (1,564). The number of confirmed cases varied significantly from fever cases, without malaria confirmation in 2014 across LGAs except Egor (Table 2a). In 2015, confirmed cases varied significantly $p<0.05$, from cases of fever without confirmation across LGAs, except in Owan west (Table 2b); in 2016, the confirmed cases varied significantly ($p<0.05$) from the fever cases, without malaria confirmation except in Igueben, Orhionmwon and Owan West LGAs (Table 2c); in 2017, the confirmed cases varied significantly ($p<0.05$) from the fever cases, without malaria confirmation, except in 5LGAs (Esan south-east, Etsako, Igueben, Orhionmwon and Owan west) (Table 2d); in 2018, the confirmed and fever cases without malaria confirmation did not vary significantly ($p>0.05$) (Table 2e). The numbers of fever cases without malaria confirmation varied across LGAs and years. Fever cases, without malaria test confirmation of 5% and higher were recorded 2

times in the population and constituted 58.00-68.00% of all fever cases annually. In 2014, the rates in the populations were 1.67-8.58% in Ikpoba-Okha and Owan West respectively. In 2015, 1.41-6.30% in Esan SouthEst and Ovia Southwest LGAs respectively; in 2016, the rates were 1.90-6.72% in Owan East and Uhunmwonde LGAs respectively; in 2017, the rates were 1.50-12.49% in Esan Southeast and Ovia Southwest LGAs respectively; in 2018, 1.76-6.77% in Orhionmwon and Ovia Southwest LGAs respectively (Tables 2a,b,c,d,e). In confirmed cases of malaria, most of them were uncomplicated in 2014, except in Egor (65.44%), Ikpoba-Okha (86.36%) and Oredo (86.80%); consequently, the highest percentages of severe cases were recorded in these 3 LGAs in 2015, except in Egor (75.08%); Etsako West (88.38%); Igueben (85.63%), Oredo (89.95%); consequently, the highest numbers of severe cases were recorded in these 4 LGAs; in 2016-2017, most of the cases were uncomplicated in all LGAs. In 2018, most of the cases were uncomplicated except in Oredo (85.84%). The ratios of uncomplicated and severe cases of malaria varied significantly ($p<0.05$) over the years (2014, 2015, 2016, 2017, 2018) (Table 2a b, c, d, e).

Malaria incidence rates varied among LGAs in each of the years: 2014 (0.75-5.48%); in 2015 (0.24-2.55); in 2016 (1.44-5.21%); in 2015 (1.17-9.69%, in 2018 (0.63-4.03%). However these differences were not significant (2014, F=1.097; 2015, F=0.827; 2016, F= 0.830; 2017, F=1.010; 2018, F=0.967. In the period, 2014- 2018, incidence rates of 5.00% and above were recorded only 5 times across LGAs: Egor, 2014 (5.48%); Esan central, 2016 (%); Ovia south west, 2016 (5.21%); 2017 (9.69%); Urhunmwonde, 2017 (5.05%) (Table 2a, 2b, 2c, 2d, 2e).

4. DISCUSSION

Incidence rates declined during the 5-year period (2014-2018), compared to the 8-year period (2006- 2013). In the period, 2014-2018, incidence rates of 5.00% and above, were recorded only 5times: Egor 2014 (5.48%), Esan Central 2016 (5.14%), Ovia South West 2016 (5.21%) and 2017 (9.69%), Urhunmwonde 2017 (5.05%). The urban/rural divide apparently did not affect incidence rates, Egor and Esan Central LGAs have major urban areas: Benin City and Uromi respectively, while Ovia South West and Urhunmwonde LGAs are mostly rural. Similarly, vegetation also was not a factor because Esan Central LGA is in derived savanna, while Ovia South West, Egor and Urhunmwonde LGAs are in lowland rainforest/freshwater swamp forest. In contrast, during the period, 2006-2013, incidence rates of 5.00% and above were recorded 38 times: in Esan Central, the incidence rates were more than 6.5% in each of the 8 years, the maximum rate was 13.6648% in 2013; in Urhunmwonde, the incidence rates were consistently more than 6.0% except in 2010, when it dipped to 4.3642%. In the period, 2005-2013, double digit incidence rates were recorded 5 times in Esan Central (10.0313%, 13.5873%, 13.6548%) and Urhunmwonde (10.4512%, 11.495%). Several factors might have led to the decline. Concerted efforts by the World Health Organization, World Bank, Bill and Melinda Gates Foundation culminated in 2008, to the launch of the Global Malaria Action Plan (GMAP). The UN inter-agency and Expert group on MDG indicators established incidence and death rates associated with malaria as one of the indicators for monitoring progress on the disease control. At the national level, the National Malaria Control Programme is driving the process. Consequently, there was increased awareness, leading to efforts at reducing incidence and prevalence. Some of the tools included: the use of Insecticide treated nets (ITNs), Indoor residual sprays (IRS) (8-10, 2010, 2012), the use of physical structures such as insect-proof netting to prevent mosquitoes entering homes and reduction of natural and man-made breeding sites [7,8].

On the eve of the 21st century, Nchinda of WHO wrote that fever was still the most recognizable symptom of malaria and that studies were underway to determine the number of fever cases, actually due to malaria [3]. These results revealed the danger in using fever exclusively as the key malaria symptom. Although it was noted in 2017 that there had been recession in the prevalence of *Plasmodium falciparum* in sub-Saharan Africa, these had been interrupted by periods of rapidly increasing and decreasing transmission. There has been little change in the continued high transmission belt covering large parts of west and central Africa [16]. The dominance of uncomplicated cases in the current study compared favourably with those of Camponovo et al.[25] who obtained in-patient cases of uncomplicated (478.7) and severe(44.8) per 100.000 persons annually. Nkumama et al. [15] observed that in geographical risk areas, as transmission declines, and the proportion of individuals harbouring asymptomatic

Table 2a. Edo State malaria dagnioses / incidence rate in 2014

Lgas	Population	Confirmed in population						Fever, without confirmation population			
		Uncomplicated		Severe		Total confirmed					
		Number	%	Number	%	Total	Incidence rate	Number	%	% Uncomplicated in confirmed	% Severe in confirmed
Akoko-Edo	325954	7493	2.30	129	0.04	7622	2.34	12853	3.94	98.31	1.69
Egor	422691	15159	3.59	8005	1.89	23164	5.48	21122	5.00	65.44	34.56
Esan Central	130961	5070	3.87	37	0.03	5107	3.90	9267	7.08	99.28	0.72
Esan North-East	148416	2920	1.97	75	0.05	2995	2.02	7090	4.78	97.50	2.50
Esan South-East	208574	2169	1.04	52	0.02	2221	1.06	6757	3.24	97.66	2.34
Esan West	156494	1135	0.73	46	0.03	1181	0.75	2995	1.91	96.10	3.90
Etsako Central	117611	5065	4.31	31	0.03	5096	4.33	7839	6.67	99.39	0.61
Etsako East	181557	3445	1.90	145	0.08	3590	1.98	10230	5.63	95.96	4.04
Etsako West	245742	5691	2.32	278	0.11	5969	2.43	11128	4.53	95.34	4.66
Igueben	86601	2430	2.81	132	0.15	2562	2.96	4273	4.93	94.85	5.15
Ikpoba-Okha	461499	3989	0.86	630	0.14	4619	1.00	7684	1.67	86.36	13.64
Oredo	465932	10285	2.21	1564	0.34	11849	2.54	16309	3.50	86.80	13.20
Orhionmwon	227223	6656	2.93	306	0.13	6962	3.06	8433	3.71	95.60	4.40
Ovia North-East	191323	3090	1.62	47	0.02	3137	1.64	10117	5.29	98.50	1.50
Ovia South-West	168326	4919	2.92	145	0.09	5064	3.01	12416	7.38	97.14	2.86
Owan East	191990	4155	2.16	186	0.10	4341	2.26	6934	3.61	95.72	4.28
Owan West	121110	3863	3.19	90	0.07	3953	3.26	10387	8.58	97.72	2.28
Uhunmwonde	150240	6609	4.40	130	0.09	6739	4.49	12577	8.37	98.07	1.93
Total	**4002245**	**94143**	**2.35**	**12028**	**0.30**	**106171**	**2.65**	**178411**	**4.46**	**88.67**	**11.33**

Table 2b. Edo State / malaria dagnioses / incidence rate in 2015

LGAs	Population	Confirmed in population						Fever without confirmation in population		% In confirmed cases	
		Uncomplicated		Severe		Total confirmed					
		Number	%	Number	%	Total	Incidence rate	Number	%	% Uncomplicated in confirmed	% Severe in confirmed
Akoko-Edo	336385	3601	1.07	74	0.022	3675	1.09	11777	3.50	97.99	2.01
Egor	436217	5083	1.17	1687	0.387	6770	1.55	10925	2.50	75.08	24.92
Esan Central	135152	2998	2.22	74	0.055	3072	2.27	5037	3.73	97.59	2.41
Esan North-East	153165	2063	1.35	50	0.033	2113	1.38	6334	4.14	97.63	2.37
Esan South-East	215248	515	0.24	3	0.001	518	0.24	3041	1.41	99.42	0.58
Esan West	161502	1680	1.04	21	0.013	1701	1.05	2575	1.59	98.77	1.23
Etsako Central	121375	1015	0.84	2	0.002	1017	0.84	1786	1.47	99.80	0.20
Etsako East	187367	1757	0.94	17	0.009	1774	0.95	4669	2.49	99.04	0.96
Etsako West	253606	4092	1.61	538	0.212	4630	1.83	9103	3.59	88.38	11.62
Igueben	89373	1949	2.18	327	0.366	2276	2.55	3392	3.80	85.63	14.37
Ikpoba-Okha	476267	5037	1.06	522	0.110	5559	1.17	9305	1.95	90.61	9.39
Oredo	480842	6656	1.38	744	0.155	7400	1.54	13692	2.85	89.95	10.05
Orhionmwon	234494	2012	0.86	130	0.055	2142	0.91	4114	1.75	93.93	6.07
Ovia North-East	197445	2445	1.24	1	0.001	2446	1.24	7861	3.98	99.96	0.04
Ovia South-West	173712	5787	3.33	66	0.038	5853	3.37	10941	6.30	98.87	1.13
Owan East	198133	1117	0.56	74	0.037	1191	0.60	1879	0.95	93.79	6.21
Owan West	124985	3443	2.75	38	0.030	3481	2.79	7940	6.35	98.91	1.09
Uhunmwonde	155048	1518	0.98	24	0.015	1542	0.99	2943	1.90	98.44	1.56
Total	**4130317**	**52768**	**1.28**	**4392**	**0.106**	**57160**	**1.38**	**117314**	**2.84**	**92.32**	**7.68**

Table 2c. Edo State malaria dagnioses / incidence rate in 2016

LGAs	Population	Confirmed in population						Fever without confirmation IN population		% confirmed cases	
		Uncomplicated		severe		Total confirmed					
		Number	%	Number	%	Total	Incidence rate	Number	%	% Uncomplicated in confirmed	% Severe in confirmed
Akoko-Edo	347149	9156	2.64	100	0.029	9256	2.67	14516	4.18	98.92	1.080
Egor	450176	16179	3.59	351	0.078	16530	3.67	22224	4.94	97.88	2.123
Esan Central	139477	7129	5.11	34	0.024	7163	5.14	9148	6.56	99.53	0.475
Esan North-East	158067	6263	3.96	58	0.037	6321	4.00	8832	5.59	99.08	0.918
Esan South-East	222136	4266	1.92	82	0.037	4348	1.96	6314	2.84	98.11	1.886
Esan West	166670	3586	2.15	29	0.017	3615	2.17	4991	2.99	99.20	0.802
Etsako Central	125259	4575	3.65	18	0.014	4593	3.67	6217	4.96	99.61	0.392
Etsako East	193363	4887	2.53	171	0.088	5058	2.62	7001	3.62	96.62	3.381
Etsako West	261721	9410	3.60	466	0.178	9876	3.77	13618	5.20	95.28	4.719
Igueben	92233	3775	4.09	62	0.067	3837	4.16	4447	4.82	98.38	1.616
Ikpoba-Okha	491508	8793	1.79	187	0.038	8980	1.83	10881	2.21	97.92	2.082
Oredo	496229	14657	2.95	259	0.052	14916	3.01	22051	4.44	98.26	1.736
Orhionmwon	241998	4387	1.81	59	0.024	4446	1.84	5760	2.38	98.67	1.327
Ovia North-East	203764	5212	2.56	0	0.000	5212	2.56	9652	4.74	100.00	0.000
Ovia South-West	179271	9249	5.16	99	0.055	9348	5.21	13304	7.42	98.94	1.059
Owan East	204474	2864	1.40	72	0.035	2936	1.44	3879	1.90	97.55	2.452
Owan West	128985	6229	4.83	36	0.028	6265	4.86	8619	6.68	99.43	0.575
Uhunmwonde	160010	7803	4.88	71	0.044	7874	4.92	10759	6.72	99.10	0.902
Total	**4262487**	**128420**	**3.01**	**2154**	**0.051**	**130574**	**3.06**	**182213**	**4.27**	**98.35**	**1.650**

Table 2d. Edo State malaria dagnioses / incidence rate in 2017

LGAs	Population	Confirmed in population						Fever without confirmation In population			
		Uncomplicated		Severe		Total confirmed					
		Number	%	Number	%	Total	Incidence Rate	Number	%	% Uncomplicated in confirmed	% Severe in confirmed
Akoko-Edo	358258	10622	2.96	44	0.012	10666	2.98	16099	4.49	99.59	0.413
Egor	464581	9703	2.09	5	0.001	9708	2.09	17646	3.80	99.95	0.052
Esan Central	143940	4216	2.93	11	0.008	4227	2.94	5571	3.87	99.74	0.260
Esan North-East	163125	5826	3.57	63	0.039	5889	3.61	7214	4.42	98.93	1.070
Esan South-East	229245	2663	1.16	24	0.010	2687	1.17	3434	1.50	99.11	0.893
Esan West	172004	2907	1.69	1	0.001	2908	1.69	4024	2.34	99.97	0.034
Etsako Central	129267	3987	3.08	30	0.023	4017	3.11	4831	3.74	99.25	0.747
Etsako East	199551	5648	2.83	122	0.061	5770	2.89	7766	3.89	97.89	2.114
Etsako West	270096	7180	2.66	121	0.045	7301	2.70	10716	3.97	98.34	1.657
Igueben	95184	4204	4.42	75	0.079	4279	4.50	5112	5.37	98.25	1.753
Ikpoba-Okha	507236	13268	2.62	0	0.000	13268	2.62	14857	2.93	100.00	0.000
Oro	512108	11574	2.26	832	0.162	12406	2.42	18408	3.59	93.29	6.706
Orhionmwon	249742	4749	1.90	52	0.021	4801	1.92	6193	2.48	98.92	1.083
Ovia North-East	210284	6565	3.12	19	0.009	6584	3.13	9184	4.37	99.71	0.289
Ovia South-West	185008	16647	9.00	1287	0.696	17934	9.69	23104	12.49	92.82	7.176
Owan East	211017	2888	1.37	41	0.019	2929	1.39	4111	1.95	98.60	1.400
Owan West	133112	5301	3.98	27	0.020	5328	4.00	7470	5.61	99.49	0.507
Uhunmwonde	165130	8320	5.04	17	0.010	8337	5.05	10417	6.31	99.80	0.204
Total	**4398886**	**126268**	**2.87**	**2771**	**0.063**	**129039**	**2.93**	**176157**	**4.00**	**97.85**	**2.147**

Table 2e. Edo State malaria dagnoses / incidence rate in 2018

LGAs	Population	Confirmed in population						Fever, without confirmation in population		% In confirmed cases	
		Uncomplicated		Severe		Total confirmed					
		Number	%	Number	%	Total	Incidence rate	Number	%	% Uncomplicated in confirmed	% Severe in confirmed
Akoko-Edo	369722	6581	1.78	17	0.005	6598	1.78	12737	3.45	99.74	0.26
Egor	479448	9814	2.05	12	0.003	9826	2.05	17826	3.72	99.88	0.12
Esan Central	148546	4854	3.27	74	0.050	4928	3.32	6795	4.57	98.50	1.50
Esan North-East	168345	3102	1.84	1	0.001	3103	1.84	4457	2.65	99.97	0.03
Esan South-East	236581	3318	1.40	4	0.002	3322	1.40	3641	1.54	99.88	0.12
Esan West	177508	2652	1.49	5	0.003	2657	1.50	3559	2.00	99.81	0.19
Etsako Central	133404	2120	1.59	48	0.036	2168	1.63	2634	1.97	97.79	2.21
Etsako East	205936	4989	2.42	43	0.021	5032	2.44	6692	3.25	99.15	0.85
Etsako West	278739	6676	2.40	239	0.086	6915	2.48	7792	2.80	96.54	3.46
Igueben	98230	3534	3.60	58	0.059	3592	3.66	4865	4.95	98.39	1.61
Ikpoba-Okha	523467	2034	0.39	0	0.000	2034	0.39	2343	0.45	100.00	0.00
Oro	528496	7531	1.42	1242	0.235	8773	1.66	13544	2.56	85.84	14.16
Orhionmwon	257733	1612	0.63	17	0.007	1629	0.63	4528	1.76	98.96	1.04
Ovia North-East	217013	2554	1.18	11	0.005	2565	1.18	4854	2.24	99.57	0.43
Ovia South-West	190928	7653	4.01	47	0.025	7700	4.03	12934	6.77	99.39	0.61
Owan East	217769	2529	1.16	68	0.031	2597	1.19	4010	1.84	97.38	2.62
Owan West	137372	2507	1.82	23	0.017	2530	1.84	3899	2.84	99.09	0.91
Uhunmwonde	170414	5222	3.06	10	0.006	5232	3.07	6685	3.92	99.81	0.19
TOTAL	4539651	79282	1.75	1919	0.042	81201	1.79	123795	2.73	97.64	2.36

or clinical infections decreases, the geographical clustering of infections become more apparent, such clusters they referred to are malaria hotspots, but none was discernable in the present study. The high numbers of confirmed cases in 3LGAs (Egor, Oredo, Ikpoba-Okha) were probably associated with the high human population density because the State capital, Benin City metropolis straddles the 3LGAs; this enhances transmission rates.

Finally, the decline in incidence rates is an indication of progress in our long-term goal of significantly reducing the malaria burden but there are still daunting challenges. These include: drug resistance, dearth of quality control of drugs, inaccurate malaria epidemiological data, incorrect diagnosis, dearth of effective rural drug distribution mechanism, widespread intermittent presumptive treatment, poor community involvement /participation in drug distribution [26] that leads to drugs expiring in stores if workers are prevented from deriving benefits from sales, inadequate finances [20], etc. Other challenges are: changing clinical epidemiology, reflected in increase in median age of admission in hospitals, resistance in mosquitoes, acquired either through target mutations or related to detoxification and sequestration of active ingredients and behavioural resistance and mosquito behavioural plasticity (heterogeneous behavior, early biting or indoor versus outdoor, varying by species. Biting behavior may also vary with geographical locations [9].

5. CONCLUSION

The decline in malaria incidence rates in 2014-2018, over those obtained in 2006-2013, indicated progress. However, all stakeholders (Government, Non-Governmental organizations-NGOs, academia, communities, individuals, etc.) must intensify efforts to ensure that the daunting challenges enumerated above are overcome or significantly reduced. Efforts must be intensified at health centres to ensure that all reported fever cases are followed by malaria tests to exclude or incriminate malaria as cause of fever.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

ACKNOWLEDGEMENT

The authors are indebted to the State Ministry of Health and the National Population omission, Benin City, for providing malaria and population data respectively. The efforts of Ms. Kamayou Monkam Elise Vianney of the Centre for Petroleum Geosciences/African Centre of Excellence, University of Port Harcourt for re-formatting the data for statistical analyses are appreciated. The dedication of Dr. Emmanuel Biu of the Department of Mathematics/ Statistics, University of Port Harcourt in undertaking statistical analyses was commendable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. World Health Organisation. Investing in Health research for development: Report of the Ad Hoc Committee on Health Research Relating to Future Intervention Options. Geneva. The Organisation. Report No. TDR/Gen. 1996;96.
2. Organisation of African Unity (OAU). Harare Declaration on Malaria Prevention and Control in the context of African economic recovery and development *In:* Proceeding of the 33rd Ordinary session of the Assembly of Heads of State and Government, OAU, Harare, Zimbabwe; 1997.
3. Nchinda TC. 1998. Malaria: A Reemerging Disease in Africa. WHO special Issue. 1998;4(3):398-403.
4. World Health Organisation. Malaria Control Today: Current WHO recommendation working document. Geneva. 2005; 75.
5. World Health Organisation. Pregnancy, childbirth, postpartum and newborn care: A guide for essential practice, WHO, UNFPA, UNICEF, and the World Bank Group; 2003.
6. World Health Assembly. Malaria Control. *In* fifty eighth World Health Assembly, Geneva. Resolutions and Decisions, and list of participants. Geneva. 2005;1.
7. United Nations. The global malaria action plan for a malaria-free world. Geneva. Roll Back Malaria, 2008.
8. United Nations, World Malaria Report; 2011.

9. Guyant P. et al. Past and new challenges for malaria control and elimination: The role of operational research for innovation in designing interventions. Malaria Journal. 2015;14:11.
10. Galatas B. et al. Malaria parasites in the asymptomatic: Looking for the hay in the haystack. Trends in Parasitology. 2016; 32:296-308.
11. Ceesay SJ. et al. Changes in Malaria indices between 1999 and 2007 in the Gambia: A retrospective analysis. Lancet 2008;372:1545-1554.
12. Pinchoff J. et al. 2016. Individual and household level risk factors associated with malaria in Nchelenge District, a region with perennial transmission: A serial cross-sectional study from 2012 to 2015. Plos One. 2016;11:eO156 717.
13. Chaponda EB. et al. High burden of malaria infection in pregnant women in a rural district of Zambia: A cross-sectional study. Malaria Journal. 2015;14:380.
14. Jenkins R. et al. Prevalence of malaria parasites in adults and its determinants in malaria enemic area of Kisumu County, Kenya. Journal of Infectious Diseases. 2015;213:1516-1517.
15. Nkumana IN, O'Meara WP, Osier FHA. Changes in malaria epidemiology in Africa and new challenges for elimination. Trends in Parasitology. 2017;33(2):128-140.
16. Snow RW et al. The prevalence of *Plasmodium falciparum* in sub-Saharan Africa since 1990. Nature. 2017;550(76-77):515-518.
17. Hemingway J. and Bates I. Malaria: Past problems and future prospects. After more than a decade of neglect, malaria is finally back on the agenda for both biomedical research and public health politics. EMBC Rep. 2003;4:329-331.
18. Federal Ministry of Health. Nigerian Demographic and Health Survey; 2011.
19. National malaria Control Programme. Annual Malaria Report; 2011.
20. Chwukwuocha UM. Malaria control in Nigeria. Primary Health Care. Open Access. 2012;2(3):5.
21. Ebomwonyi A, Omoregie AO, Noutcha MAE, Okiwelu SN. Trend in malaria incidence rates (2006-2013) in Edo State, Nigeria. International Journal of Tropical Disease and Health. 2015;7(2):40-48. ISSN: 2278–1005
22. Bartoloni A, Zammarchi L. Clinical aspects of uncomplicated and severe malaria. Mediterranean Journal of Haematology and Infectious diseases. 2012;4:10
23. Warrell DA. Clinical features of Malaria. *In* Bruce-Chwat's Essential Malariology. Giles HM and Warrell DA (Eds) 3rd Edition. A Hodder Arnold Publication, London. 1993; 35-49.
24. Harinasuta T, Bunnang D. The clinical features of malaria. In Malaria: Principles and practice of malariology. Wernsdorfer WH, McGregor I. (Eds). Churchill Livingstone, London. 1988;709-734.
25. Camponovo F, et al. Incidence and admission rates for severe malaria and their impact on mortality in Africa. Malaria 2017;16:1-12.
26. Okoroaffia NQ. The fate of donated malaria drugs in Rivers State, Nigeria. The theses repository for undergraduate project reports, Departmental Library, Department of Animal and Environmental Biology, University of Port Harcourt, Nigeria; 2015.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/53345