Epidemiological profile of malaria among various socio-demographic groups in a western district of Odisha, India

Nitika Pradhan1,2, Prakash Pradhan3, Sanghamitra Pati2, Rupenangshu K. Hazra2
1KIIT School of Biotechnology, KIIT University, Bhubaneswar, Odisha, India; 2Regional Medical Research Centre, Bhubaneswar, Odisha, India; 3Chief District Medical Officer, Bargarh, Odisha, India

SUMMARY

A retrospective analysis of malaria incidence, patterns and trends in Bargarh, a western district of Odisha, India, over five consecutive years (2012 to 2016) among various socio-demographic components was established from the National Vector Borne Disease Control Programme (NVBDCP), Bargarh, as well as from district survey reports. The increasing trend in malariometric indices such as the Annual Blood Examination Rate (ABER), the Annual Parasite index (API) as well as the Total Positive Rate (TPR) reveals a better surveillance activity but an alarming situation for malaria. The trend for P. falciparum and P. vivax infection is found to be zigzagging or fluctuating for the five years in question, with the preponderance of P. falciparum infection. Malaria in Bargarh district is age-specific where there is a strong positive correlation between the age factor and malaria morbidity, but it is gender-blind. The incidence of malaria is increasing among deprived communities as well as pregnant women in the district. The community perception study reveals the knowledge level regarding cause, prevention and treatment for malaria, which is lower among deprived communities than more progressive communities. The overall epidemiological study highlights the dynamics of disease transmission among various demographic members in Bargarh district, whilst evaluating awareness of current malaria endemicity.

Keywords: Malaria, Odisha, Bargarh, Socio-demographic.

INTRODUCTION

Malaria, a vector borne disease persists as the major public health problem in India [1]. The eastern state, Odisha is one of the major hot spots for malaria transmission, contributing one-third of malaria cases to the country’s total burden. The state lies between latitude 17º 78’ N to 22º 73’ N and longitude 81º 37’ E to 87º 53’ E [2]. The region is highly receptive to malaria transmission due to its variable ecological conditions and climatic diversity that create a suitable environment for malaria vector and its parasite [3]. Human malaria is caused by five different species of a parasite viz. Plasmodium falciparum, Plasmodium vivax, Plasmodium malariae, Plasmodium ovale, and Plasmodium knowlesi out of which the first two species are most prevalent [4]. Of the total 30 districts, the southern districts of Odisha are afflicted with high incidence of malaria while the coastal districts are least affected having API (Annual Parasite index) lower than 2 [5, 6]. The rest of the districts are considered as “moderate zones” or “meso-endemic zones” for malaria. Most of the western districts of Odisha are included in this zone. Our study was conducted in a western district, Bargarh which is close to the border of the state, Chhattisgarh. Bargarh is an administrative district of Odisha state in eastern India. The incidence of malaria is

Corresponding author
Rupenangshu K. Hazra
E-mail: rupenkh@yahoo.co.in
on the raise in this western district in the recent years and there is not much information on malaria incidence from this region. Comparatively the other western districts of Odisha, particularly Sambalpur, Sudergarh, Nuapada, Deogarh and Bolangir are more malaria prone with API in the range of 4-13. Although the earlier malaria situation was in controlled condition in Bargarh district (API <1), in the last couple of years, the trend line for epidemicity of the disease was gradually projecting upward indicating an alarming sign of hyper-endemicity. The increase of malaria morbidity in this area is due to a variety of factors among which lack of public awareness and implementation of research programme are the two major contributors [7].

The pattern of malaria varies between different demographic groups in relation to age, sex, caste, etc. [8]. The climatic, ecological, socio-economic as well as socio-cultural factors are the major determinants influencing the variable degree of transmission [9]. The objective of this study was to assess the incidence of malaria in various socio-demographic population of Bargarh by using the retrospective NVBDCP (National Vector Borne Disease Control Programme) data and basing on some district survey reports, developing a long term and reliable strategy for monitoring and controlling the disease.

**MATERIALS AND METHODS**

*Study area:* The retrospective study was conducted in Bargarh district, located in Western Odisha, India (Figure 1). It is positioned at 21.33°N

![Map showing the study area, Bargarh district of Odisha, India along with total CHC, SDH, DHH.](image)
82.62°E covering an area of 5,837 km². The district has a total population of 1,478,833 as per 2011 census with male to female ratio of 1.02 (i.e., almost equal) with an average literacy rate of 76%. The backward community (socially and educationally disadvantaged) constitutes nearly 30% of the total population. The district is inhabited by tribes like Sahara, Binjhal, Kondh, Gond, Munda, Bhuinya, Oran, Kisan, Mirdha, Kharia and Parja having agriculture as the main source for their livelihoods besides their traditional weaving occupation. Bargarh district experiences a versatile climate with very hot and dry summer followed by humid monsoon and chilling winter. The average annual rainfall in Bargarh is 1527 mm while the temperature varies between 10 °C to 46 °C. For the present study a total of 13 CHC, one DHH and one SDH were taken into consideration (Figure 1).

Data collection, methodology design and data analysis
The epidemiological data was collected from NVBDCP, Bargarh for the five years (2012-2016). The National Vector Borne Disease Control Programme (NVBDCP) is a surveillance system to measure the malaria incidence on the basis of blood smear examination at Primary Health Centres (PHC). It uses various malariometric indices such as API, ABER (Annual Blood Examination Rate), TPR, SPR (Slide Positivity Rate), Pf% and deaths to measure the malaria incidence, morbidity as well as mortality by compiling the data from a village level and assembles to make a district level data. Thus each year data for a district provides an overall scenario for clinical and epidemiological profile of malaria. Proper interpretation of that data is required to study the trends of malaria in the past years while at the same time to detect any alarming sign for the upcoming years. Simultaneously a survey was also conducted among the people of Bargarh district regarding malaria. The data collected from all those sources were gathered together and the malaria victims were categorized into different groups according to age, sex, caste, etc. Besides this, data regarding type of malaria infection (P. falciparum or P. vivax) as well as malaria cases among pregnant women were also assembled to study the trends of malaria among different groups. All sets of data thus collected were analyzed with suitable statistical procedures using Microsoft Excel 2007. Unpaired t-test was carried out to compare the mean malaria cases among the backward communities of Bargarh district since 2013. A regression analysis was carried out to find out the age specific malaria morbidity. Further a chi square test was conducted to study whether clinical malaria in Bargarh district exhibited a sex bias.

RESULTS
A general trend of malariometric indicators for the last five years in Bargarh district
The trends of API (Annual Parasite Index) and ABER (Annual Blood Examination Rate) for the last five years (2012-2016) were depicted in Figure 2A for Bargarh district. The ABER had remained around 10 to 15 during the last five years. However there had been increase in API from 0.66 to 2.29 from 2012 to 2015. The district TPR (Total Positive Rate) also showed an increasing trend from 0.67 to 1.62 in the last five years. The proportion of total malaria positive cases out of total fever cases reported in the district was found to be increasing from 2013 whereas from 2012 to 2013, there had been decline in the trend (Figure 2B-a). When comparing the proportion of Pf (Plasmodium falciparum) and Pv (Plasmodium vivax) positive cases out of total positive cases (Figure 2B - b, c) it was observed that the line graph was projecting upward for Pv positive cases whereas trend was decreasing for Pf positive cases since 2012 although the proportion of Pf cases were more in comparison to Pv. However after 2014, there was slight upward and downward shifting in the trend line for Pf and Pv cases respectively.

Malaria cases in backward communities (Schedule Tribe/Schedule Caste) of Bargarh district
Although the malaria trend was increasing among the total population of Bargarh district (not in a continuous fashion), an observable increased tendency was found among the backward communities since 2013 (Figure 3A). There was a drastic change in the mean malaria morbidity among these communities in a single year from 2012 to 2013. The malaria cases were highest in the year 2012. However the malaria incidence data of four consecutive years from 2013 to 2016 showed an increase shift among these backward communities.
The t-test result revealed a significant difference ($p<0.05$) in the mean malaria incidence between the year 2013-2015 and 2013-2016 where no significant change was observed between the years 2013-2014.

**Knowledge status regarding malaria among two different communities (Forward vs. Backward)**

The survey report (2015-16) between the two different communities ($n=80$ for each forward and backward community) of Bargarh district (Figure 3B) depicted that the knowledge status regarding cause and symptoms of malaria was 76% and 39% for the forward and backward groups. Similarly the knowledge level for prevention and treatment of malaria was 81% and 34% while the knowledge regarding personal hygienic maintenance was 69% and 47% for the forward and backward groups respectively.

**Age specific incidence of malaria cases in Bargarh district**

In order to determine the age dependent malaria incidences among the population of Bargarh district in the last five years, a linear regression plot was carried out (Figure 4). The graph showed a strong positive correlation (Pearson correlation coefficient, $r=0.984$) between the age factor with the malaria morbidity. The graph depicted the equation for age dependent malaria incidences in
Epidemiological profile of malaria among various socio-demographic groups in a western district of Odisha, India

Bargarh district as given below: malaria incidence = 19.99 * (Age) +46.93.

Gender based distribution of malaria incidences among total population of Bargarh district

To assess the existence of a sex bias among the malaria positive population of Bargarh district, a chi square test was conducted which revealed that there was no significant variation ($X^2=1.09$, $P=0.89$) in distribution of malaria incidences in response to gender of a patient (Table 1). Hence sex biased was not observed among the malaria victims of Bargarh district. Although male victims were quantitatively more than the female victims but the difference was statistically insignificant.

Malaria cases among pregnant women of Bargarh district

The tendency of malaria was found to be increasing among the pregnant women since 2013 where as it was nil in 2012 (Figure 5A). Therefore 2013 onwards, the proportion of malaria cases contributed by pregnant women in each year to the total pregnancy related malaria cases for the last four years (2013-2016) was significantly increasing. The MIP (Malaria in Pregnancy) cases grew five times more in last year (2016) compared to 2013. Hitherto, the comprehensive study provided a complete epidemiological scenario of malaria among different socio-demographic groups of Bargarh district. The Figure 5B depicted the
contribution (%) of malaria cases by different demographic groups to the total district malaria cases in the last five years of which the adult categories (of forward community and age >15 yrs) were the major contributors for malaria morbidity, followed by backward communities and children (below 15 yrs). The pregnant women contributed only 1% of total malaria cases in the district.

Table 1 - Gender based distribution of malaria incidences among total population of Bargarh district (2012-2016).

| Year | Gender specific distribution of malaria incidences |  
| --- | --- | --- | --- |
|  | Male | Female |  
| 2012 | 566 | 429 |  
| 2013 | 518 | 383 |  
| 2014 | 1190 | 945 |  
| 2015 | 1737 | 1332 |  
| 2016 | 1958 | 1483 |  

\[ X^2 = 1.09, P=0.89 \]
Result: NS at p< 0.05; NS- Not Significant

Malaria, a major quandary in global health is the most prevalent parasitic disease [10]. More than 200 million new malaria cases have been reported worldwide in 2015 of which South-East Asia region is the major contributor for these global cases of malaria after African region [11]. Although malaria is preventable and treatable, more than 20% of India’s population live in high transmission zones. In India, maximum malaria is contributed by the state, Odisha though it constitutes only 4% of country’s population. Except the coastal belt of Odisha, bulks of malaria cases have been reported from rest of the districts. Despite tremendous efforts, the southern and few regions from western Odisha still remain hyper-endemic for malaria [12]. The epidemiology of malaria has hardly been studied in the western districts of Odisha although, the trends for malaria incidences are gradually increasing.

In Bargarh district, the epidemiological indicator ABER was found to be increasing for the last five years indicating a good surveillance system.
For an improved malaria situation, a high ABER should be followed by a low API but in Bargarh district the trend for API as well as TPR was increasing since 2012, indicating a warning situation for malaria.

The trend of total malaria cases was gradually increasing in Bargarh since 2013 although there was slight decline in the trend from 2012 to 2013 which might be due to some implementation of active malaria control strategies. The proportion of *Plasmodium vivax* cases is quite low in comparison to *Plasmodium falciparum* in Odisha where, as the former accounts for one-third of all malaria cases in India mostly affecting the children [13, 14]. The southern districts of Odisha are hyper endemic for *P. falciparum* infection [5]. The trend of falciparum and vivax infection showed a zig-zag graph for the last five years that was changing in an alternative fashion, i.e. from 2012 to 2014 the proportion of Pf positive cases were increasing and that Pf cases were decreasing where as 2014 onwards the trend was vice versa. The fluctuation in the trend from year to year might be due to the effect of climatic variation and ecological factors (edaphic, topographic, and biotic). In most endemic areas, *P. vivax* cohabits with *P. falciparum* showing mixed infection and it is more difficult to control and eliminate *P. vivax* infection than *P. falciparum* in areas of co-transmission [15]. In India, co-infection due to falciparum and vivax are very less. The dynamics of co-infection is variable as some studies showed that dual infection in children increases the severity of the disease while some others revealed that *Pv* infection suppresses the severity of falciparum infection [16]. Therefore changes in parasite population structure provide the baseline evidence for control and elimination programs.

Malaria is a vector borne disease which can affect any population, irrespective of their caste, creed, age and sex. However, in Bargarh district the magnitude of malaria incidence was increasing among the backward communities (ST/SC) since 2013. Due to implementation of some anti malaria
activities, though there was a drastic declination of malaria morbidity from the year 2012 to 2013 but afterwards there was no constancy in that trend. Besides this, knowledge status about disease causation, treatment, prevention, etc. was less among the backward community as compared to the forward community. In Bargharh district the tribal population constitutes a major proportion in backward communities. Due to lack of health awareness and their traditional belief regarding disease, they don’t seek treatment within the right time. According to their local dialect they consider fever as “Jaar” which might happen because of some supernatural power. So instead of any medical treatment they prefer “traditional healer” or “faith healer”. Most of the people of backward community are migrating out of their native place for livelihoods. Hence their socio-cultural, health practices, migration, behavioural attitude are the major factors responsible for the progressive trend of malaria in that district. Although the networks of PHCs and CHCs have been giving comprehensive healthcare services in an efficient manner, but some ultra rural inaccessible pockets are devoid of these facilities and have less access to malaria control interventions. Insecticide treated nets, (ITNs) have been found to reduce morbidity and mortality but lack of sustainable distribution, proper utilization, replacement of old nets and more importantly poor knowledge regarding the disease was low in many communities. Therefore, apart from intervention measurers, a thorough health education and improvement of behavioural pattern among these communities is essential for an effective control strategy.

The relationship between age-dependent malaria morbidity has been established in Bargharh district for the last five years. It was found that the intensity of malaria incidence was increasing with increase in age factor. In oppose to this, there are some research articles which explain that malaria morbidity is age-independent or more prevalent among children [17,18]. Besides lack of adequate protective measures as well as natural immunity, more outdoor activities and migration to high malaria endemic regions for livelihood might have been the major contributing factor for high prevalence of malaria infection among the adult groups. However, the best simple explanation for increasing of malaria incidence with age is due to increase in chance of infection as they get older. Last five years district data revealed that, the incidence of malaria was independent of gender. Malaria and its vector Anopheline mosquitoes are both gender blind, i.e. host sex independent [19]. Though, the quantitative data for malaria cases in Bargharh was more in males than females but the differences were not significant indicating an equal mobility of both the gender towards utilization of health care services for disease detection and treatment. There are many papers reporting that gender significantly influences the incidence of malaria or any other parasitic diseases but there is no such sharp evidence regarding vulnerability of the disease in response to sexual dimorphism [20]. Males are more susceptible to malaria because they spend more times in outdoor, hence more vector exposure. Also the post pubertal behavioural changes such as alcohol consumption might contribute to the increasing malaria morbidity in males [21, 22]. Therefore, a gender assessment tool is required to identify the gender specific vulnerabilities in a population.

Pregnant women constitute an important risk group for malaria infection [23]. Even if, the malaria infection rate was quite low among the pregnant women in Bargharh district, the increasing trend for malaria shed light on the vulnerability of the disease. Malaria in pregnancy can lead to maternal morbidity as well as low weight child or premature delivery [24]. Malaria-associated maternal illness is mostly caused by P. falciparum and P. vivax infection. Due to poor immunity, pregnant women are more susceptible to malaria than the general population. Apart from preventive measures involving chemoprophylaxis and vector avoidance, supportive measures such as implementation of maternal health awareness programmes, health related messages through local health workers or ASHA can be an initiative approach for prevention and control of pregnancy related malaria incidence.

The overall study gives new insights into the dynamics of disease transmission among various demographic members of Bargharh district. As 50 to 60 per cent of patients depend on private health services rather than Primary health Centres (PHCs), more than 10% of data regarding malaria morbidity is misdiagnosed. Still this data is more enough to display the overall epidemiological profile of malaria in Bargharh district. Although the earlier API range in Bargharh was close to API
of the coastal hypo-endemic areas of the state, but since 2015 the trend was gradually increasing and crossed the threshold value to become included into the less endemic zones. Besides the climatic, ecological, and socio-economic conditions which are the major contributors for epidemics of the disease, the mosquito vector prevalence and distribution also accounts for the persisting transmission of the disease in that region. Hence, if the current situation of malaria in this district can’t be controlled, more rigorous measure is needed to combat malaria in future.

ACKNOWLEDGEMENTS
The authors gratefully acknowledge Dr S. C Das, District Malaria Officer, Bargarh, India. This work was supported by a research grant from the Indian Council of Medical Research, New Delhi [6/9-7(107)/2015-ECD-II]. We also extend our thanks to KIIT School of Biotechnology, KIIT University, Bhubaneswar, India.

Conflict of interest
The authors have no conflicts of interest.

REFERENCES