



STUDY ON EPIDEMIOLOGICAL APPROACHES FOR MALARIA ELIMINATION IN ANAND DISTRICT OF GUJARAT STATE

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Abstract : Malaria is a Vector borne disease which primarily spreads by an infected female anopheles mosquito bite. These mosquitoes favour hot and humid conditions therefore are prevalent in tropics and subtropics. Malaria poses a significant challenge to health in regions like Africa, Southeast Asia, and South America. Effective control of malaria includes medications for treatment and preventive measures like insecticide treated bed nets and indoor spraying. Malaria is manifested with range of symptoms (mild to severe) which majorly depend on the species of malaria parasite and immunity status of individual. Mild symptoms typically include fever, chills often accompanied by shivering, headache. Confusion, fatigue, difficulty in breathing, respiratory distress and seizures are considered its severe symptoms. There are five species of Plasmodium parasites which are found to infect humans and cause malaria, *P. falciparum* and *P. vivax* are the most significant in terms of public health impact.

Key words: Vector borne disease, Plasmodium parasites, Insecticide treated bed nets

1. INTRODUCTION

Malaria is a Vector borne disease which primarily spreads by an infected female anopheles mosquito bite. These mosquitoes favour hot and humid conditions therefore are prevalent in tropics and subtropics. Malaria poses a significant challenge to health in regions like Africa, Southeast Asia, and South America. Effective control of malaria includes medications for treatment and preventive measures like insecticide treated bed nets and indoor spraying. Malaria is manifested with range of symptoms (mild to severe) which majorly depend on the species of malaria parasite and immunity status of individual. Mild symptoms typically include fever, chills often accompanied by shivering, headache. Confusion, fatigue, difficulty in breathing, respiratory distress and seizures are considered its severe symptoms (Jill *et al.*, 1997). Besides mosquito bites, malaria other modes of transmission are blood transfusions with infected blood and through contaminated needles and syringes. *Plasmodium falciparum* malaria if left untreated can indeed progress rapidly and lead to severe illness, potentially leading to death within a short period, sometimes as quickly as within 24 hours after the onset of symptoms. Untreated or incomplete treatment of *P. vivax* malaria cases may cause relapses. There are five species of Plasmodium parasites which are found to infect humans and cause malaria, *P. falciparum* and *P. vivax* are the most significant in terms of public health impact (Chigozie *et al.*, 2006). The other three Plasmodium species that infect humans are *P. ovale*, *P. malariae*, and *P. knowlesi* (Bhatt, 1989; Baharia, 2021). Malaria elimination efforts have seen significant progress over the past century, with more than 100 countries successfully eliminating malaria. Additionally, by 2015, 106 countries had reduced malaria incidence by more than 75%, marking substantial strides in controlling this disease globally (WHO, 2015). The aim of the present study was to determine the future towards malaria elimination in Anand district of India using epidemiological parameters.

2. NEED OF THE STUDY

Malaria is a Vector borne disease which primarily spreads by an infected female anopheles mosquito bite. These mosquitoes favour hot and humid conditions therefore are prevalent in tropics and subtropics. Malaria poses a significant challenge to health in regions like Africa, Southeast Asia, and South America. Effective control of malaria includes medications for treatment and preventive measures like insecticide treated bed nets and indoor spraying. Therefore present study is very much important for Malaria elimination.

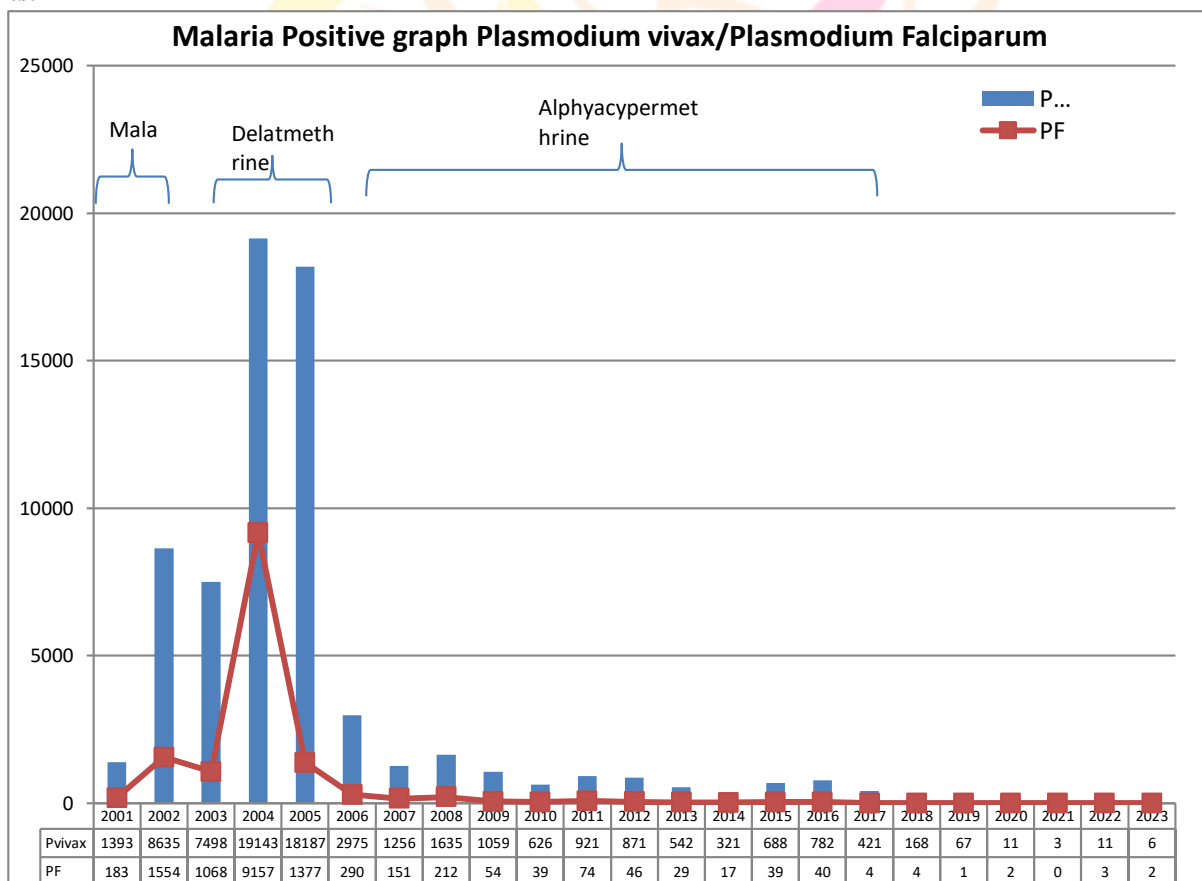
3. RESEARCH METHODOLOGY

3.1 Materials and Methods:

Analytical studies of epidemiological parameters from Malaria branch at Anand District Panchayat of last two decades was performed. Yearly data collected involved information on malaria cases, categorized them in age groups and gender. In Anand district different clinics and PHCs where malaria cases of *Plasmodium vivax* and *P. falciparum* were diagnosed microscopically.

Anand is located at approximately 22.34°N latitude and 72.56°E longitude which is characterized by its geographical and demographic attributes. South west monsoon usually sets in the region around mid-June to September with average amount of precipitation being approximately 500-700mm. The regional temperature range between 25°C-32°C. In PHCs/CHCs all febrile patients with their symptoms were registered and Peripheral smear carried out which was stained with JSB-I & II for Microscopic Examination. Blood smear examination with Jaswant Singh-Bhattacharji stain (JSB-I & II) is a common technique for the diagnosis of malaria. The microscopic examination of minimum 100 fields were also analysed and recorded month-wise at the Anand district panchayat, Anand.

4. Results:



The year 2004 marked a significant peak in malaria cases reported in Anand district. A total 28300 malaria cases reported in Anand district, among these 19143 cases of *Plasmodium vivax* and 9157 cases of *Plasmodium falciparum* were reported. Annual Parasite Index (API) was 14.15 in the year 2004 which was very high, while from 2007 onward API is less than one. The overall declining trend in malaria cases, with the exception of the years 2004 and 2005. Malaria epidemic was occurred in Anand in the year 2004 and 2005. The data of age wise group indicated that 72% of above 15 years' aged people were affected with Malaria infections. Fever with rigor manifested as the most common symptom in all age sets. After the year 2019, the malaria cases declining below 100 which is significant improvement in Malaria control.

TABLE:1. EPIDEMIOLOGICAL SITUATION AND INDICATORS FOR MALARIA IN ANAND DISTRICT(2001-2022)

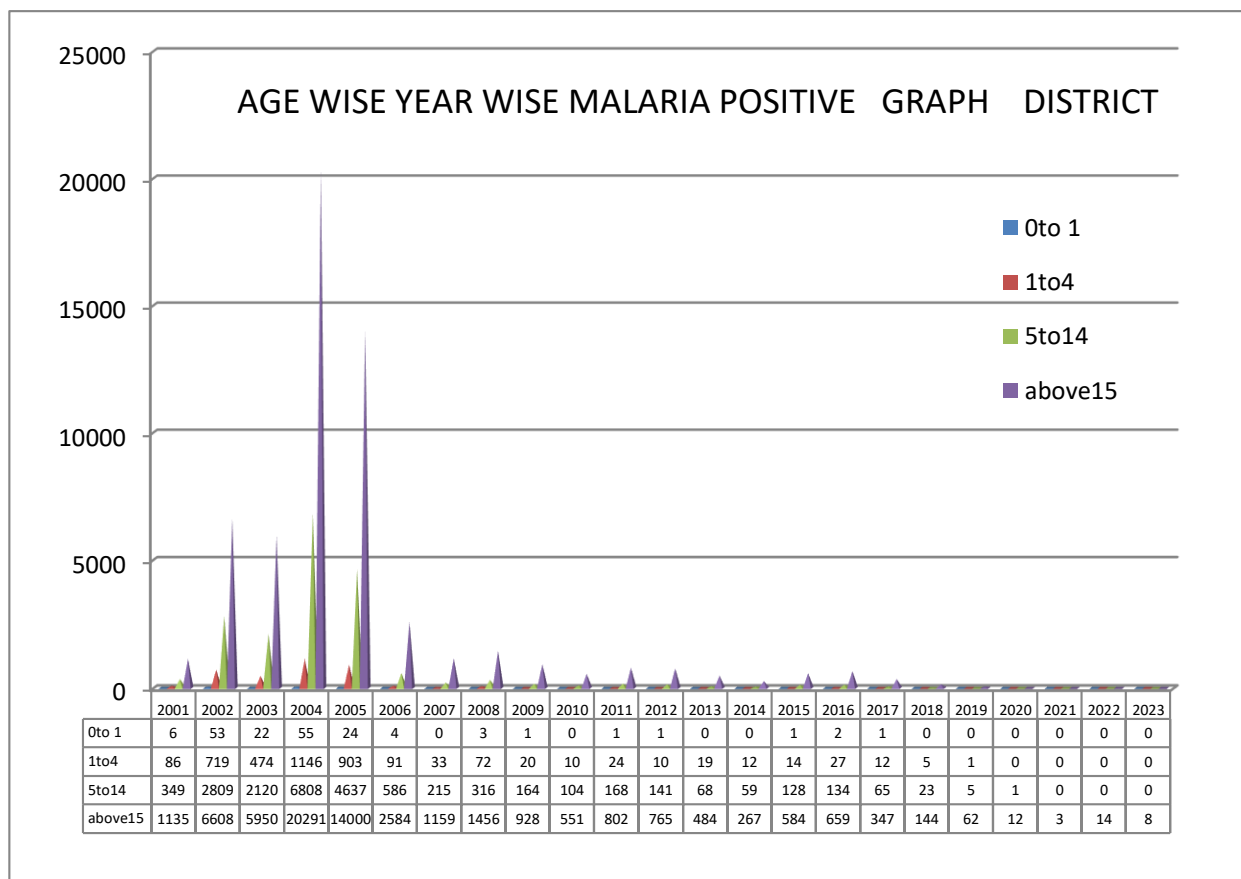
Year	Population	BSC/BSE	Total Malaria cases	PF Cases	ABER	API	SPR	SFR	PF%
2001	1883393	283481	1576	183	15.05	0.837	0.556	0.0646	11.61
2002	1903000	325220	10189	1554	17.09	5.354	3.133	0.4778	15.25
2003	1951000	376716	8566	1068	19.31	4.391	2.274	0.2835	12.47
2004	2000000	528293	28300	9157	26.41	14.150	5.357	1.7333	32.36
2005	2000000	609886	19564	1377	30.49	9.782	3.208	0.2258	7.04
2006	1989900	534219	3265	290	26.85	1.641	0.611	0.0543	8.88
2007	1999700	362323	1407	151	18.12	0.704	0.388	0.0417	10.73
2008	2024300	376002	1847	212	18.57	0.912	0.491	0.0564	11.48
2009	1960545	456587	1113	54	23.29	0.568	0.244	0.0118	4.85
2010	1969712	385573	665	39	19.58	0.338	0.172	0.0101	5.86
2011	1975064	398808	995	74	20.19	0.504	0.249	0.0186	7.44
2012	2090276	405387	917	46	19.39	0.439	0.226	0.0113	5.02
2013	2140366	457270	571	29	21.36	0.267	0.125	0.0063	5.08
2014	2168084	473826	338	17	21.85	0.156	0.071	0.0036	5.03
2015	2190503	466982	727	39	21.32	0.332	0.156	0.0084	5.36
2016	2212408	561784	822	40	25.39	0.372	0.146	0.0071	4.87
2017	2265948	568514	425	4	25.09	0.188	0.075	0.0007	0.94
2018	2312419	528373	172	4	22.85	0.074	0.033	0.0008	2.33
2019	2343062	562833	68	1	24.02	0.029	0.012	0.0002	1.47
2020	2368946	434425	13	2	18.34	0.005	0.003	0.0005	15.38
2021	2373108	469531	3	0	19.79	0.001	0.001	0.0000	0.00
2022	2401035	496971	14	3	20.70	0.006	0.003	0.0006	21.43

Seasonality of malaria

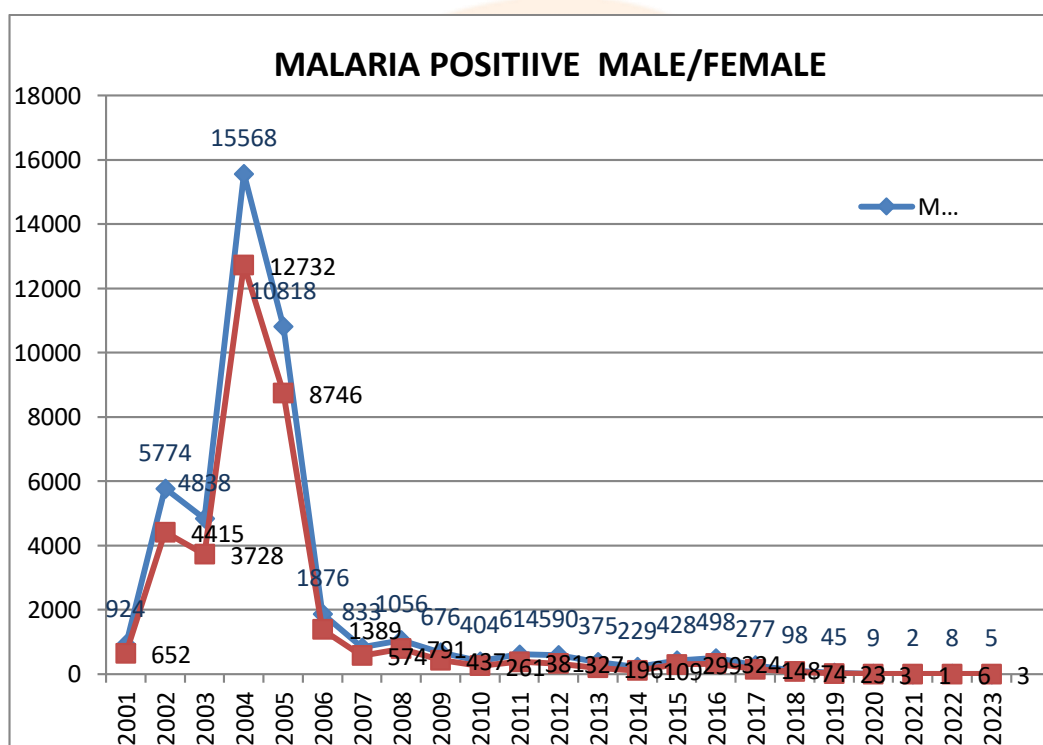
In non-transmissible season (January to May) few malaria cases were reported while in transmissible season (June to October) malaria cases were reported high. *P. falciparum* transmission initiates in monsoon with highest rate of infection being reported in September, where multiple peak occur in both August and september.The transmission of *P. falciparum* usually begins in monsoon and highest number of cases was recorded in September, with multiple peaks occurring in both August and September.

Malaria by age group and gender

All the data available since 2001, they were categorized into age groups and gender distribution of malaria cases were studied. Out of Malaria Positive 56.3% were males and the remaining cases of females of different age groups. The data of age wise group indicated that 72% of above 15 years' aged people were affected with Malaria infections. Most vulnerable group with age 0-5 years recorded low incidence accounting for only 5%. (Koram *et al.*, 1995).



Wide outlook of malaria cases in 2004 as per age categories, *P. falciparum* was most prevalent in the age group above 15 years (73%), thereafter in those aged 6-15 years (26%) and 0-5 aged children being lowest among all(1%). The Information related to gender and age specific seasonal prevalence in country is restricted. (Kumar, *et al.*, 2007). In 2004, *P. vivax* cases were most prevalent among 15 years above age group (72%) followed by 6-15 years(24%) and lowest in aged 0-5 years (4%). From 2004 to 2019 there was year on year decrease in cases of both *P. falciparum* and *P. vivax* in all age sets. During the year 2019 to 2023, not a single death reported in Anand district in any age group. Hence the mortality rate during this mentioned period was zero. As per epidemiological data gender wise data shown more in male 56% and female 44%. Gradually the cases of malaria declined in both genders.

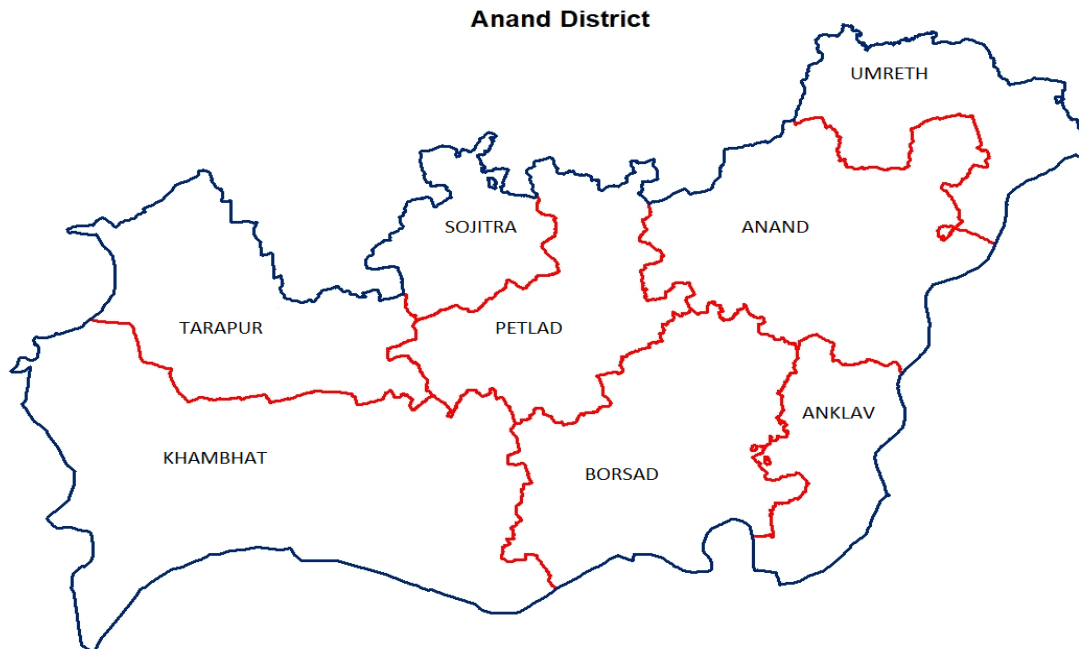


Measures taken in the last 20 years (2001–2022)

The major functions for malaria control in Anand district as per National Drug Policy are vector control by using Long lasting insecticide Nets (LLINs) and indoor residual insecticide spraying (IRS). In 2001 and 2002 IRS done by Malathion 2003 to 2005 IRS done by Deltamethrin. Subsequently, mosquitoes developed resistance to malathion, leading to a gradual increase in malaria cases and culminating in an epidemic across the state in 2004. Thereafter in Anand District, there was not a single village with API greater than one. Subsequently, in 2008, the NVBDCP distributed long-lasting insecticidal nets (LLNs) in vulnerable areas.

5. Discussion

The Anand district is situated at a distance of 15km from Nadiad which is presently in Kheda district. Previously Anand was also in the Kheda district. Thereafter Anand got its District status in 1997.



The National Institute of Malaria Research (NIMR) is a prestigious institute under ICMR. Its regional branch was established at Nadiad in 1983. The main objectives of NIMR are research and development, Surveillance and monitoring, Capacity building (training to laboratory technicians regarding malaria microscopic examination) and Public awareness and education.

In the year 2002, areas in Anand district having Annual Parasitic Incidence (API) greater than 2 were covered with malathion for vector control but malathion resistance was developed, and a situation of malaria epidemic was reported in several villages of Gujarat in 2004.

In 2007 onwards in Gujarat, Deltamethrin resistance was reported, and alphacypermethrin was introduced to control the *An. culicifacies*, and also ACT (artesunate + sulfadoxine -pyrimethamine) was implemented to control the situation. Malaria in Gujarat can be directly gauged with rainfall situation (Gillian, 2010). *P. vivax* infections typically rise in Anand during the secondary transmission phase i.e (August or September).

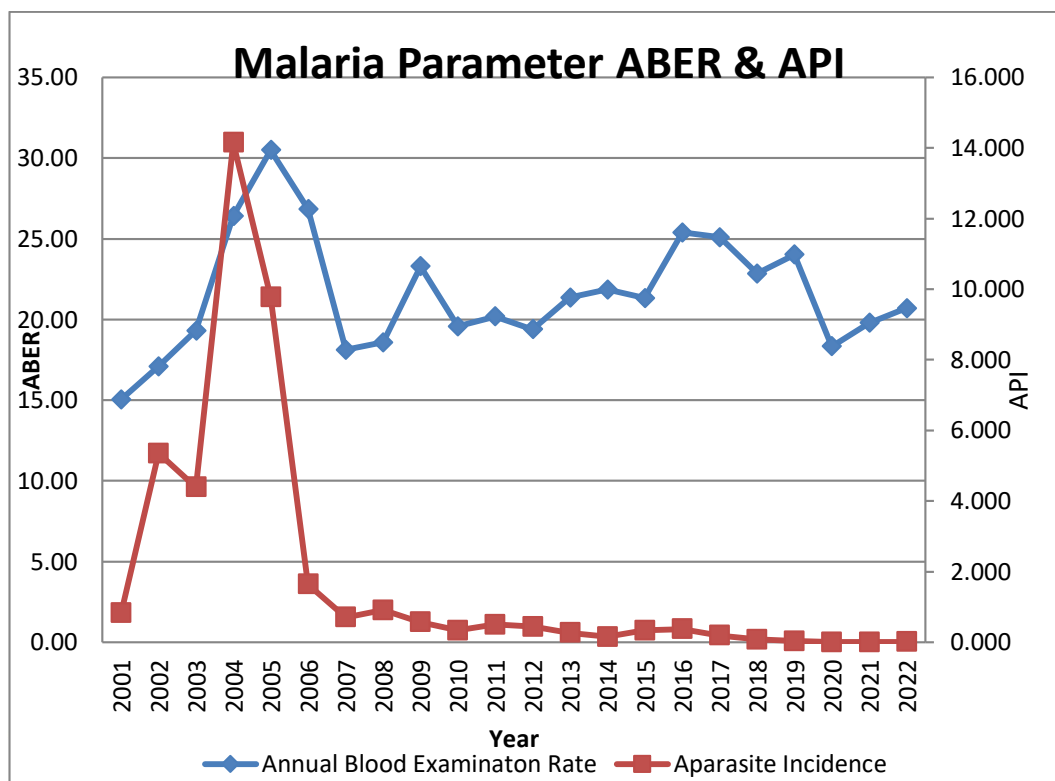
Under the present National Malaria Drug Policy, the treatment regime of *P. vivax* is for first 3 days is chloroquine followed by primaquine for next 14 days. This regimen increases the risk of incomplete treatment. As a result, the likelihood of incomplete treatment is higher due to the inability of patients to take therapy. Govt. of Gujarat initiated to give 14 days door treatment by ASHA to infected patients personally under NVBDCP. National Malaria Drug Policy introduced *P. falciparum* treatment protocol involving Artemisinin based combination therapy (ACT) for 3 days and Primaquine for a single dose on second day as per age, along with new efficient tools and vector control methods. Most of the malaria cases recorded during the monsoon and post-monsoon due to hikes in mosquitoes densities and active transmission during this period (Nitika *et al.*, 2022).

During the summer and winter seasons, low malaria prevalence has been recorded (Brhane *et al.*, 2019). There are very few studies on the age and gender distribution of Malaria. During analysis, it was observed, males are prone to get infected by malaria in Anand due to outdoor activities (Regmi *et al.*, 2016). In the present study, malaria infection didn't discriminate between different age group categories. The highest prevalence of malaria with primary symptoms was found in 15+ age group, followed by children in age group of 6-10.

The integrated vector management (IVM), IRS and LLINs were used to control the *An. Culicifacies* (primary malaria vector in Gujarat, India). Various insecticides were reported resistance from the 90s onwards. DDT, Malathion, Permethrin, and Deltamethrin were found resistant against *An. culicifacies*. At present, alphacypermethrin is being used as an efficient insecticide to control the *An. Culicifacies* (Sahu *et al.*, 2015).

Due to continuous effort by the Govt. of Gujarat towards malaria control, overall state API is less than one. The Govt. of Gujarat followed the state framework for Malaria elimination, which includes surveillance, integrated vector management; focus on active foci, and migratory population and intersectoral coordination.

The National Vector Borne Disease Control Program recommends that the annual blood examination rate (ABER) for malaria should be at least 10%, based on the assumption that 10% of the population will experience fever at some point during the year (Kumar, *et al.*, 2007b). The Annual Parasitic Incidence (API) of malaria for India during 2004 was 14.15 which came down to 0.7 during 2007. A method by which the API can be brought down as it is physically through campaigns that detect the malarial antigen in both febrile persons as well as asymptomatic carriers (Arvind *et al.*, 2021).



As per National framework for Malaria elimination API is primary criteria which were classified in different categories mentioned in following table.

Sr. No.	Category	Definition	API
1	Category-0	Prevention of re-establishment Phase	District API should be zero
2	Category-1	Elimination Phase	District, Taluka, Village-API less than one
3	Category-2	Pre Elimination Phase	District API less than one But Some of Taluka reporting API One
4	Category-3	Intensified Control	District API one at a risk

As per table Anand district in Category-1 in 2022. Continuous efforts of Govt. of Gujarat to create Anand district towards malaria elimination.

However, frequent updates to the drug policy based on chloroquine (CQ) efficacy assessments, along with enhanced active and passive surveillance using rapid diagnostic tests (RDTs) likely improved diagnosis and treatment services of malaria which in turn reduced the cases especially of *P. falciparum*. In Gujarat, *An. culicifacies* was the primary malaria vector. From the 90s onwards, DDTs were resistant, and after that Malathion, permethrin, deltamethrin were found resistant towards the main malaria vector (Kamaraju *et al.*, 2022).

Alphacypermethrin insecticide was found susceptible towards the Malaria vector, which is used in the IRS and LLINs (Corine *et al.*, 2017). Despite active and passive surveillance with integrated vector management (IVM), still, malaria control programs need active attention to achieve malaria elimination in 2030.

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