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A report on outbreak investigation of malaria in Gaya district, Bihar, India establishing new niches

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Abstract
Gaya district has been endemic for malaria since long. Southern blocks of the district are malaria endemic. However, the malaria outbreak was reported from northern blocks in 2015 where since past few years reported malarial cases have been negligible. Epidemiological, Entomological and Environmental investigations were done to understand the causes of the outbreak and suggest remedial measures. Total 874 cases of malaria were reported in Gaya in 2015 from 3 blocks viz: Pariaya, Town block and Tekari. Slide Positivity Rate (SPR) was highest in Tekari (79.67%)>Town block (48.7%)>Pariaya (18.74%). Slide Falciparum & Slide Vivax Rate (SPR/SVR) was highest in Tekari (8.13%/69.9%)>Town Block (1.9%/35.37%)>Pariaya (0.2%/18.2%).Proportion of falciparum cases were highest in Tekari (10.20%)>Town block (3.97%)>Pariaya (1.28%). Larval index in all potential breeding sources was high, thus favouring disease transmission. Most of the affected population belonged to low socio-economic strata, with most of the houses being semi –pucca/ or mud-plastered category. The report establishes that the malaria outbreak in Gaya in 2015 was not a seasonal phenomenon rather was an outbreak and the vectors are establishing new niches for disease transmission.

Keywords: outbreak, slide falciparum rate, slide vivax rate

1. Introduction
Malaria accounts for 17 percent of the global burden of infectious diseases [1]. It is difficult to obtain accurate information on the disease incidence in highly endemic and hard to reach areas due to inadequate reporting. Malarial incidence is stabilized to around 1.6 million cases annually in India for last 5 - 6 years [2] however, the proportion of *plasmodium falciparum* has risen from 20 (1970) to now 41percent. *Anopheles culicifacies* is the primary rural vector of malaria in India and can cause epidemic in its range of distribution [3]. Most effective strategy of malaria control is "early diagnosis & prompt treatment (EDPT)"[4] As per National Vector Borne Disease Control Programme (NVBDCP), Govt. of India guidelines, malaria may be defined as a case of fever which may be accompanied with any of the following: headache, backache, chills, rigors, sweating, myalgia, nausea and vomiting; splenomegaly and anemia; generalized convulsions, coma, shock, spontaneous bleeding, pulmonary edema, renal failure and death (untreated falciparum infection) [5].

Although malaria is an endemic diseases, outbreaks have been reported in areas with low seasonal transmission. [6, 7, 8, 9, 10] Several factors like increase in vector breeding sites, influx of infected people into a vector rich populated area having susceptible people, new efficient vectors, inefficient vector control measures and resistance of vectors to insecticides may lead to outbreaks [11, 12].

As per Bihar State Health data, Gaya district has been endemic for malaria since long. Generally, southern blocks are endemic. In 2015, malaria outbreak was reported from 3 northern blocks where since past few years reported malarial cases were negligible. Outbreak investigation was done to review and assess the situation of Malaria outbreak in Gaya, to determine the causes of current outbreak, to conduct an epidemiological and also entomological survey in some of the affected areas of Gaya, to assess the environmental and sociological factors contributing to the abundance of malaria vector, to assess the current situation by district wise analysis of Malaria outbreak and to recommend remedial measures to overcome the current outbreak and prevent occurrence of outbreaks in future.

2. Materials and methods
Epidemiological investigations included discussion with the District authorities and medical and paramedical staff to know the background information of the affected areas, genesis of outbreak, investigations carried out so far and control measures undertaken; discussion with the physicians who treated the cases about the clinical presentation of cases, results of laboratory investigations and outcome of cases; interview and clinical examination of some of the cases; visit to affected areas; rapid fever survey by house to house visit and collection of sera samples from suspected cases for malaria confirmatory test. Besides this Descriptive analysis on the basis of time, place and person was carried out. Analysis of data collected from IDSP reporting unit was also done. Entomological investigations based on larval survey were done to understand the larval species prevalent in the area; Larvae were collected with the help of dippers. Three dips per sq m of breeding habitat surface area were taken; while environmental investigation, knowledge, attitude and practices of the community were also analyzed as per pre-planned questionnaire, examination of water logged and storage practices were also done in affected areas.

3. Results & Discussion

Total 874 cases of malaria were reported in Gaya from 3 blocks viz: Pariaya, Town block and Tekari. Index case was reported on 3 Aug 2015 in Town block; on 21 Aug in Pairaya and on 19 Sep in Tekari block.12 cases were also reported from other districts as per reports collected. These included 2 cases from Aurangabad, 5 cases from Jamui, 1 case from UP and rest cases from other blocks. [Figure 1 a to b and Table 1]. Slide Positivity Rate (SPR) was highest in Tekari (79.67%)>Town block (48.7%)>Pariaya (18.74%). Slide Falciparum & Slide Vivax rate (SPR/SVR) was highest in Tekari (8.13%/69.9%)>Town Block (1.9%/35.37%)>Pariaya (0.2%/18.2%).Proportion of falciparum cases were highest in Tekari (10.20%)>Town block (3.97%)>Pariaya (1.28%).The disease afflicted almost all the age group but the incidence was more in the age group 6-11 followed by 12-17 in all the three affected blocks. Males (81%) were more affected (51% & 52%) than females (49% & 48%) in Pariaya and Town block respectively while females (61%) were more affected than males (39%) in Tekari block [Table 2, 3, 4]. Out of total malaria cases reported 22%, 19% & 14% of the cases were reported from village Jagernathpur, Kesuru and Kosama in Pariaya block. Out of total malaria cases 60%, 15% & 5% of the cases were reported in villages Dariyapur, Belama and Vishnuganj respectively in Tekari block while it was 22%, 21% & 14% in villages Solara, Sudhani and Sudhi Razpur in Town block respectively. Ahir and Manjhi tolas were mostly affected. [Fig 2 and Table 5] The most common clinical features shown by malarial patients were fever with chills (76%)>Headache (50%)>Bodyache (24%) [Table 8]. During rapid fever survey in affected areas, 5 fever cases from village solara and ahir tolas were referred to seek diagnosis & treatment in APHC Solara of block Pariaya due to its location nearby. Seven blood samples were collected from symptomatic patients in village Dariyapur of block Tekari for serological confirmation in PMCH, Patna. As per lab reports, one sample was found positive for malaria (Pv).This emphasizes the need for rapid fever survey by the health workers for early case detection and its referral as per need. One death was also reported due to malaria in village Dariyapur, Tekari block, Gaya. The deceased was a woman aged 30 years. The death occurred on 19 Sep 2015 at ANMCH, Gaya. As per the report, the deceased was anaemic and mentally retarded and was diagnosed positive with *P.vivax* malaria. Jaundice was found as co-morbid factor leading to death. Slide falciparum rate was highest in Tekari block that poses risk for death if not treated on time [Table 6]. History of travel outside the locality was insignificant during the field visit. The general weather condition during the last one month before the disease outbreak was hot and humid followed by spells of rain. Hot and humid conditions might also have favoured behavioural changes in vector and increased parasitic load & transmission that is supported by previous studies [13, 14, 15].

Different sites were searched for identifying anopheline larval breeding sites. Transient water pools where rain water was accumulated was the major breeding source in village solara, block Pariaya while stagnant water in rock pools in village Dariyapur, block Tekari was the major breeding source identified. Larval index in all potential breeding sources was high, thus favouring disease transmission. Results have been briefed in [Table 7]. Several studies have implicated abandoned wells as breeding sites [16, 17]. *An. culicifacies* abounds in the village wells of India. It breeds in domestic wells, clean water, agricultural drains, puddles and paddy fields [18].

Most of the affected population belonged to low socio-economic strata, with most of the houses being semi –pucca/ or mud-plastered category. Majority of them belonged to agricultural labour community. Majority of the affected population were illiterate (54%) and unaware of the cause of the disease.40% of the cases seek treatment in Govt. institutions while 30% & 20% cases seeked treatment in private institutions and through quacks respectively.94% of the cases did not receive hospitalization while 6% seeked hospitalizations on account of convulsions. 60% of the affected population did not take anti-mosquito measures. About 50% of the cases informed economical reasons to be the main cause of not adopting anti-mosquito measures [Table 8]. During rapid fever survey in affected areas it was found that majority of the affected cases were not taking complete dose of prescribed drugs. Main reasons given by such cases were gastritis and vomiting after taking first few courses of the drugs. In village Solara, ASHA Health Worker who was supposed to ensure search of symptomatic cases in affected areas and ensure intake of complete drug course by affected cases was herself suffering from malaria and did not take complete dose of drugs. This may also be one of the reasons for the the outbreak. Most of the affected areas were very dirty & no proper waste management was being done. Majority of the affected population used hand-pump and well water for drinking purpose. Water storage was not universally practiced.

4. Tables and Figures

Time wise distribution of Malaria cases in Gaya

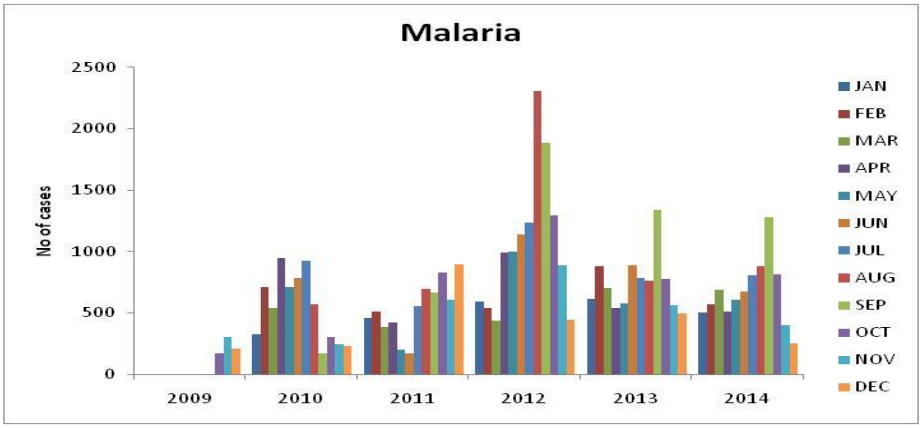

Fig 1: Year wise & Month wise trend of Malaria in Gaya (Based on presumptive surveillance)

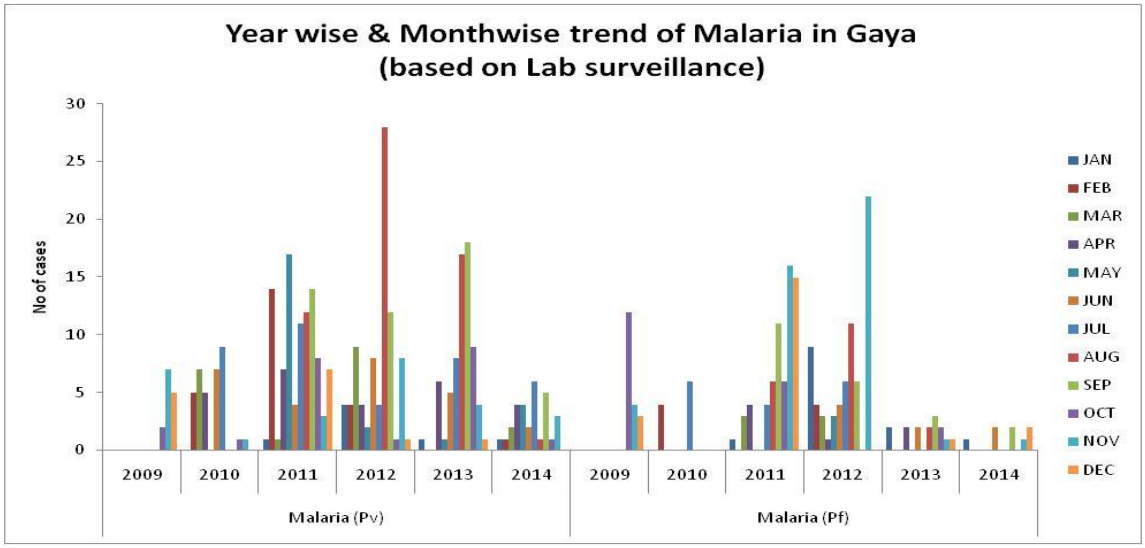

Fig 2: Year wise & Month wise trend of Malaria in Gaya (Based on laboratory surveillance)

Table 1: Yearly Epidemiological status of Malaria in Pariaya Block, Town Block and Tekari Block, Gaya

Yearly Epidemiological Status of Malaria in Pariaya, Tekari & Town Block, Gaya (Source: NVBDCP Gaya)				
Block	**Year**	**Slides taken**	**Slides examined**	**No of cases (Pv/Pf)**
Paraiya	2014	306	306	0
	2013	418	418	0
Tekari	2014	3016	3016	0
	2013	3062	3062	0
Town Block	2014	479	479	0
	2013	437	437	31 Pv

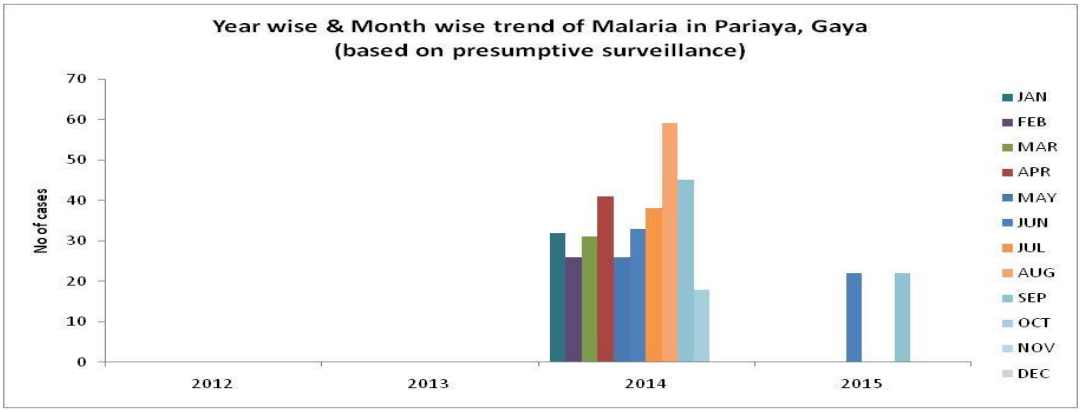

Fig 3: Year wise & Month wise trend of Malaria in Pariaya Block, Gaya (Based on presumptive surveillance)

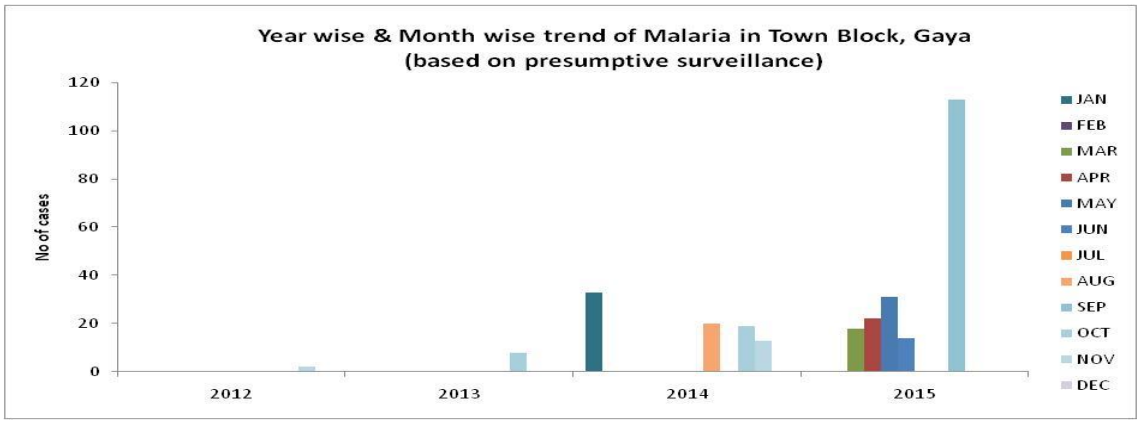

Fig 4: Year wise & Month wise trend of Malaria in Town Block, Gaya (Based on presumptive surveillance)

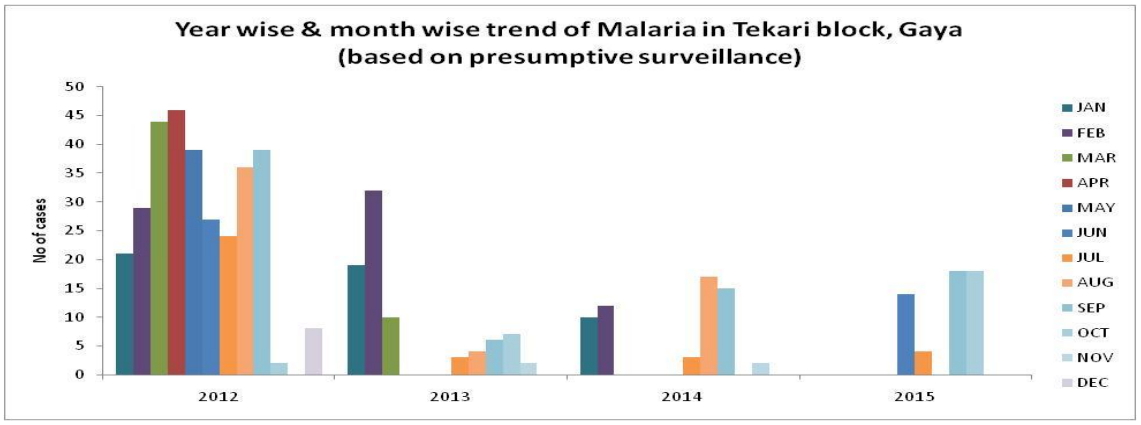

Fig 5: Year wise & Month wise trend of Malaria in Tekari Block, Gaya (Based on presumptive surveillance)\

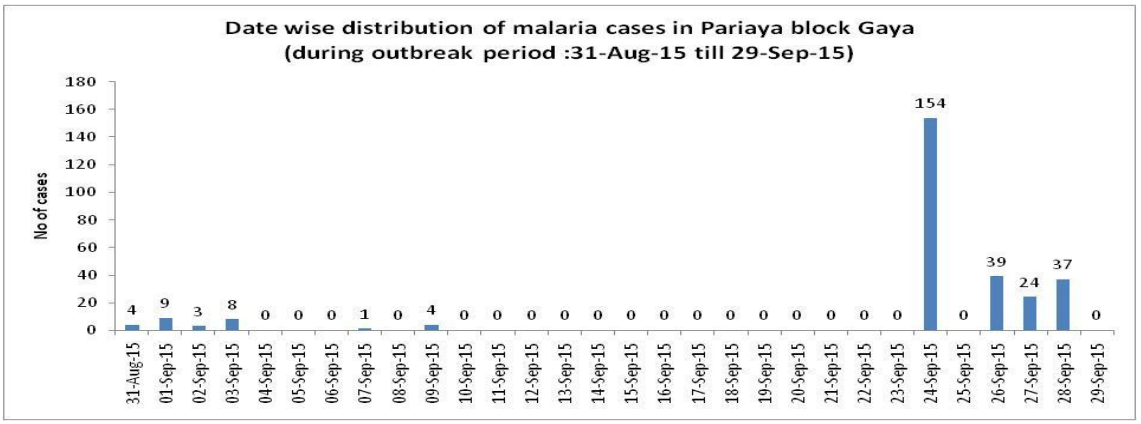

Fig 6: Date wise distribution of malaria cases in Block Pariaya, Gaya during outbreak period in 2015

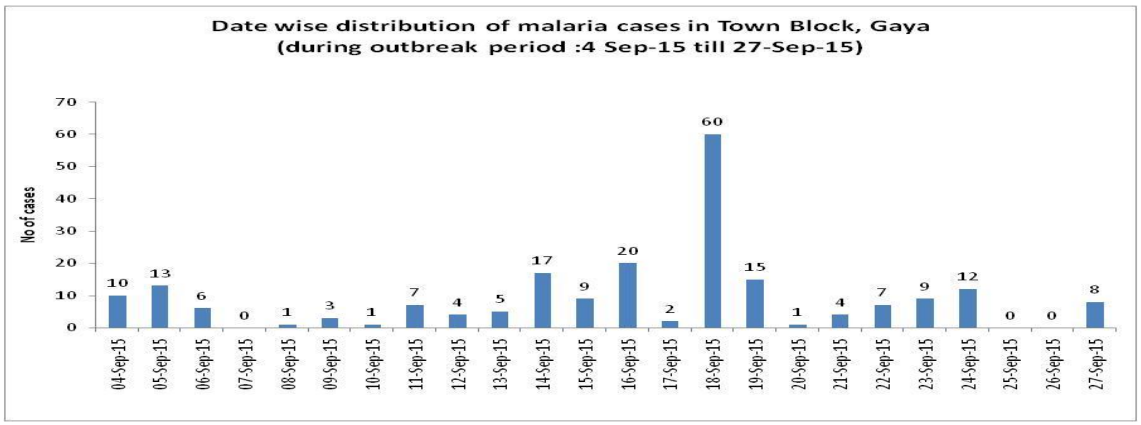

Fig 7: Date wise distribution of malaria cases in Town Block, Gaya during outbreak period in 2015

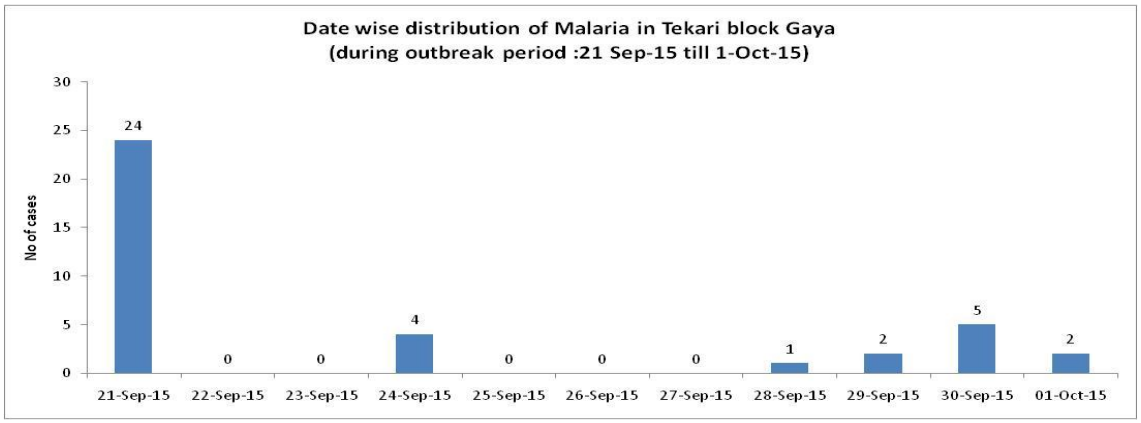

Fig 8: Date wise distribution of malaria cases in Tekari Block, Gaya during outbreak period in 2015

Table 2: Person wise distribution of Malaria cases in Gaya in Block Pariaya

Person wise distribution of Malaria in Pariaya block, Gaya		
Age Group	**Frequency**	**Percentage (%)**
0-5	30	11
6-11	58	20
12-17	40	14
18-23	22	8
24-29	26	9
30-35	37	13
36-41	20	7
42-47	9	3
48-53	11	4
54 & Above	30	11
Total	**283**	**100**
Data NA	**28**	
Sex	**Frequency**	**Percentage (%)**
Male	148	52
Female	135	48
Data NA	**28**	
Total	**283**	**100**

Table 3: Person wise distribution of Malaria cases in Gaya in Town Block

Person wise distribution of malaria in Town block, Gaya		
Age Group	**Frequency**	**Percentage (%)**
0-5	53	12
6-11	87	19
12-17	86	19
18-23	49	11
24-29	39	9
30-35	38	8
36-41	18	4
42-47	18	4
48-53	22	5
54 & Above	43	9
Total	**453**	**100**
Sex	**Frequency**	**Percentage (%)**
Male	233	51
Female	220	49
Total	**453**	**100**

Table 4: Person wise distribution of Malaria cases in Gaya in Block Tekari

Person wise distribution of malaria cases in Tekari block, Gaya		
Age Group	**Frequency**	**Percentage (%)**
0-5	4	7
6-11	12	22
12-17	10	18
18-23	2	4
24-29	3	5
30-35	6	11
36-41	9	16
42-47	5	9
48-53	2	4
54 & Above	2	4
Total	**55**	**100**
Sex	**Frequency**	**Percentage (%)**
Male	22	39
Female	33	61
Total	**55**	**100**

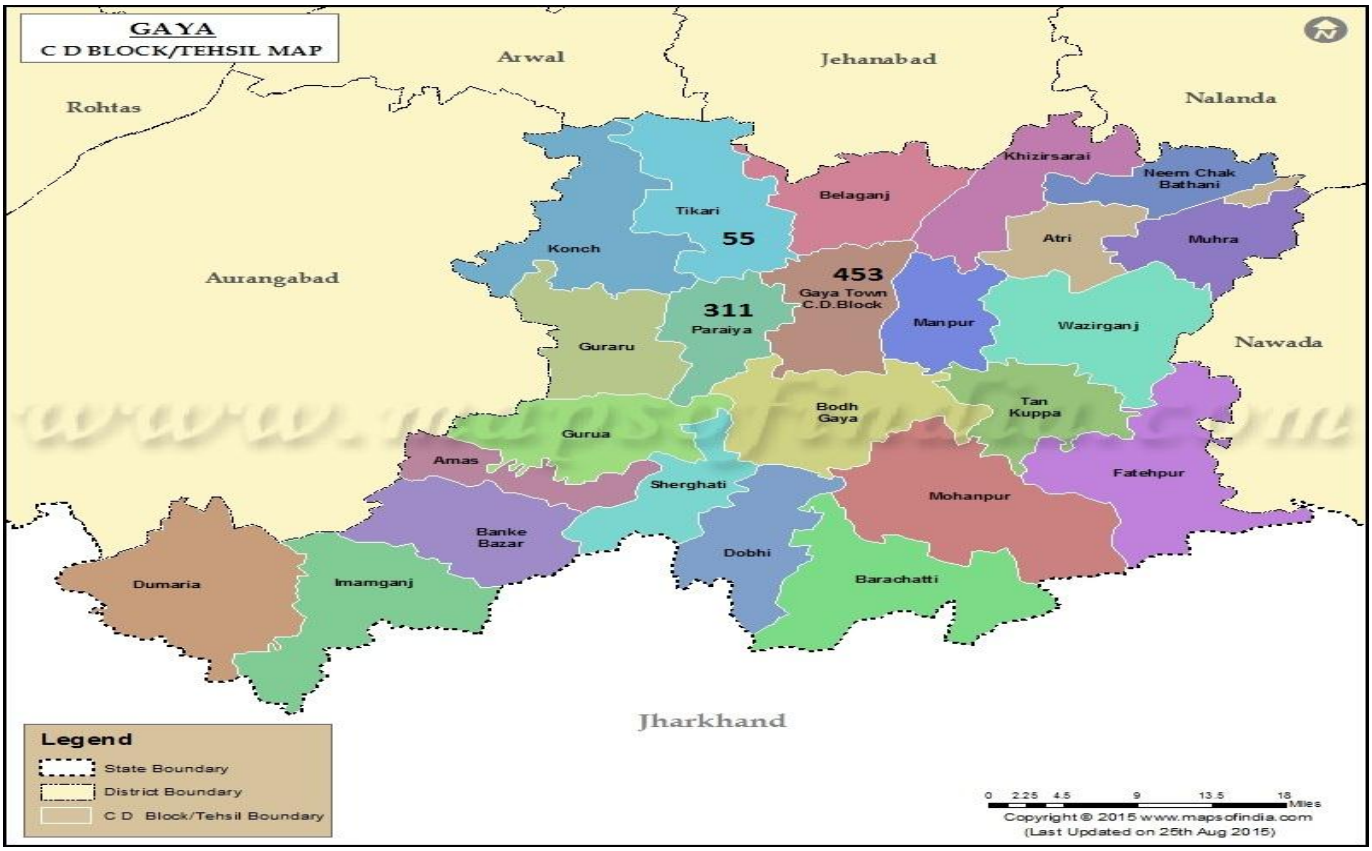

Fig 9: Place wise distribution of Malaria cases in Gaya

Table 5: Village wise distribution of malaria in Gaya

Block	Village most affected (proportion of cases out of total cases reported)	Age group most affected (block wise)	Sex most affected (block wise)
Pariaya	Jagernathpur (22%)>Kesuru (19%)>Kosama (14%)	6-11 (19%)>12-17 (19%)>18-23 (12%)	Male (51%)>Female (49%)
Tekari	Dariyapur (60%)>Belama (15%)>Vishnuganj (5%)	6-11 (22%)>12-17 (18%)>36-41 (16%)	Female (61%)>Male (39%)
Town Block	Solara (22%)>Sudhani (21%)>Sudhi Razpur (14%)	6-11 (20%)>12-17 (14%)>30-35 (13%)	Male (52%)>Female (48%)

Table 6: Malariometric indices in Pariaya, Town Block and Tekari

Block	Malariometric indices								
	Slides examined	Slides positive	Fever rate	Blood smear examination rate	Slide positivity rate	Slide falciparum rate	Slide vivax rate	Slide mix infection rate	Proportion of falciparum cases
Pariaya	1659	311	0.35% (311/86694)	1.9% (1659/86694)	18.74% (311/1659)	0.24% (4/1659)	18.2% (302/1659)	0.30% (5/1659)	1.28% (4/311)
Tekari	123	98	0.05% (98/189712)	0.06% (123/189712)	79.67% (98/123)	8.13% (10/123)	69.9% (86/123)	1.62% (2/123)	10.20% (10/98)
Town Block	930	453	0.27% (453/167720)	0.55% (930/167720)	48.7% (453/930)	1.9% (18/930)	35.37% (329/930)	1.29% (12/930)	3.97% (18/453)
Total	2712	862							

Table 7: Anopheline Larval density survey results

Larval density of *Anopheles Culicifacies* collected from breeding sites		
	Type of breeding habitat	**Larval density (3 dips/sq mt)**
Village (Solara): Block Pariaya	Temporary pools	38
	Pond margins	45
	Margins of paddy field	35
	Cattle feeding containers	25
	Rain water collection	50
Village (Dariyapur): Block Tekari	Rock Pool	60
	Temporary pools	39
	Well	15
	Margins of paddy field	54

Table 8: Knowledge, Attitude and Practices of affected community

Knowledge, Attitude & Practices in affected population		
Characteristics	**No. (N = 50) (includes combined figures of village Solara & Dariyapur)**	
Educational status	**No.**	**%**
Illiterate	27	54
Up to primary	16	32
Up to SSC	5	10
Up to HSC & above	2	4
Symptoms of malaria narrated		
Fever only	5	10
Fever with chills	38	76
Headache	25	50
Body ache	12	24
Vomiting	10	20
Abdominal pain	4	8
Cough	1	2
Feeling unwell	3	6
Convulsion	1	2
Giddiness	1	2
Treatment seeking		
Government agency	20	40
Private agency	15	30
Quack	10	20
Chemist	5	10
Hospitalization		
Yes	3	6
No	47	94
Anti mosquito measures adopted)		
Yes	20	40
No	30	60
Reason for not using anti mosquito measures (N = 30)		
Economical	15	50
Do not know	9	30
Do not care	4	13.33
No history of mosquito bite	2	6.66

5. Conclusions

Approximately 862 malaria cases were reported from 3 blocks Tekari, Town block and Pariaya in Gaya. Many cases were reported in the same family and neighbourhood. These blocks did not show malaria confirmed cases since last two years except Town block where 31 confirmed malaria cases were reported in 2013.Analysis of data showed that cases of malaria through presumptive surveillance was reported continuously in these 3 blocks, failure to verify such cases could have resulted in late recognition of the present outbreak. Slide Positivity Rate (SPR) was highest in Tekari block followed by Town block and Pariaya block.SPR was highest in age group 6-11 followed by 12-17 respectively in all the 3 blocks. Larval index in all potential breeding sources was high, thus favouring disease transmission. Most of the affected population belonged to low socio-economic strata where illiteracy was widely significant. Majority of the cases that were met during the field visit were not taking complete dose of drugs that may be assumed to be one of the important reasons for disease transmission. It can also be assumed that high temperature and humidity followed by spells of rain may be favouring behavioural changes in vector leading to increased parasitic load and its transmission, thus resulting in present outbreak. The study also throws light that the vectors have started establishing new niches favouring disease transmission. Majority of the affected cases did not show any migratory history. In addition, lack of awareness among affected community may also be the reasons of the present outbreak.

6. Recommendations

- Strengthening of the surveillance, particularly fever along with appropriate response
- Health Workers viz: ASHAs and ANMs should be informed to keep a close vigil on fever cases in their respective areas and refer them to nearest health facility for early diagnosis and prompt treatment to reduce parasitic load and hence its spread.
- Sensitization of medical and para-medical personnel in the government as well as private sectors needs to be done for appropriate and timely management of cases.
- Ensuring complete/full chemotherapy to all malaria cases.
- District level coordination meeting comprising of local community leaders of affected areas and other departments like municipality and other stakeholders should be called to spread awareness regarding the disease & to prevent future outbreaks.
- Medical camps in affected areas to build community awareness.
- Malathion fogging/DDT spray in areas having greater concentration of cases must be undertaken on a priority basis.
- Anti-larval measures with Temephos (Abate) may be undertaken for larval control. In addition, use of

kerosene/used diesel oil in stagnant water bodies may also be undertaken.

- Vector & larval surveillance should be carried out throughout the year to map the vector density & larval breeding sites through Health Workers/Surveillance Workers.
- Awareness of Community through IEC, IPC & BCC must be done for success of intervention methods. This should cover following aspects:
  a) Cause and transmission of malaria, about the vector breeding places, breeding and biting habits, etc, symptoms of the disease, management including treatment of the cases, and community measures for prevention of breeding and to prevent man-mosquito contact.
  b) Vector control measures like intensification of entomological surveillance in the area on regular basis.
  c) Spread of awareness on preventive measures like wearing full sleeved clothes, using insect repellents, mosquito nets, fumigation, taking additional care of children, elderly and pregnant women and undertaking source reduction activities.
- All places adjoining the affected areas where malaria cases/outbreak have been recorded should be made alert and close vigil on all the fever cases should be kept for early recognition of cases and their timely referral for cases management to prevent further future outbreaks.
- Availability of drugs and rapid test kits should be ensured at all the hospitals for preliminary screening of cases and for their prompt treatment.
- Waste management should be properly planned by District Health Authorities

7. Acknowledgments

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