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Awareness on critical prevention practices to combat the drug resistance in *Plasmodium falciparum* and *Plasmodium vivax* malaria from Rajasthan, India

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Abstract
The ability of the *Plasmodium* parasites to develop resistance to commonly used antimalarial is the biggest challenge for malaria elimination. This threat is being accelerated by the systematic misuse or overuse of antimalarial, as well as inadequate infection prevention and control. Most disease control strategies require active community participation, which in turn depends on an individual's knowledge and alertness to the disease. This study was undertaken to understand the awareness of the local public, predominantly rural, regarding the use of antimalarial, current status of drug resistance and critical prevention practices or alternatives used to combat malaria in and around Jhunjhunu, Rajasthan. A questionnaire-based cross-sectional study was designed and data was collected using an observational checklist. On the whole, our data shows that while nearly three fourth of the respondents were aware of the mosquito bite, only 10% knew about the parasite *Plasmodium*. About one-tenth of the people were aware of Chloroquine as well as drug resistance. Further, to fill the knowledge gaps of the target audiences, malaria control strategies were personalized as an effort to strengthen existing malaria prevention approaches and proper usage of drug regimens to eliminate malaria.

Keywords: Malaria, *Plasmodium*, drug resistance, community participation, awareness, Rajasthan

1. Introduction
Humans are susceptible to many infectious diseases, among which malaria is one of the most dreadful diseases affecting people all over the world. According to the World Health Organisation, in 2018, an estimated 228 million cases of malaria occurred worldwide [1]. One of the major bottlenecks in our fight against malaria is the emergence and spread of drug resistance, due to which most of the currently available antimalarial drugs are losing their efficacy. In the last few years, India has shown a sharp decline in the number of cases (only 3% of total cases) and deaths due to malaria (reduced from 4% to 2%). However, despite the progress, India is still contributing to the maximum number of cases outside Africa, i.e., 85.2% of total malaria cases in Southeast Asia [1]. Thus, India is a key country in the perspective of global malaria elimination.

In India, about 80% of malaria cases are reported mainly from Eastern states like Odisha, Kolkata, Jharkhand, North-Eastern states like Meghalaya and Tripura [2], along with other high-risk areas like Madhya Pradesh, Chhattisgarh, Maharashtra and Rajasthan. Of these, Maharashtra experienced a sudden outbreak in 2010 and is now the fourth worst affected state in the country [3]. Rajasthan has been endemic for malaria for around 20 years, where most of the malaria cases were reported from Bikaner [4], which was also, declared a hypo endemic area for malaria after the 1994 epidemic. Earlier, malaria was witnessed mostly in rural India due to a lack of prevention and treatment attitude, but more recent research marked a significant high in urban areas as well [5], one of the primary reasons being building constructions etc.

To control the malaria spread and outbreaks, the Indian Government has been initiating many control programmes, one such being the National Vector Borne Disease Control Programme (NVBDCP) [6]. The key objectives of this programme are to educate and communicate for promoting community participation and at the same time to increase awareness to use a bed net, insecticide spray and biological measures to control the disease [7]. Recently, the Government of India has also developed a National Framework for Malaria Elimination (2016-

(2016-2030) [8] and a National Strategic Plan (NSP, 2017-2022) [9] intending to eliminate malaria by 2027 - three years ahead of the regional and global target [10]. For achieving the goal of malaria elimination, key modules were identified which included, improvisation of surveillance systems, disease management at micro (district) levels and scaling up of effective intervention strategies [10]. Though many such awareness programmes are operational / implemented in India, the awareness about malaria varies across demographic and geographic groups [11]. Even in endemic areas, where gauging the awareness of malaria among the community and educating them is imperative, knowledge of the disease is not consistent [12].

At present, when the control of drug resistance in malaria parasites requires reducing the overall drug pressure through the more selective use of drugs and improving the ways the drugs are used, it is necessary to have active community participation in spreading awareness on present knowledge and attitudes of the population concerning malaria as a disease, its prevention and treatment. Thus, the objective of this study is to gauge differences in basic and core knowledge of malaria and attitude in the use of prevention practices among residents of Jhunjhunu and make them aware of the current status of the disease in the country. As per our knowledge, this is the first awareness program on malaria conducted among the school and college students and the rural population of Jhunjhunu district to create awareness about the cause, symptoms, prevention and current status of malaria.

2. Materials and Methods

2.1 Development of the Questionnaire

A semi-structured questionnaire was developed based on prior studies [13-16] to assess the current understanding of the participants about malaria. The survey contained a few simple and basic questions to evaluate the perception of malaria, such as its cause and symptoms, mosquito biting time, breeding sites etc. It also included prompts for specifying the Socio-demographic information which included name (optional) age, gender, education level and occupation of individual respondents. Further, the respondents were assessed for their awareness about current treatments available for malaria including home remedies, drug resistance and disease recrudescence. Irrespective of the responses, every set of the population was explained about the disease in detail. These aspects included mosquito life cycle, host-parasite interactions, symptoms, diagnosis and treatments available for malaria, drug resistance acquired by the *Plasmodium* parasite and the importance of control methods, including keeping the surroundings clean. All the responses were compiled and analysed statistically.

2.2 Study site – Jhunjhunu District, Rajasthan

The questionnaire-based cross-sectional study was conducted between September 2019 and December 2019 among the residents of the Jhunjhunu district. Jhunjhunu district lies in North East of Rajasthan, India. It has six tehsils [17, 18] in which, Jhunjhunu tehsil has 272 (the highest number) villages whereas Udaipurwati tehsil has 94 (the lowest number) villages. Jhunjhunu district has 927 villages, with 926 villages inhabited. According to the 2011 census, the Jhunjhunu district has a population of 2,137,045 [19], of which 77.1% belong to rural and 22.9% to urban areas. Amongst rural areas, Sultana (Tehsil: Chirawa) is the most populous (16,377 persons) village and Chak Alampura (Tehsil: Chirawa) is the least populous (02 persons) village. Twelve statutory towns such as Pilani, Vidya Vihar, Bagar, Bissau, Chirawa, Jhunjhunu, Khetri, Mandawa, Mukandgarh, Nawalgarh, Surajgarh and Udaipurwati are present in the Jhunjhunu district [19].

2.3 Study population and setting

A clustered cross-sectional survey was administered to a stratified random sample of 1500 participants from 31 villages of Jhunjhunu. The study population was the residents living in and around the villages and small towns of Chirawa Tehsil and from selected towns and villages of other Tehsils of Jhunjhunu district, Rajasthan, India. The categories of participants chosen for the study were;

1. School and College students (Residents and students living in hostels)
2. Professors and Teachers of Colleges and Schools
3. Housewives (Females living in campuses and rural lower-class females)
4. Unemployed
5. Business people
6. People in Agriculture (Individuals from rural lower-class section)
7. Others – Office Assistants, Hospital Staff, Cooks, Sweepers, Helpers, Watchman, Salesman, Drivers etc. (Individuals from rural middle/lower class)

The inclusion criteria for a student was at least standard 10 or above, while for other individuals, it was at least 18 years of age or older. The aforementioned verbal consent was obtained from the Heads of Institutions and the participants who were willing to fill the questionnaire.

2.4 Data Collection and Analysis

Responses were recorded on paper questionnaire forms and further checked for errors and comprehensiveness. Out of 1500 survey forms collected, only 1428 forms were selected for this study, as the remaining 72 forms had incomplete responses. Data were then entered into a Microsoft Excel 2010 spreadsheet and results were analyzed using descriptive statistics. All responses were calculated separately for each category as well as overall. Differences in distribution were evaluated using the chi-square ($\chi 2$) test by SPSS version 16.0 and a significance level of $\alpha = 0.05$ was set for all statistical analyses.

3. Results

3.1 Demographic characteristics of enrolled participants

A total of 1500 people participated in the survey conducted from 31 villages of Jhunjhunu (Figure 1a), from which 1428 respondents were considered for the study. The largest proportions (61.20%) of the respondents were students, followed by Teachers (8.96%) and Agriculture section (8.26%). Roughly all respondents had resided in the Jhunjhunu district for over eight years, except some of the student community with noticeably shorter duration. The age of the participants ranged from 14 to 78 years, with a median of 46 years. Among the participants, 43.28% were male and 56.72% were female (Figure 1b). The literacy among the respondents was high along with 7.63% primary level education and 4.34% uneducated in our study area (Figure 1c).

Fig 1a: Study Area – Jhunjhunu District, Rajasthan, India (Adapted from Shyoran. et al. 2013 [18])

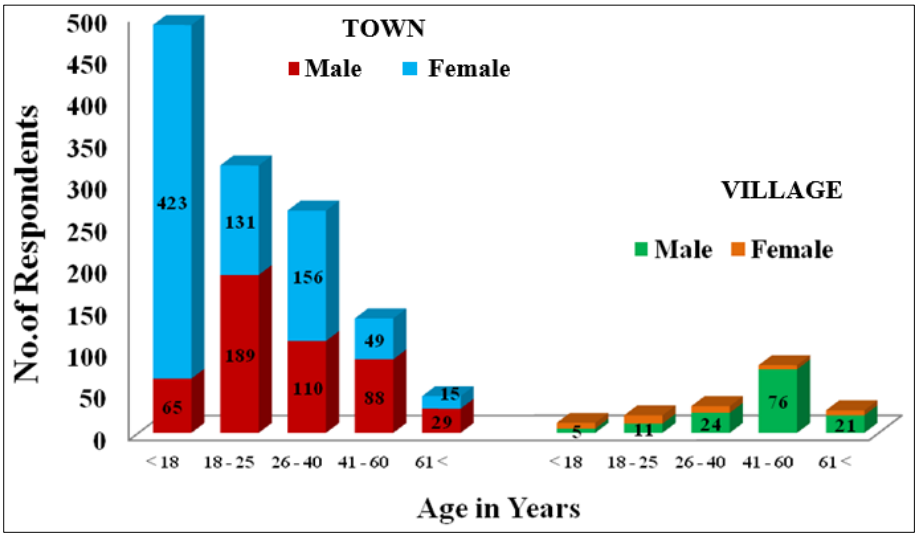


Fig 1b: Total Respondents (1428) categorised SEX/ AGE WISE

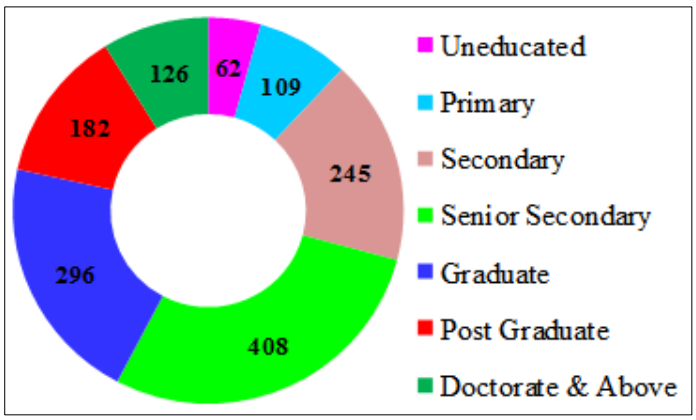


Fig 1c: Total respondents (1428) categorised based on education

3.2 General Awareness on malaria

Taken as a whole, 97.34% of respondents had heard of malaria, but awareness of malaria differed by category. Only 54.13% of respondents were aware that though malaria is an infectious disease, it is not communicable in most instances to uninfected individuals (Figure 2). On being asked about malaria transmission, 79.83% of respondents are aware, that mosquito bite is the leading cause of malaria. Around 75.30% of students were already familiar with the above fact, amongst which 3.95% were from villages. On the other hand, 6.30% of respondents incorrectly assumed other sources like, drinking contaminated water or eating contaminated food or close contact (2.18%) with a malaria patient as a cause of malaria. Many even assumed that malaria could spread by touching or being with malaria patients without a mosquito bite. However, the knowledge about specific mosquito and parasite causing the disease was not known to more than half the respondents. While the species of mosquito causing malaria i.e., *Anopheles* was at least known to 42% of the respondents (with 31.45% even aware about female *Anopheles*) only 6.86% reported *Plasmodium* parasite as a causative organism for malaria where the species *P. falciparum* and *P. vivax* was mentioned only by 2.66% of the participants. This was also observed more in the educated sections (Table 1).

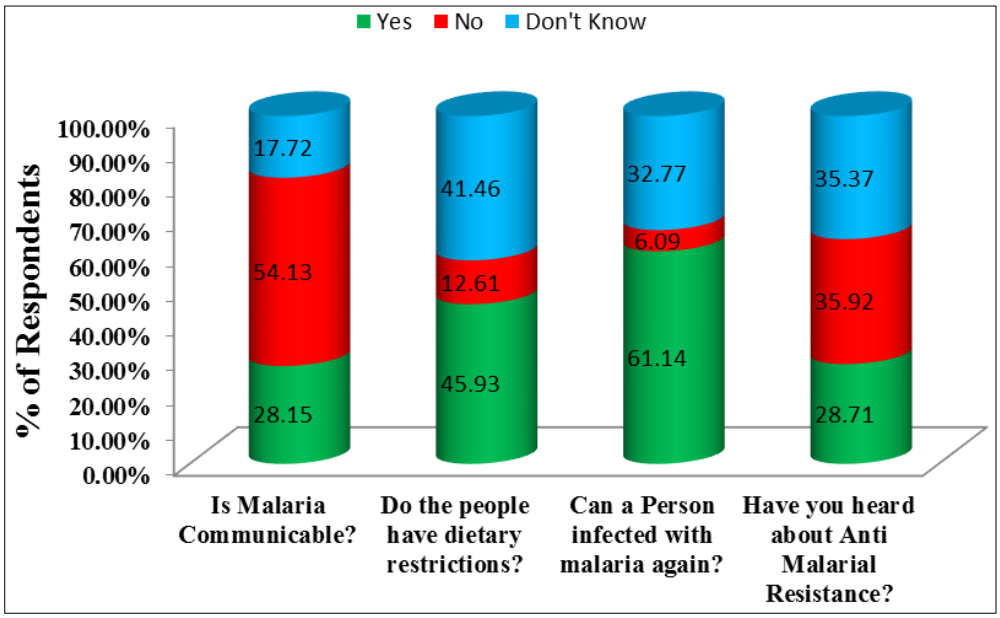


Fig 2: Responses (%) on the Participant's Attitude and Core Knowledge of Malaria

For the breeding sites of mosquitoes, 54.35% responded that the dirty stagnant water is a breeding place for mosquitoes. However, the awareness of other breeding sites, such as ponds and lakes, dark and wet areas, bushes and animal shelters varied among sections. Only 5.95% of respondents were aware of mosquito breeding in clean stagnant water bodies such as ponds, rivers and streams etc. Most respondents of the agriculture section (91.53%) accurately identified bushes and animal shelters where mosquito breeds but this understanding was deficient (20.59%) in more than half of respondents in the student's section ($P<0.00001$) (Table 1).

83.05% of respondents were well aware about of the fact that in the rainy season, malaria reaches its peak. Still, some of the respondents incorrectly identified winter (4.06%), summer (3.23%), or any time (4.13%) as the peak season for malaria. 34.87% knew that malaria-causing mosquitoes primarily bite in late evening and night, however, 32.22% of respondents erroneously supposed that malaria-infected mosquitoes bite any time and 18.07% supposed daytime.

Table 1: Significant correct Answers as given by respondents (Category wise)

Total = 1428 Respondents	Causes		Peak Season	Biting Time	Symptom	Medicines	Mosquito	Highest Cases
Categories (Total)	Mosquito Bite	*Plasmodium* Parasite	Rainy Season	Night-time	Fever with Chills	Chloroquine Quinine Artemisinin	(Female) *Anopheles*	Africa
Student (874)	658(75.29%)	104(11.90%)	748(85.58%)	237(27.12%)	522(59.73%)	240(27.46%)	450(51.49%)	237(27.12%)
Teacher (128)	114(89.06%)	26(20.31%)	118(92.19%)	75(58.59%)	112(87.5%)	66(51.56%)	81(63.28%)	53(41.41%)
Housewife (85)	71(83.53%)	14 (16.47%)	70(82.35%)	32(37.65%)	36(42.35%)	18(21.18%)	26(30.59%)	13(15.29%)
Business (70)	62((88.57%)	0	60 (85.71%)	33(47.14%)	18(25.71%)	7(10.00%)	5(7.14%)	3(4.29%)
Agriculture (118)	112(94.92%)	0	75 (63.56%)	54(45.76%)	38(32.20%)	15(12.71%)	1(0.85%)	0
Unemployed (31)	28(90.32%)	0	21(67.74%)	14(45.16%)	8(25.81%)	13(41.94%)	5(16.13%)	3(9.68%)
Others (122)	95(77.87%)	4 (3.28%)	94 (77.05%)	53(43.44%)	79(64.75%)	29(23.77%)	36(29.51%)	23(18.85%)

*$P<0.001$ suggesting the significance of data

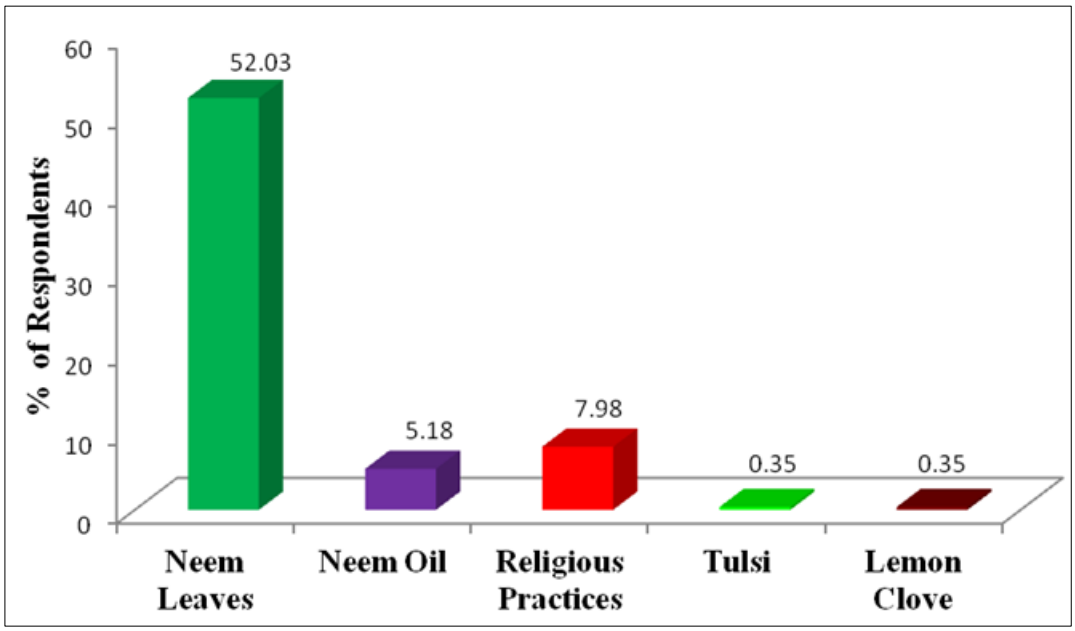
Most of the respondents knew well about the symptoms of malaria. 31.51% knew fever and 56.93% knew fever with chills as a significant symptom of malaria. Yet, most were less familiar with other common symptoms and it is differed by sections (Table 1). 47.55 % of the study population knew about the severe manifestation of malaria, but it was less

prevalent across the sections. The majority of respondents (49.72%) identified cleanliness, avoiding stagnant water in and around as a prevention strategy. Many of the respondents were aware of bed nets, window nets, spraying insecticides, mosquito repellents and coil usage, wearing full clothes and applying mosquito repellent creams as successful strategies to avoid malaria. Wearing long-sleeved clothing, using repellent coils/ creams and bed nets were more (13.32%) in the rural middle class and lower class when compared to rural high class (6.09%) ($P<0.005$). At the same time, the use of liquid repellents and window-nets was common in the rural high class. Although 70.17 % of respondents reported that they have seen health workers spraying around their house, surprisingly in the same community, some were not aware and this shows they have not noticed it. Across the sections, fewer respondents (6.44%) assumed taking the preventive medication by consulting the doctor and not let mosquito to bite as a measure to prevent malaria. 14 respondents (0.98%) were those who had recovered from malaria and 446 respondents (31.23%) reported that their family member or friend already previously had malaria. Hence, they responded well about malaria symptoms and medicines.

3.3 Awareness about treatments available and Drug resistance

About the prevention of malaria, 83.26% of respondents believed malaria is curable with proper and timely medication while 52.59% of them said that malaria could cause death if left untreated. Many respondents knew about Chloroquine (25.42%) to treat malaria, while quinine (1.75%) was known only to some respondents. But, many respondents erroneously supposed paracetamol (5.18%) or antibiotics (21.64%) could treat malaria. Only one research scholar knew about Artemisinin. Many respondents (41.25%) did not know about any vaccine for malaria and only 19.81% were aware that there is no vaccine still for public use. Only one participant, a professor, accurately said that the vaccine trials had been reported.

Almost all respondents (85.78%) replied that they would go to the hospital to receive treatment, whereas 12.47% of people responded that they try self-medication (mostly wet cloth) for a day or two before consulting a doctor. This was found higher in the housewife and female category. 45.93% of respondents (Figure 2) believe that milk with porridge and fruits are the dietary restrictions to be followed for the quick recovery from malaria fever. Most of the respondents knew about home remedies; including burning of dry Neem leaves (52.03%) or using Neem oil (5.18%) to prevent mosquito bites as indigenous methods for their protection. Five respondents reported drinking Tulsi water and smelling the half cut lemon inserted with Clove prevents malaria. 7.98% of people also mentioned a few religious practices such as smoke of Incense sticks, Camphor, Cow dung and Lighting Lamps to prevent malaria (Figure 3).



*Religious Practices include smoke of Incense sticks, Camphor, Cow dung and Lighting Lamps

Fig 3: Responses (%) on the participant's attitude on home remedy using Natural Products

61.14% of respondents believed that malaria could reoccur if not treated well or again bitten by a mosquito (Figure 2). Overall, 28.71% of respondents (Figure 2) know about the drug resistance and this data varied depending upon the sections. 34.53% of students and teachers were aware of the development of resistance against chemotherapeutic agents by *Plasmodium*; however, only 4.62% of village people know about the antimalarial drug resistance. Only 2.54% of people in agricultural sector had knowledge towards drug resistance (Figure 4). Almost most respondents believed malaria to be mostly spread in Africa (23.32%) and Asia (2.87%), but many believed India (23.60%), as a most populated country, must report the highest malaria cases. Overall, differences across categories were seen with the educated sections responding significantly well compared to respondents in the villages.

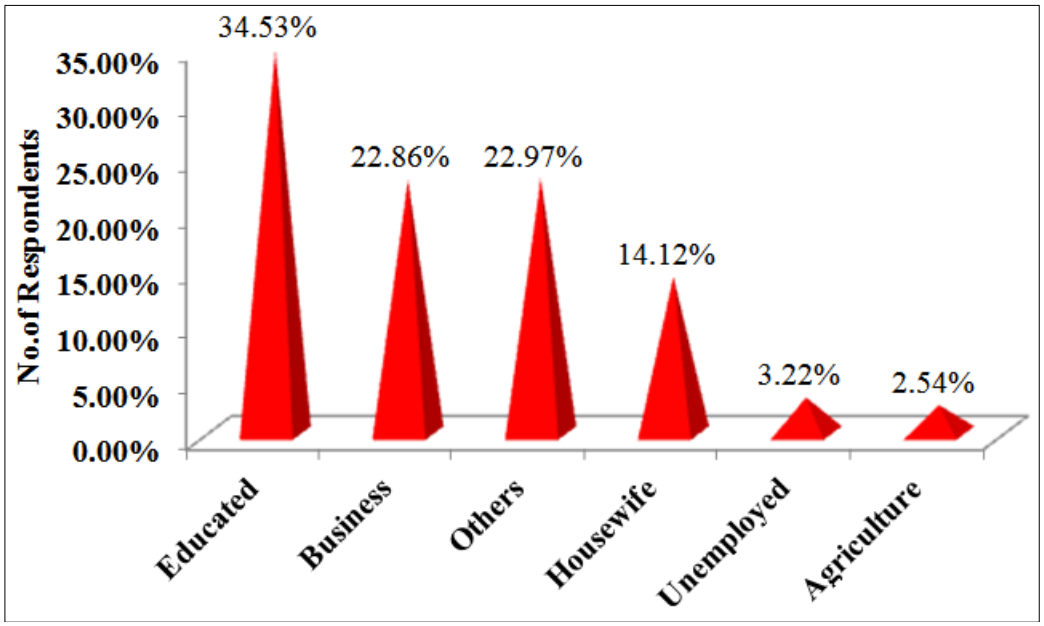


Fig 4: Responses (%) on Participant's Knowledge on Drug Resistance

3.4 Discussion

Malaria accounts for approximately 85% of the infectious disease burden across the world. However, proper awareness and surveillance programs along with adequate control measures can prevent and treat it to a larger extent. This study is one such initiative towards understanding the basic and core knowledge about malaria among the residents of Jhunjhunu, Rajasthan, India. Taken as a whole, respondents were generally aware of malaria. They had outstanding awareness about the mosquito bite, biting time and breeding sites of mosquitoes, symptoms of malaria, yet, there were illusions. At least half of the participants were aware of cleanliness in and around, bed nets, window nets, insecticide spray and full clothing as efficient prevention strategies. This high rate of awareness about malaria transmission is in concordance to the earlier report from India [16], where many responders ranked malaria as an important health issue. However, similar to the report, there was a gross lack of knowledge regarding the prevention, treatment and usage of drugs of malaria and drug resistance gained by the *Plasmodium* parasite. Prevention practices varied to some extent across the sections based on the status and education level of participants in the study (Table 1). This is similar to previous studies that found better malaria-related knowledge in India to be associated with high education levels [11, 20].

Though many respondents reported bed nets as a major malaria prevention strategy, only 6 participants reported using them. This observation is consistent with the results published in the earlier studies by Mishra et al., 2007 [21], where it was reported that most village health workers did not use bed nets, even when they knew bed nets were effective in preventing malaria. Bed nets might be unaffordable [16] to economically lower-class people. On the other hand, educated people influenced by different methods also don't use bed nets though they could meet the expenses. These people may feel inconvenient in sleeping under nets or lazy to set up nets every night and hence chose repellents/coils as preventive measures. Most of the villagers reported fewer mosquitos in their area and zero malaria cases for the past two decades and therefore, they have been using the fan only to avoid mosquito bites.

The survey showed that people are more aware of the home remedies using natural plants and products in comparison to specific chemotherapeutic antimalarial drugs in use. More than half of the population knew the benefits of neem (leaves or oil), while few of them also suggested the use of Tulsi leaves for curing malaria and the fever caused by it. Other than the ways to combat the *Plasmodium* parasite, people also suggested various ways to kill and get rid of the mosquitoes like cloves inserted in lemon, burning neem leaves etc. The burning of neem leaves is being followed by many as it is quite useful and without any financial implication. Several other religious practices were also mentioned as a way to prevent the spread of mosquitoes. On mining the reports available on these products, a lot of research was seen on neem leaves that suggested their activity against blood-stage parasites, gametocytes as well in sexual stages in mosquitoes. [22, 23] Thus, exploring natural products in malaria treatment could be useful for new drug discovery to combat drug resistance. Past achievements emphasize the significance of natural products to overcome the drug resistance gained by the *Plasmodium* parasite to all available chemotherapeutics.

This study shows that although people are aware of malaria and its symptoms, they still lack in knowledge related to the exact cause and the treatments available. As drug resistance makes the prevention practices critical and without community participation, malaria elimination would be difficult. Thus, there is an urgent need to spread awareness among people about different treatment strategies available and the recent developments in terms of the parasite resistance to most of the available drugs.

4. Conclusion

It is evident that the participants had varying levels of knowledge about malaria. Though the majority of individuals knew about the cause, symptoms and prevention practices of malaria, the delusions should be corrected. A significant percentage of people seem ignorant of the disease and education about malaria is needed. Conducting health workshops, distributing print notices in the local language,

posters on preventive measures in hospitals/health centres and a campaign through TV channels help to educate nearly everyone. Opportunities for disseminating information about diverse aspects of malaria should be utilized during treatment by Doctors. Malaria prevention strategies such as environmental management, early closing of windows at home need to be strengthened to complement existing malaria prevention approaches in rural areas.

However, we cannot deny the fact that Recall bias is the limitation of this study. Relying on this self-report might be prejudice as there is a possibility that the respondents did not accurately report their prevention practices. In the end, this study is limited to only a few specific towns and villages of Jhunjhunu. The conclusions drawn about malaria-related knowledge might not apply to residents of other geographic areas of the district. However, this study still provides threshold information for future studies of malaria knowledge in the study area. It also suggests that malaria elimination is a ruthless but achievable goal requiring the highest level of dedication and a sense of urgency as the target year for elimination is not too distant.

Abbreviations

WHO: World Health Organization

NVBDCP: National Vector Borne Disease Control Programme

NSP: National Strategic Plan

Conflict of interest

The authors declare no conflicts of interest.

Ethical Statement, Involvement of Human/ Animal in the study

The study received oral ethical approval from each participant. Respondents participated after the purpose of the research had been clearly explained to them. Aforementioned verbal consent was obtained from the Heads of institutions.

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6. References

1. World malaria report, 2019. https://www.who.int/publications/i/item/world-malaria-report-2019.
2. Dhiman S, Veer V, Dev V. Declining Transmission of Malaria in India: Accelerating Towards Elimination. Towards Malaria Elimination: A Leap Forward. IntechOpen, 2018, 257.
3. Mumbai is state's malaria capital | Mumbai News - Times of India. https://timesofindia. indiatimes.com/city/mumbai/Mumbai-is-states-malaria-capital/articleshow/8031918.cms. 2011.
4. Kochar DK, Sirohi P, Kochar SK, Budania MP, Lakhotia JP. Dynamics of malaria in Bikaner, Rajasthan, India. Journal of Vector Borne Diseases. 2007; 44(4):281-285.
5. Dash AP, Valecha N, Anvikar AR, Kumar A. Malaria in India: Challenges and opportunities. Journal of Biosciences. 2008; 33(4):583-592.
6. National Vector Borne Disease Control Program. http://nvbdcp.gov.in.
7. Sharma R, Dutta AK. Malaria and national vector borne disease control programme. Indian Journal of Paediatrics. 2011; 78(12):1527-1535.
8. National Framework for Malaria Elimination (NFME) in India, 2016-2030. http://www.indiaenvironmentportal.org.in/content/441919/national-framework-for-malaria-elimination-nfme-in-india. 3 February 2016
9. National Strategic Plan for Malaria Elimination, 2017-22. http://www.indiaenvironmentportal. org.in/content/445149/national-strategic-plan-for-malaria- elimination-2017-22. 12 June 2017
10. Narain JP, Nath LM. Eliminating malaria in India by 2027: The countdown begins! Indian Journal of Medical Research. 2018; 148(2):123-126.
11. Sharma AK, Bhasin S, Chaturvedi S. Predictors of knowledge about malaria in India. Journal of Vector Borne Diseases. 2007; 44:189-197.
12. Dhawan G, Joseph N, Pekow PS, Rogers CA, Poudel KC, Bulzacchelli MT. Malaria-related knowledge and prevention practices in four neighbourhoods in and around Mumbai, India: A cross-sectional study. Malaria Journal. 2014; 13(1):1-11.
13. Sivasangeetha K, Sushi KM, Thatchinamoorthy G, Jacob SM. Health awareness on malaria and its recent developments in college students, Chennai, South India. International Journal of Current Research and Review. 2015; 7(17):15.
14. Ahorlu CK, Dunyo SK, Afari EA, Koram KA, Nkrumah FK. Malaria-related beliefs and behaviour in southern Ghana: Implications for treatment, prevention and control. Tropical Medicine & International Health. 1997; 2(5):488-499.
15. Singh N, Singh MP, Saxena A, Sharma VP, Kalra NL. Knowledge, attitude, beliefs and practices (KABP) study related to malaria and intervention strategies in ethnic tribals of Mandla (Madhya Pradesh). Current Science. 1998; 75:1386-1390.
16. Sabin LL, Rizal A, Brooks MI, Singh MP, Tuchman J, Wylie BJ et al. Attitudes, knowledge, and practices regarding malaria prevention and treatment among pregnant women in eastern India. American Journal of Tropical Medicine and Hygiene. 2010; 82(6):1010-1016.
17. The official portal of Jhunjhunu District, Rajasthan. https://jhunjhunu.rajasthan. gov.in /content/ raj/jhunjhunu/en/home.html. 23 July 2019.
18. Shyoran D, Kumar V. Assessment of Avifaunal Diversity of Jhunjhunu District, Rajasthan, Including Migratory Species, in Reference to Their Conservation Perspective. A Project Report submitted to Department of Science and Technology, Government of Rajasthan, 2013.
19. District Census Handbook Jhunjhunun. https://www.censusindia.gov.in/ 2011census/ dchb/ 0805_PART_B_DCHB_0805_JHUNJHUNUN.pdf. 2011.
20. Sharma AK, Aggarwal OP, Chaturvedi S, Bhasin SK. Is education a determinant of knowledge about malaria among Indian tribal population? The Journal of Communicable Diseases. 2003; 35(2):109-117.

21. Mishra SK, Satpathy R, Panigrahi P. Malaria awareness of village health workers from Sundargarh in Orissa - the state contributing half of the malaria-related deaths in India. Tropical Doctor. 2007; 37(2):126-127.
22. Udeinya JI, Shu EN, Quakyi I, Ajayi FO. An Antimalarial Neem Leaf Extract has Both Schizonticidal and Gametocytocidal Activities. American Journal of Therapeutics. 2008; 15(2):108-110.
23. Siddiqui BS, Ali ST, Rajput MT, Gulzar T, Rasheed M, Mehmood R. GC-based analysis of insecticidal constituents of the flowers of *Azadirachta indica* A. Juss. Natural Product Research. 2009; 23(3):271-283.
24. Valecha N, Staedke S, Filler S, Mpimbaza A, Greenwood B, Chandramohan D. Malaria-attributed death rates in India. Lancet. 2011; 377(9770):992-993.