School-age Children as Asymptomatic Malaria Reservoir in Tribal Villages of Bastar Region, Chhattisgarh

Malaria is a major health concern in India, especially in regions populated by tribals. In this cross-sectional survey carried out in Bastar region of Chhattisgarh, 35 Plasmodium infections were detected in 451 participants screened during the non-transmission season; 27 (77.1%) were asymptomatic. Participants with age 6-14 years were at high risk of asymptomatic infection [OR 4.09, 95% CI, 1.69 to 9.89, *P*=0.001], and may act as an under-appreciated reservoir for sustained malaria transmission.

Keywords: *Control, Diagnosis, Plasmodium, Management, Transmission.*

India has a target of malaria elimination by 2030. Controlling and elimination of malaria from tribal communities is a major task and need more attention to achieve the target of malaria elimination [1]. Tribal populations are reported to have naturally acquired immunity to malaria [2]. Due to this immunity, individuals do not develop clinical symptoms and do not seek medical treatment. School-age children and adults that are not the main focus of malaria prevention strategies may act as reservoirs for malaria transmission due to the naturally acquired immunity [3]. Tribals constitute more than 30% of the total population of Chhattisgarh. To control and eliminate malaria from Chhattisgarh it will be important to identify the potential reservoir for malaria transmission. This study was undertaken to find out the reservoir of asymptomatic malaria in the tribal population of Bastar region, Chhattisgarh, just before the transmission season in July 2017.

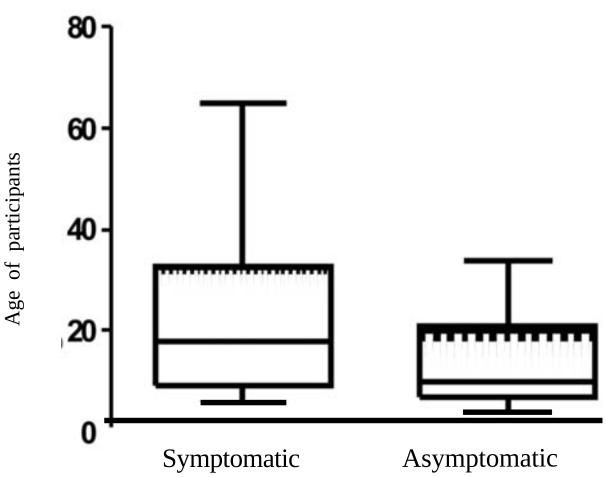

FIG.1. *Box-and-whisker plot showing age-distribution among symptomatic and asymptomatic malaria cases.*

The study was carried out in the Keshkal block, Kondagaon district, Bastar division, Chhattisgarh. Using Epiinfo 7 software, a sample size of 422 was calculated with expected frequency 7% [5], design effect 1.5 and 99.9% confidence interval. Five villages were randomly selected for the survey out of 101 villages in the block. Households from these villages were selected using systematic sampling, and blood sample was collected from every member of household who was eligible and had given consent. Blood samples were collected from 451 participants. Written informed consent was obtained from all the participants and the guardian of minors participating in the study. This study was approved by the institutional ethics committee, ICMR-National Institute of Malaria Research.

A short clinical assessment of all the study participants was done and information related to malaria-related symptoms (fever, headache, vomiting, and nausea) was recorded. Malaria diagnosis was performed using microscopy. Blood slides were stained with JSB stain and examined under compound microscope (Carl Zeiss Oberkochen, Germany) at 100X magnification for malaria parasite detection. Diagnosis was done by two trained laboratory technicians. Both thick and thin smears were made on the microscopic slides. Thick smears were used for parasite detection and thin smears were used for species identification. Statistical analysis was performed using SPSS version 20.0 (Armonk, New York, USA) and GraphPad Prism software (La Jolla, CA 92037 USA). Student t-test and chi-square test were used. P-value <0.05 was considered as significant.

Mean age (range) of participants was 19 (1-71) years (61.8% females) (***Table* I**). A total of 35 (7.8%) malaria cases were detected in the surveyed population; 94.3% were by *Plasmodium falciparum* and the rest were the mixed infection with *P. vivax*. Of these, 77.1% of the cases were asymptomatic. Two-thirds (66.7%) of asymptomatic patients belonged to school-age group (6-14 years) (***Table* I**). Mean age of participants with asymptomatic malaria was significantly lower than the symptomatic cases and non-malarial participants (***Fig.* 1**). Asymptomatic malaria showed association with age, and

TABLE I AGE- AND GENDER-WISE DISTRIBUTION OF STUDY PARTICIPANTS

Variable	*Total participants (n=451)*	*Malaria negative (n=416)*	*Asymptomatic malaria positive (n=27)*	*Symptomatic malaria positive (n=8)*
Male sex, *n* (%)	174 (38.6)	158 (38.0)	13 (48.1)	3 (37.5)
Age (y)*	23.4 (16.7)	24.0 (16.8)	13.4 (8.9)	23.6 (19.7)
Age distribution, n (%)				
6 mo-5 y	26 (5.8)	24 (5.8)	2 (7.4)	0
6-14 y	75 (16.6)	53 (12.7)	18 (66.7)	4 (50)
≥15 y	350 (77.6)	339 (81.5)	7 (25.9)	4 (50)

no association was observed with gender. Risk of asymptomatic malaria was high in participants with age ≤14 years (OR 4.09, 95% CI 1.69 to 9.89, *P*=0.001).

Controlling malaria in tribal populations requires more effort and is of immense importance to achieve the target of malaria elimination in the country. The malaria transmission season in Chhattisgarh starts from August with the peak in October-November, the asymptomatic reservoir present in the population in July-August may act as a very important contributing factor for increased transmission in the coming months. This is the time when vector density increases, leading to high transmission in the following months. As microscopy is the method available at Primary Health Center level, we used it to find out the asymptomatic cases in monsoon season *i.e.*, July end.

Asymptomatic malaria cases were reported to be five times the clinical cases of malaria in low transmission season in central Malli, West Africa [4]. 6.8% of the population was an asymptomatic carrier of infection in eastern India [5]. Chaurasia, *et al*. [6] reported that 77.7% of malaria infections were asymptomatic. In our study, we found that 6% of the population was carrying asymptomatic malarial infection in low transmission season.

Alves, *et al*. [7] previously reported an association of asymptomatic malaria with older age group [7], whereas previous Indian authors found a high prevalence of afebrile parasitemia in younger individuals (<14 years) [8,9]. Aju-Ameh, *et al*. [10] also showed a prevalence of asymptomatic malaria in the age group 2-10 years. Prevalence of asymptomatic malaria was reported to be higher in age group >15 years in Chhattisgarh [6]. Our study contradicts findings of Alves, *et al*. [7] and Chaurasia, *et al*. [6] and supports the earlier reported observations [8-10].

The results of this study indicate that for malaria control and elimination within the set time frame, strategies should be designed to find out and target the reservoir of asymptomatic malaria before the rainy season. This may show a significant reduction in number of malaria cases in high transmission season. This strategy may be highly effective for bringing areas in control phase of malaria to pre-elimination phase. The limitation of this study is the small sample size. Studies with a large sample size and at multiple sites are warranted to better understand the problem of asymptomatic reservoir in Chhattisgarh, and other areas with high transmission of malaria.

Contributors: DG, GS: conceptualized and designed the study; DG: collected the data; RR: analyzed the data and drafted the manuscript. All authors approved the final version of manuscript, and agree to be accountable for all aspects of study.
Funding: None; *Competing interest*: None stated.

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Exposure to Household Air Pollution During Pregnancy and Birthweight

This case-control, hospital-based study aimed to study the role of household air pollution in adverse birth outcomes like low birth weight. 200 newborn babies weighing <2500 g were included in the study along with 200 matched controls. After adjusting for confounders, it was found that exposure to second hand smoke (adjusted OR 1.72, 95% CI 0.85, 3.50, *P*=0.13) or indoor air pollution due to cooking fuel (adjusted OR 1.63, 95% CI 0.71, 3.72, P=0.25) were not significantly associated with birth weight.

Keywords: *Epidemiology, Low birth weight, Smoking.*

Household air pollution is an important risk factor for morbidity and mortality, and has been estimated to contribute to 4.5 million deaths globally in 2012, almost all in low- and middle-income countries [1]. The studies have shown its association with multitude of adverse health and birth outcomes among women [2-4].

The current case-control study attempted to evaluate the role of household air pollution in adverse birth outcomes like low birth weight (LBW). It was conducted from January to December 2014 in one rural and one urban hospital of Delhi. Two hundred cases, constituted by all newborn babies weighing less than 2500 g were included in the study along with 200 matched controls. A control was a newborn baby weighing 2500 g or more, born on the same day as the case in the same hospital but unrelated to the same. Ethical clearance was obtained from Institutional ethics committee before the start of the study.

A semi-structured questionnaire was designed using various determinants and factors known to be associated with low birth weight. It was pretested on 10 mothers of newborn babies born in the hospital over a period of 5 days. The questionnaire was devised in both English and Hindi versions, and the Hindi version was translated back into English for validation. In order to be consistent with the epidemiological literature, binary classifications of household use of solid fuels (biomass and coal) were used as a practical surrogate for actual exposure to indoor air pollution. Thus, mothers giving a history of consistent usage of solid fuel were categorized into the group exposed to household air pollution. The outcome (birth weight of baby) was measured by the investigator using a digital non-hanging type Salter scale and rounded to the nearest 10 grams. Birth weight was assessed within 24 hours of birth.

The data collected was entered in MS-Excel sheet and was analyzed and statistically evaluated using SPSS version 16. Odds ratio and 95% confidence interval were used to quantify the risk factors. P<0.05 was considered significant. Univariate analysis was followed by multivariable logistic regression to calculate adjusted odds ratios. Variables with a *P* value of 0.2 or less were used for adjustment in calculation of adjusted odds ratio.

The frequency of females was more (*P*=0.003) in cases compared to controls and the difference was statistically significant. Household air pollution as a result of cooking using biomass fuel (cow dung cakes, wood, coal) and kerosene during pregnancy was identified in 86 (43.0%) cases which was more than the controls (41, 20.5%). The use of LPG as fuel for cooking was more (P<0.001) among controls than cases.

Exposure to second hand tobacco smoke (SHTS) or passive smoking was associated with higher odds (OR 3.78; 95% CI=2.39, 5.98; P<0.001) for risk of LBW compared to mothers with no such exposure during pregnancy. Household air pollution resulting from use of