SEASONAL CHANGE AS BASIS FOR PREDICTION OF *PLASMODIUM* SPECIES IN EPIDEMIC REGIONS OF VISAKHAPATNAM DISTRICT, ANDHRA PRADESH.

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ABSTRACT:

Malaria epidemics due to *Plasmodium* species are reported frequently in the Andhra Pradesh, Visakhapatnam highlands with high case fatality rates. There have been formal attempts to predict epidemics by the use of climatic variables that are predictors of transmission potential. However, little consensus has emerged about the relative importance and predictive value of different factors. Understanding the reasons for variation is crucial to determining specific and important indicators for epidemic prediction. The impact of temperature on the duration of a mosquito's life cycle and the sporogonic phase of the parasite could explain the inconsistent findings. To improve reliability and general liability within similar climatic conditions, we grouped the districts into two climatic zones, hot and cold. In cold districts, rainfall was associated with a delayed increase in malaria cases, while the association in the hot districts occurred at relatively shorter lags. The interaction between climatic factors and their biological influence on mosquito and parasite life cycle is a key factor in the association between weather and malaria. These factors should be considered in the development of malaria early warning system.

Key words: *Plasmodium* species, Andhra Pradesh, Visakhapatnam, Epidemics, Endemic region,

INTRODUCTION:

Vector-borne diseases account for around 20% of all irresistible infections, causing more than 1- million passing every year among which mosquito vector borne diseases plays a major part (WHO, 2014). In later a long time, vector-borne diseases have risen as a genuine open wellbeing issue in nations of the South-East locale, counting India (Thankachan and Gopinath,2017). In spite of seriously inquire about and gigantic consumption towards the control of mosquito vector borne diseases, no such techniques are compelling till presently. Satisfactory information on mosquito science is the establishment on which ready to trust to control them and along these lines the mosquito vector borne diseases (Suh *et al*., 2016).

Plasmodium species malaria is a life-threatening disease for individuals with low immunity(Reiskind and Zarrabi, 2012), Panigrahi *et al*., (2014). Communities that are not normally exposed to high rates of malaria transmission are therefore vulnerable to explosive epidemics that can cause high case fatality rates among all age groups (Tillman A.M *et al*.,(2004)Sutherland C. J *et al*.,(2005). Epidemics can be defined by their main causal factors

and in this paper we concentrate on those triggered predominately by climate or weather(Bentley, M. D., Day, J. F. (1989). In spite of their severity, research on malaria epidemics is limited. Estimates of the population at risk of weather or climate dependent malaria epidemics in India are contradictory which makes estimation of the epidemiologic burden of epidemics(WHO AFRO, (1996) Snow RW *et al*.,(1999).

Climate also determines human behaviors that may increase contact with *Anopheles* mosquitoes between dusk and dawn, when the *Anopheles* are most active (Najera JA *et al*.,(1998) (Kovats SR *et al*.,(2003) Tiwary M (2007). Hot weather may encourage people to sleep outdoors or discourage them from using bed nets (Kiszewski AE (2004). During harvest seasons, agricultural workers might sleep in the fields or nearby locales, without protection against mosquito bites (Yanoviak, S.P. (2001).

MATERIAL AND METHODS:

To estimate the epidemiologic burden of malaria epidemics, we first present a definition of the types of malaria epidemics and identify those included in this analysis. On the basis of this definition, we examine available estimates of the population at risk of epidemics. Estimates of the frequency of occurrence of epidemics are obtained from the literature and applied to our chosen at risk population estimate. We then go on to examine the possible consequences of these epidemics in terms of morbidity and mortality using available figures and place our results in the context of estimated annual worldwide malaria mortality. For the present experiment, the species *Plasmodium vivax and Plasmodium falciparum* were collected from infected persons from Public Health Centers in Visakhapatnam district.

Sterilization:

In the course of experimentation, instruments such as syringes, needles, scissors, forceps, bottles and vials etc., were sterilized before use. The sample collecting bottles were sterilized in autoclave. The hot air oven was also used to dry the needles and other necessary glass vials for the collection.

Blood Collection:

The blood (*Plasmodium vivax and Plasmodium falciparum antigens*) were extracted from peripheral vein of hand of infected person and was collected in sterilized test tubes with physiological citrated saline.

Preparation of antigen:

Freshly drawn infected blood was placed directly in to a clean test tube with anticoagulant EDTA. The cells were washed several times in Phosphate Buffered Saline (PBS, pH 7.0) by centrifugation at 1000 rpm for 15minutes. The washed red cells were suspended in phosphate buffered saline and packed by centrifugation. The supernatant serum was removed with rubber bulb pipette. After obtaining antigen it was immediately used for investigations. Antigen which was not used immediately was stored at -20°C until use.

Staining:

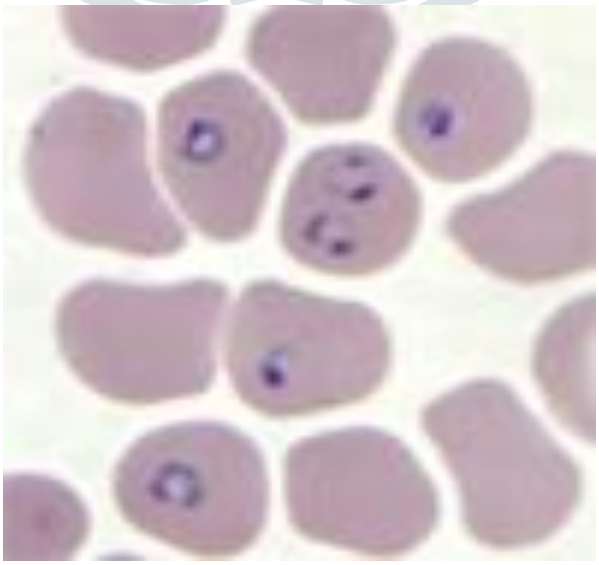
The blood smears were made on clean slides and dried immediately. The smears were covered with Leishman's stain for one minute. They were added equal quantity of distilled water and mixed by tilting the slide or blowing over the stain. They were stained for 10 minutes, washed with water and immediately dried. The blood smears were examined under oil immersion at a magnification of 10x100 under the microscope. The parasite was studied by counting the parasites were expressed in terms of the number of infected cells per 100 RBC. Different erythrocytic stages were identified in the red blood corpuscles.

Identification Malaria Parasites:

Malaria parasites are micro-organisms that belong to the genus *Plasmodium*. There are more than 100 species of *Plasmodium*, (Anne Hudson, B.N. (1956). which can infect many animal species such as reptiles, birds, and various mammals. Four species of *Plasmodium* have long been recognized to infect humans in nature. In addition there is one species that naturally infects macaques which has recently been recognized to be a cause of zoonotic malaria in humans. (There are some additional species which can, exceptionally or under experimental conditions, infect humans).

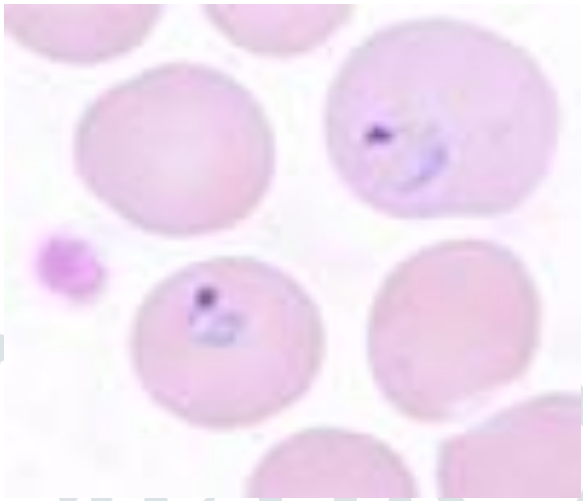
The species infecting humans are:

P. falciparum, which is found worldwide in tropical and subtropical areas. It is estimated that every year approximately 1 million people are killed by *P. falciparum*, especially in Africa where this species predominates. *P. falciparum* can cause severe malaria because it multiples rapidly in the blood, and can thus cause severe blood loss (anemia). In addition, the infected parasites can clog small blood vessels. When this occurs in the brain, cerebral malaria results, a complication that can be fatal.



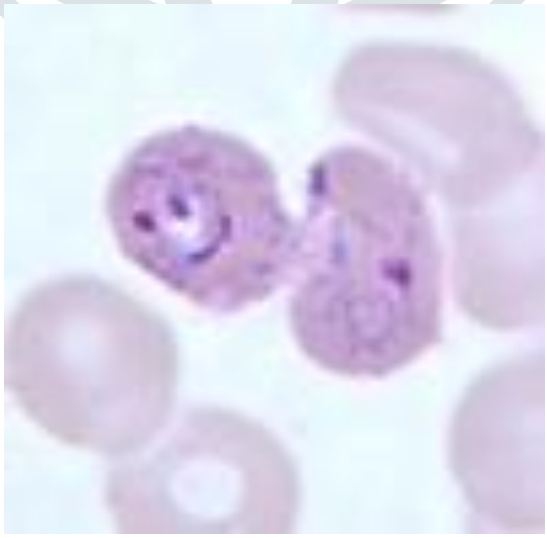
Ring-form trophozoites of *P. falciparum* in a thin blood smear.

P. vivax, which is found mostly in Asia, Latin America, and in some parts of Africa. Because of the population densities especially in Asia it is probably the most prevalent human malaria parasite. *P. vivax* (as well as *P. ovale*) has dormant liver stages ("hypnozoites") that can activate and invade the blood ("relapse") several months or years after the infecting mosquito bite.



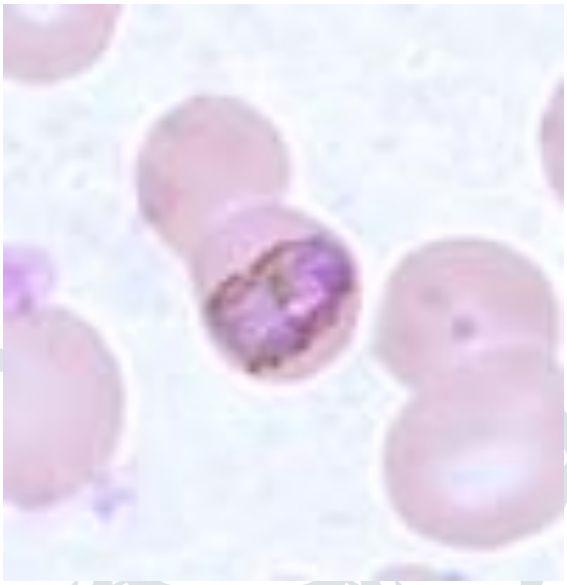
Ring-form trophozoites of *P. vivax* in a thin blood smear

P. ovale is found mostly in Africa (especially West Africa) and the islands of the western Pacific. It is biologically and morphologically very similar to *P. vivax*. However, differently from *P. vivax*, it can infect individuals who are negative for the Duffy blood group, which is the case for many residents of sub-Saharan Africa(Wirth &Dyann2002). This explains the greater prevalence of *P. ovale* (rather than *P. vivax*) in most of Africa.



Trophozoites of P. *ovale* in a thin blood smear

P. malariaefound worldwide, is the only human malaria parasite species that has a quart an cycle (three-day cycle). (The three other species have a tertian, two-day cycle.) If untreated, *P. malariae* causes a long-lasting, chronic infection that in some cases can last a lifetime. In some chronically infected patients *P. malariae* can cause serious complications such as the nephritic syndrome have been reported.



Band-form trophozoites of *P.malariae* in a thin blood smear.

TABLE –I

YEAR WISE MALARIA EPIDEMIOLOGICAL SITUATION

VISAKHAPATNAM DISTRICT

Year	B.S. Collection	POSITIVES			ABER	API	SPR	SFR	PF%
		Pv	Pf	Total					
RURAL									
2012	937569	3984	7832	11816	23.20	3.20	1.26%	0.84%	66.28%
2013	1093154	3132	9465	12597	28.40	3.40	1.15%	0.87%	75.14%
2014	920510	2582	7312	9894	22.60	2.50	1.07%	0.79%	73.90%
2015	1014787	2481	8572	11053	25.67	3.01	1.09%	0.84%	77.55%
2016	768442	2063	3921	5984	20.70	1.60	0.78%	0.51%	65.52%
2017	711664	2200	3051	5251	17.43	1.29	0.74%	0.43%	58.10%
2018	706313	2440	2509	4949	17.30	1.21	0.70%	0.36%	50.70%
2019	838262	2681	3182	5863	21.96	1.50	0.70%	0.38%	54.27%
TRIBAL									
2012	470215	1374	7038	8412	76.10	14.70	1.79%	1.50%	83.67%

2013	559487	1133	8661	9794	93.10	16.80	1.75%	1.55%	88.43%
2014	456669	799	6456	7255	77.40	12.70	1.59%	1.41%	88.99%
2015	540500	908	7640	8548	89.96	15.19	1.58%	1.41%	89.38%
2016	313981	383	3205	3588	54.10	6.20	1.14%	1.02%	89.33%
2017	288556	313	2281	2594	49.51	4.45	0.90%	0.79%	87.93%
2018	277235	110	1604	1714	43.74	2.74	0.62%	0.58%	93.58%
2019	346928	157	2593	2750	58.10	4.60	0.79%	0.75%	94.29%
URBAN									
2012	177407	2024	58	2082	19.81	2.32	1.17%	0.03%	2.79%
2013	156947	1562	44	1606	18.45	1.89	1.02%	0.03%	2.74%
2014	138530	1409	22	1431	15.10	1.56	1.03%	0.02%	1.54%
2015	131130	1238	74	1312	12.50	1.43	1.00%	0.06%	5.64%
2016	121757	1413	44	1457	12.50	1.43	1.20%	0.04%	3.02%
2017	123851	1456	50	1506	10.76	1.31	1.22%	0.04%	3.32%
2018	134283	1862	74	1936	13.48	2.00	1.44%	0.06%	3.82%
2019	128488	1985	45	2030	13.77	2.20	1.58%	0.04%	2.22%

Parameters: Annual Blood Examination Rate (ABER),Annual Parasite Incidence (API), Slide Positivity Rate (SPR), Slide *Falciparum* Rate (SFR), Annual *Falciparum* Rate (AFR)

TABLE –II

P.H.C. WISE, SUB-CENTRE WISE EPIDEMIOLOGICAL DATA 2015 to 2019

(HIGHLY ENDEMIC AREAS OF VISAKHAPATNAM DISTRICT)

Primary Health Centre: ANANTHAGIRI

Sec. CodeNo.	Name of the Sub-Centre	Year	Pop.	TOTAL				PARAMETERS					Deaths	Total Villages
				Tot. B.S Coll.	Positives			ABER	API	SPR	SFR	Pf%		
					Pv.	Pf.	Tot.							
A-15	ANANTHAGIRI	2015	3127	2856	25	140	165	158.5	52.8	3.3	2.8	85	1	25
		2016	3852	2563	16	41	57	91.6	18.2	2.0	1.4	72	0	
		2017	4210	2212	6	39	45	70.7	14.4	2.0	1.8	87	0	
		2018	4527	1284	0	18	18	41.1	5.8	1.4	1.7	98	0	
		2019	4709	3579	1	19	20	108.5	6.1	0.6	0.5	95	0	
A-16	TOKURU	2015	3029	2969	17	66	83	124.1	34.7	2.8	2.2	80	0	21
		2016	3216	1167	5	10	15	48.8	6.3	1.3	0.9	67	0	
		2017	3393	928	0	9	9	38.8	3.8	1.0	1.0	100	0	
		2018	3547	853	0	11	11	33.5	4.3	1.3	1.4	97	0	
		2019	3630	1139	0	10	10	43.3	3.8	0.9	0.8	97	0	
A-17	GETUVALASA (BORRA)	2015	3952	2713	12	67	79	91.9	26.8	2.9	2.5	85	0	21
		2016	4100	1078	6	11	17	36.5	5.8	1.6	1.0	65	0	
		2017	4254	1290	13	19	32	43.7	10.8	2.5	1.5	59	1	
		2018	4568	1273	0	11	11	45.2	3.9	0.9	0.7	85	0	
		2019	4782	1873	0	15	15	61.0	4.9	0.8	0.6	97	0	
A-18	SINGARBA	2015	1778	2432	6	34	40	136.8	22.5	1.6	1.4	85	0	21
		2016	1896	1643	4	17	21	92.4	11.8	1.3	1.0	81	0	
		2017	1950	592	1	8	9	33.3	5.1	1.5	1.4	89	0	
		2018	2028	1826	0	6	6	120.9	4.0	0.3	0.5	90	0	
		2019	2115	1232	0	10	10	64.2	5.2	0.8	0.5	94	0	
A-7	KOTHURU	2015	2520	1898	6	26	32	89.6	15.1	1.7	1.4	81	0	20
		2016	2732	1214	4	17	21	57.3	9.9	1.7	1.4	81	0	
		2017	2928	1674	1	9	10	79.0	4.7	0.6	0.5	90	0	
		2018	3048	1614	0	5	5	78.8	2.4	0.3	0.8	80	0	
		2019	3261	1189	0	10	10	40.2	3.4	0.8	0.4	84	0	
A-5	KASIPATNAM	2015	3374	2786	6	24	30	86.0	9.3	1.1	0.9	80	0	15
		2016	3468	1933	3	26	29	59.6	8.9	1.5	1.3	90	0	
		2017	3635	1350	2	33	35	41.7	10.8	2.6	2.4	94	0	
		2018	3945	989	0	5	5	25.2	1.3	0.5	0.4	94	2	
		2019	4073	1297	0	8	8	31.8	2.0	0.6	0.7	95	0	
	TOTAL	2015	17780	15654	72	357	429	686.9	161.2	13.4	11.2	496	1	123
		2016	19264	9598	38	122	160	386.2	60.9	9.4	7.0	456	0	
		2017	20370	8046	23	117	140	307.2	49.6	10.2	8.6	519	1	
		2018	21663	7839	0	56	56	344.7	21.7	4.7	5.5	544	2	

		2019	22570	10309	1	72	73	349.0	25.4	4.5	3.5	562	0	

DISCUSSION:

Estimating the epidemiologic burden of malaria epidemics is more challenging than estimating or measuring the burden of endemic malaria for a number of reasons(Roberts L, (2001).Different definitions are used to describe epidemics and these may vary according to epidemiologic settings. Currently, no standardized thresholds for the declaration of epidemics have been agreed upon since they strongly depend on local epidemiologic situations (WHO, 2004)Wallis, R.C(1955). Efforts are ongoing to field test and validate epidemic thresholds to identify unusual deviations from normal figures in various epidemiologic settings/conditions especially in Andhra Pradesh. Finally, even if an economic evaluation such as a cost-effectiveness analysis can be satisfactorily carried out, the transferability of the results to other settings will be limited by the unique nature of many epidemics and the settings in which they occur.

CONCLUSION :

The epidemiologic and economic impact of epidemic malaria is likely to be different from that of endemic malaria. To move forward with accurately estimating the burden of epidemic malaria, it must be recognized that the evidence on the economic impact, effectiveness, and cost-effectiveness of interventions obtained from endemic settings is not necessarily applicable to areas prone to unstable or epidemic transmission. While substantial progress has been made over recent years, thanks to the support of the Roll Back Malaria initiative, in estimating the burden of malaria, the human and economic burden of malaria epidemics remains largely un quantified, although our estimates show that it is clearly significant: epidemic malaria in India alone may be causing up to 10% of annual malaria mortality worldwide, including up to 15% of adult malaria deaths. This evidence is required to support planning and policy decisions in epidemic emergency situations that may otherwise be driven by panic and influenced heavily by the media.

ACKNOWLEDGEMENT:

The authors wish to thank Marine Biological Research Laboratory, Department of Zoology, Andhra University Visakhapatnam for Provided necessary laboratory facilities during this entire research work. I express sense of gratitude and indebtedness to my beloved research supervisor for the patience and affection and which have helped me a lot completing the task. I also express my sincere thanks to my colleagues and Department of Zoology.

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