CLINICO-HEMATOLOGICAL PATTERN OF MALARIA IN RAJKOT CITY (GUJARAT, INDIA).

Amit H. Agravat*, Gauravi A. Dhruva , Khyati Babaria, Kalpesh Rathod

Department of Pathology, Pandit Deendayal Upadhyaya Government Medical College, Rajkot.
E-mail of Corresponding Author: amitagravat70@gmail.com

Abstract
Background: This study was done to correlate clinico-hematological pattern of Malaria infection, its relation with rainfall & various affiliated demographic profile in Rajkot district, Gujarat, India. This study was conducted at P.D.U. Government Medical College, Rajkot from year 2008 to 2011.
Methods: Thick and thin peripheral blood smears were made from each patient with fever and chills and body temperature ≥ 37.5°C (on medicinal thermometer). The stained slides were examined microscopically for malaria parasites. All patients who were admitted in the clinical ward from year 2008 to 2012 with fever were considered for this study. Patients were registered specially by their residential location for demographic data and rainfall pattern was noted.
Results: A direct relationship is observed between malaria infection transmission and average monthly rainfall. Two peaks of high parasite density were observed in September & October, each peak was coinciding with high rainfall pattern of rainy season. There was a positive and significant correlation between parasite density and rainfall and breeding places of mosquitoes, suggesting that malaria is more common during heavy rainfall season and with poor living standards. There is also a significant positive correlation between parasite density and body temperature.
Conclusions: Our study proves that malarial infection has got direct relationship with average rainfall during monsoon. As well as water stagnation & accumulation plays a major role in mosquito breeding and subsequent spread of malaria. Poor sanitation in lower socioeconomic class has maximum number of malaria cases.
Keywords: Malaria; Rainfall; Socioeconomic status; Residential area.

1. Introduction

Malaria is a very common infection occurring in the Gujarat State (Western India). The occurrence & existence of malaria is closely related to naturally existing environmental and climatic conditions. The incidence, severity and distribution of malaria are also affected substantially by human activities such as water and agricultural developments and by urbanization. Estimates indicate that 90% of the global burden of malaria is attributable to environmental factors [1]. Occurrence of malaria is generally more common amongst the people who live in the slum areas where mosquitoes breeding places are more, where in-house crowding is more and mainly in the lower to lower middle class families. The most pronounced effects of climate on vector-borne diseases such as malaria would undoubtedly occur in places where the disease is newly introduced and are at the edges of the vector range, and where the population has built little immunity against malaria [2]. In Rajkot, high temperature and rainfall experienced in 2010 brought malaria into the community where higher number of slum areas and more breeding places for mosquitoes were noticed. The effect of recent changes in climatic and environmental conditions experienced in many malaria endemic countries also, could affect disease incidences, prevalence, severity, transmission, and infection intensity amongst others. These aspects have not been sufficiently studied; in this study we investigated the malaria prevalence and intensity of infection in slum areas. We further, correlated malaria infection amongst the socioeconomic classes and among the houses where crowding per house is more and fever to age groups of residents and to monthly rainfall, to get an insight of the peak period and time of occurrence of peak malaria transmission in the specific area. The study aims at underlining some of the important indicators that could be useful for public health monitoring of malaria infection intensity.

Severe malaria caused by *Plasmodium falciparum* (PF) infection may occur as a result of delay in treating uncomplicated *falciparum* malaria. In children, severe malaria may develop very rapidly. Recognition and prompt treatment of uncomplicated *Plasmodium falciparum* malaria is therefore of vital importance in averting incidence of severe malaria. A patient with severe malaria may present with confusion or drowsiness with prostration. In addition, the patient may develop other symptoms such as

cerebral malaria manifestation, generalized convulsions, severe anemia, hypoglycemia, acidosis, high fever, jaundice and hyper-parasitemia[3, 4, 5, 6,]. This severe manifestation may occur singly as a result of heavy parasitemia or more commonly in combination in some patients. Pregnant women constitute a special group with specific symptoms due to lowered immunity coupled with parasitization of the placenta. In high transmission areas, the risk of severe *falciparum* malaria developing is greatest among young children and visitors of any age coming from non-endemic areas. In non-transmission and low-transmission areas the risk of developing severe malaria is greatest among travelers returning with undiagnosed malaria infection from areas where *Plasmodium falciparum* transmission has occurred[6].

Clinical manifestation of the symptoms of malaria is a result of parasitization and destruction of the red blood cells. The developmental stages of the parasite in the liver, or its persistence as hypnozoites, mainly in *Plasmodium vivax* (PV) and *Plasmodium ovale* do not produce any symptoms [7].

Initial symptoms of the disease are quite variable, particularly in children, and may include irregular fever, general malaise, headache, muscular pains, sweats, chills, nausea, vomiting, and sometimes diarrhea. If untreated, the fever may progress to periodic bouts alternating with less or no fever. The fever paroxysms depends on the species of the malaria parasite and goes through three stages of: cold shivering rigor, hot burning fever with dry skin temperatures reaching up to 40–42°C, intense sweating and lowering of body temperature. In *Plasmodium vivax* and *Plasmodium ovale* the cycle of fever is referred to as tertian while in *Plasmodium malariae* it is quartan and *Plasmodium falciparum* malignant. *Plasmodium vivax* and *Plasmodium ovale* selectively invade young erythrocytes and *Plasmodium malariae* selects the old erythrocytes, while *Plasmodium falciparum* in discriminatively invades any red blood cell. The untreated acute attack of *Plasmodium falciparum* is shorter than that of *Plasmodium vivax*, in fatal cases death often happens 2–3 weeks, although in some cases it may occur as early as 2–3 days after onset of symptoms. Repeated infection gives rise to immune responses of the host, which eventually controls the disease and the infection.

Most anti-malarial drugs are effective against erythrocytic stage of the parasites, but not against the hyponozoites in the liver and gametocytes in the blood [8], so that while *Plasmodium falciparum* and *Plasmodium malariae* could be fully cured, *Plasmodium vivax* and *Plasmodium ovale* may produce true relapses by new invasion of the blood from latent hypnozoites, even after complete clearance of parasites from the blood. The elimination of hyponozoites and gametocytes requires long treatment periods (14 days or more) using primaquine or related drugs. Any untreated or incompletely treated infections will therefore produce several recrudescences. In the absence of reinfection, untreated *P. falciparum* may persist for 1–2 years, *Plasmodium vivax* for 3–4 years and *Plasmodium malariae* recrudescence up to 52 years [9].

2. Material and Methods

We had screened and studied for malaria parasite from the blood sample of patients who presented with fever (i.e. body temperature = 37.5°C, WHO Scale), with chills & rigor from the different locations of Rajkot city from year 2008 to year 2011 & who were admitted in our P.D.U. Government Hospital, Rajkot. We elicited their history (age, sex, residence, socioeconomic status) along with blood sample for malarial parasite detection was drawn. For each blood sample taken, two peripheral blood smears both thin and thick were made and stained with Romanowsky stains- Fields stain A & B as well as Leishmans stain. The thin smears were used to identify the species of the malaria parasite while the thick smears were used to find the scanty parasitemia.

Table-1: Year 2008 Malaria Positive Cases

Month	Total Blood Smears examined	*Plasmodium falciparum*	*Plasmodium vivax*	Total Positive cases
January	856	10	1	11
February	903	7	4	11
March	817	0	4	4
April	903	2	4	6
May	1004	3	9	12
June	1049	2	18	20
July	1242	12	21	33

August	1158	17	22	39
September	1421	31	9	40
October	1029	23	14	37
November	1285	34	12	46
December	1277	21	2	23
Total	12944	162	120	282

Table-2: Year 2009 Malaria Positive Cases

Month	Total Blood Smears examined	*Plasmodium falciparum*	*Plasmodium vivax*	Total positive cases
January	1676	9	3	12
February	1069	3	1	4
March	1211	4	3	7
April	1098	3	1	4
May	1196	2	12	14
June	1276	6	14	20
July	1575	3	3	6
August	1719	19	11	30
September	2110	64	34	98
October	2055	39	16	55
November	2183	49	7	56
December	1992	42	3	45
Total	19160	243	108	351

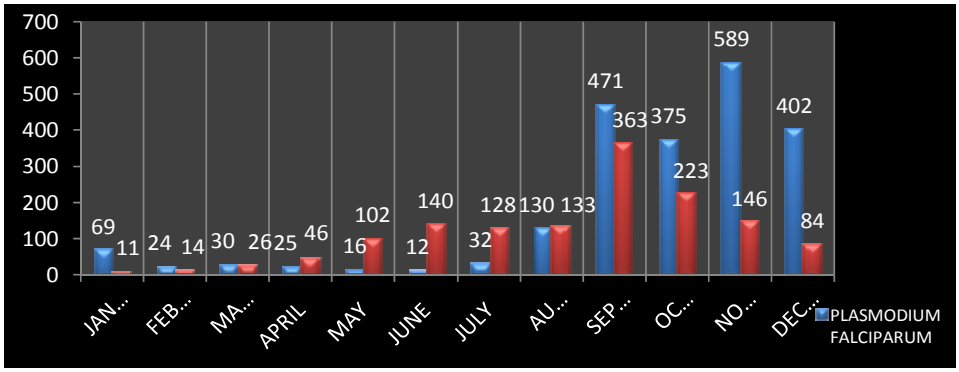
Table -3: Year 2010- Malaria Positive Cases

Month	Total Blood Smears examined	*Plasmodium falciparum*	*Plasmodium vivax*	Total Positive cases
January	1679	5	2	7
February	1624	9	4	13
March	1715	3	11	14
April	1606	2	9	11
May	1686	0	21	21
June	2059	3	28	31
July	2375	5	22	27
August	2598	45	40	85
September	3693	170	172	342
October	3563	239	142	381
November	3233	438	106	544
December	2737	281	57	338
Total	28568	1200	614	1814

Table- 4: Year 2011-Malaria Positive Cases

Month	Total Blood Smears examined	*Plasmodium falciparum*	*Plasmodium vivax*	Total Positive cases
January	2142	45	5	50
February	2180	5	5	10
March	2333	23	8	31
April	2031	18	32	50
May	2296	11	60	71
June	2361	1	80	81
July	2122	12	82	94
August	2394	49	60	109
September	3062	206	148	354
October	2888	74	51	125
November	2912	68	21	89
December	2910	58	22	80
Total	29631	570	574	1144

Figure-1: Month wise classification of total malarial cases of four year duration [2008-2011]



X Axis- Month, Y Axis- Total Number of Malaria Cases of four Years.

Table-5: Year wise rainfall and positive malaria cases (2008-2011)

Sr. Number	Year	Rainfall (In Inches)	Malarial Cases	
			Plasmodium falciparum	*plasmodium vivax*
1	2008	32.48	162	120
2	2009	22.92	243	108
3	2010	39.00	1200	614
4	2011	20.00	570	574

Table -6: Age wise distribution of malaria

AGE	PF	PV	TOTAL
Children(<15 years)	1415	848	2263
Adult(>15 years)	760	568	1328
Total	2175	1416	3591

Table- 7: Socio economic class wise distribution of malaria

Socio Economic Class	*Plasmodium falciparum*	*plasmodium vivax*	Total positive Cases
Lower	1068	772	1840
Lower middle	788	452	1240
Upper middle	295	166	461
Higher	24	26	50
Total	2175	1416	3591

Figure-2: Plasmodium Falciparum & Plasmodium Vivax in different socioeconomic classes.

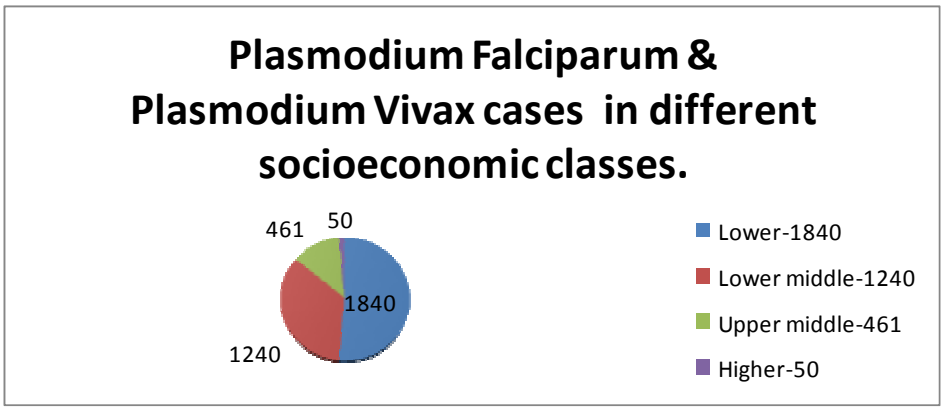


Table- 8: Area wise classification of malaria

Residential Area	*Plasmodium Falciparum*	*Plasmodium Vivax*	Total positive cases
Slum Area	1682	1089	2771
Urban Area	493	327	820
Total	2175	1416	3591

3. Results

The geometric means of malaria infection exhibited major peaks in September, October & November, which corresponds with the pattern of equatorial rainfall seasons in the months of September to November **(Table-1, 2, 3, 4)**. This rain pattern creates several breeding sites for mosquitoes. As the vector population increases, the transmission of malaria increases. The result further shows that children below 15 years have higher peaks of disease than adults **(table-6)** The study also shows the pattern of malaria is higher amongst the subjects who lives in slum area compared to people who lives in the urban area**(Table-8)** and also more common in people coming from relatively lower socioeconomic class**(Table-7).**

4. Discussion

The present study shows that there is a statistically significant relationship between malaria and the pattern of rainfall from year 2008 to year 2011 **(Table 5)**. Parasite rises soon after the start of the first rain season in July reaching peak in August & September because the rains provide good breeding sites for mosquito vectors. As vector population increases, transmission of infection subsequently rises. As rainfall decreases and breeding grounds of mosquito vector dries up at the end of the rain season around October, then falls reaching a minimum after November, probably due to a reduction in mosquito vector population. The finding in this study corroborates our laboratory case records, which indicate that two weeks following the fall of the first rains usually registers increased cases of malaria infection.

The higher incidence of malaria is observed in children **(Table-6)** is a result of a less developed immune system, which is incapable of clearing parasites more effectively as in adults. Therefore, malarial infection in children seems to give a true picture of the intensity of an infection than of adults, this may be a useful indicator for purposes of monitoring disease intensity.

Descriptive epidemiological studies of malaria infection in some slum areas of stable transmission have revealed distinct age-specific pattern of parasite prevalence and density as detected by positive blood slide smears. Data from our study is consistent with the age-related patterns of prevalence of infection **(Table-6).** The prevalence of infection decreased with increasing age or age group. The observed decline in infection is most likely due to the development of non-sterile clinical immunity over time [10]. This background immunity regulates infection and is usually pronounced in children above 15 years and in adults. These are people who have been exposed to mosquito bites over the years, hence to malaria many more times. Such limited immunity enables the individuals to tolerate severe malaria infection without getting ill even though they may get malaria fever[10, 11].

The explanation to such clinical presentations like fever, shivering & chills and responses to untreated malaria or treatment failures is a classical fever paroxysm, which may ensue every two or three days depending on the parasite species. This malaria pathogenesis leading to fever is due to rupturing of erythrocytic shizonts releasing their pyrogens in the blood[12].

Advanced studies on endogenous pyrogens by Dinarello, revealed them as subsets of cytokines that act on the thermoregulatory center in the hypothalamus to promote fever[13]. The body's thermostat becomes set at a higher point and the thermoregulatory center acts to keep the temperature at precisely this point. At the end of the fever paroxysm, the thermoregulatory center returns the body thermostat to normal set point, and the individual feels hot and perspires profusely until temperature has fallen accordingly. The subsets of cytokines that are thought to act on the hypothalamic thermostat in this manner include tumor necrosis factor (TNF), interleukin-1 beta (IL-1β), interleukin-1 (IL-1α), interleukin-6 (IL-6), interferon-α and lymphotoxin-α and macrophage inflammatory protein-1[13]. The pyrogenic properties and roles of these cytokines in the pathogenesis of malaria fever have been well demonstrated in animal models by Dinarello[4]. Therefore, the significant correlation observed between parasite density and body temperature in this study demonstrates that

the fevers are malaria induced rather than of other causes.

Conclusion

Our study proves that malarial infection has got direct relationship with average rainfall during monsoon. As well as water stagnation & accumulation plays a major role in mosquito breeding and subsequent spread of malaria. Poor sanitation in lower socioeconomic class has maximum number of malaria cases.

Recommendation

Our study on Malaria pattern wishes to create awareness at health sector level, municipal corporation level, panchayat level & individual level to take disciplinary action in monsoon season as well as government authority should find out the probable breeding sites of mosquitoes, slum areas, etc places which has to be cleaned regularly and water accumulation and stagnation should be avoided to prevent mosquito breeding. Individual awareness can create miracle, if we try to fight malaria at individual level we can win the fight against this common infection which can convert into serious life threatening infection.

References

1. WHO, author. A vision for all. Geneva, Switzerland: 1998. The World Health report, Life in the 21st century.
2. Brewster D R, Kwiatkowski D, White N J. Neurological sequelae of cerebral malaria in children. Lancet. 1990; 336:1039–1990.
3. Dinarello C A. Interleukins, tumor necrosis factors (cachectin), and interferons as endogenous pyrogens and mediators of fever. Lymphokines. 1987; 14:1–31.
4. Dinarello C A, Cannon J G, Wolff S M, Bernheim H A, Beutler B, Cerami A. Tumor necrosis factor (cachectin) is an endogenous pyrogen and induces production of interleukin-1. *J Exp Med.* 1986; 163:1433–1450.
5. Greenwood B, Marsh K, Snow R. Why do some children develop severe malaria? *Parasitlogy Today*. 1991; 7:430–440.
6. Golgi C. On the cycle of development of malarial parasites in tertian fever: differential diagnosis between the intracellular parasites of tertian, quartan fever. Extract reprinted in 'Tropical medicine and parasitology: classic investigations. Vol 1. In: Kean B H, Mott K E, Russell A J, editors. Archivo per le Scienze Mediche. Vol. 13. Ithica: Cornell University, Press; 1889. pp. 173–196. (Fre). (1987)
7. Kluger M J. Fever: role of pyrogens and cryogens. *Physiol Rev*. 1991; 71:93–127.
8. Marsh K. Malaria- a neglected disease? Parasitology. 1992; 104:53–69.
9. Marsh K, Forester D, Waruiru C, Mwangi I, Winstanley M, Marsh V, Newton C, Winstanley P, Warn P, Peshu N, Pasvol G, Snow R. Indicators of life-threatening malaria in African children. New Eng J Med. 1995; 332(21):1399–1404.
10. Markell E K, John DT, Krotoski W A. Text Book Medical Parasitology. Eight edition. Philadelphia: W. B. Saunder Company; 1998. p. 119.
11. Molineaux L. The epidemiology of human malaria as an explanation of its distribution, including some implication for its control. In: Wernsdorfer W H, McGregor I, editors. Malaria Principles and Practice of Malariology. Vol. 2. London: Churchill Livingstone; 1988. pp. 913–999.
12. Molineaux L, Grammiccia G. The Garki Project: Research in the epidemiology and control of malaria in the Sudan savanna of West Africa. Geneva: WHO; 1980. WHO Geneva.
13. Najera J A, Hempel J. The Burden of malaria. WHO. 1996 CTD/Mal 96.10 WHO Geneva.