Malaria Knowledge and Infection Among Migrant Population in the China-vietnam Border: A Questionnaire-based Survey

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Research

Keywords: the China-Vietnam, malaria, migrant population, Plasmodium falciparum, Plasmodium vivax

Posted Date: July 9th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-606850/v1

Abstract

Background

Border malaria remain as one of the greatest challenges facing elimination in China. Malaria control interventions among migrant population across border relies on personal protection from mosquito bites. Understanding the knowledge of the link between mosquitoes and malaria will inform malaria control and elimination programmes on those targeted risk population.

Methods

From March 2018 to September 2019, 108 migrant workers from Vietnam were enrolled conducted in Ning Ming County in Guangxi. Each people were interviewed using the structured questionnaires. Blood samples were collected and sent to the PCR detection and sequenced.

Results

Malaria knowledge was poor with 19.4% on transmission, 23.2% on clinical symptoms, 7.4% on awareness of the risk of death, and 14.8% on awareness of prevention methods. No significant difference was found among occupations except for migrant workers, whose knowledge rate were higher than other occupations. Most of the participants (80.6%) had mosquito nets and 73.2% of them had 2 persons who were under the bed net at night. The usage rate of bed-nets accounted for over 49.1%. For parasitological study, 5.6% (n = 6) of all participants infected tested positive for malaria, and no statistically significant differences in the positive rate among different age, sex, family size, nationality, occupation and different behaviors.

Conclusion

The health education focus on the high risk population such as migrant workers and forest goers should be strengthened. Therefore, health education based on verbal communication such as web, radio, and mobile phone may be required under the COVID-19 pandemic situation. Further risk assessment of importation and proactive case detection should also be carried out, not only in Ningming County, but also in other border counties in Guangxi, which aimed to timely detect the patients, as well as the asymptomatic infections that could cause the re-establishment of malaria.

Introduction

Malaria prevalence in border areas is often higher than in other areas due to lower access to health services, treatment-seeking behaviour of marginalized populations, difficulties in deploying prevention programmes to hard-to-reach communities, often in difficult terrain, and constant movement of people across porous national boundaries [1]. Though China has eliminated malaria and no indigenous case was reported since 2017, border areas still pose a great challenge to the achievement of malaria elimination [2-4]. Malaria elimination was challenged by diversity and complexity of the determinants in the border areas [5]. The border areas in Guangxi province, covered 8 counties, neighbouring with Vietnam, was once high endemic area [6]. The malaria incidence in those 8 counties was ranged from 125.58 to 605.77 per 10,000 [7]. After

continuous effort by the government and technical staff, the incidence has sharply declined to 0.22 per 100,000 in 2010 and no local *Plasmodium falciparum* was reported since 1996. Ningming County was one of the 8 border counties, once belong to a malaria hyperendemic area, with 31,200 malaria cases and 1.9 per 10,000 incidence reported in 1953 [8]. *Plasmodium vivax* was the predominant species since *P. falciparum* was no longer reported after 1988. However, the imported malaria cases in Ningming County, similar as the nationwide, has increased due to the frequently economic exchange. The blood examination conducted from 2000 to 2010 has reported 7 positive slides among totally 3,439 migrant population with the positive rate was 0.20%. Hence, the imported malaria caused by frequent migration was the greatest challenge for the border areas since *Anopheles* mosquito still exist in this county. Since less published documents have investigated and evaluated the malaria risk in this border county, herein we carry out malaria knowledge survey and parasitological study among the migrant population.

Methods

Study sites and samples.

The study was carried out between March 2018 and September 2019 at Ningming County in Guangxi Province, along the China-Vietnam border. Ningming County with a total population of 440,000 and a border line of 212 km, located in the southwest of Guangxi Province neighbouring with Vietnam, has eliminated malaria before 2000.

Questionnaire

The 108 respondents were selected from the immigrant returned from Vietnam. Questionnaires of all cases were carried out, including gender, ethnicity, occupation, travel history, knowledge of malaria, practise to prevent malaria, etc. All participants supplied written informed consent. The questionnaires and informed consent were designed by National Institute of Parasitic Diseases, Chinese Center for Diseases Control and Prevention.

Parasite identification and genotyping

A total of 108 blood samples March 2018 and September 2019 were collected and examined at enrollment. Approximately 100 μl of blood was obtained from a finger prick and spotted on a piece of 3MM Whatman filter paper (GE Healthcare, Boston, MA, USA) and allowed to air-dry. Each of the samples was labeled with a study number and stored at −20°C until extraction. The genomic DNA from approximately 20 μl of each dried blood sample was then extracted with a QIAamp DNA blood kit (QIAGEN, Valencia, CA) according to the manufacturer's instructions. Malaria parasite species were confirmed by nested PCR analysis of the 18S rRNA genes. The primers used for the nested PCR were as follows:

Nest 1 rPLU6 TTAAAATTGTTGCAGTTAAAACG

Nest 1 rPLU5 CCTGTTGTTGCCTTAAACTTC

Nest 2 F1 TTAAACTGGTTTGGGAAAACCAAATATATT

Nest 2 F2 ACACAATGAACTCAATCATGACTACCCGTC

Nest 2 V1 CGCTTCTAGCTTAATCCACATAACTGATAC

Nest 2 V2 ACTTCCAAGCCGAAGCAAAGAAAGTCCTTA

Nest 2 M1 ATAACATAGTTGTACGTTAAGAATAACCGC

Nest 2 M2 AAAATTCCCATGCATAAAAAATTATACAAA

Nest 2 O1 GTATCTGATCGTCTTCACTCCC

Nest 2 O2 CTGTTCTTTGCATTCCTTATGC

The PCR products were separated by electrophoresis on a 1.5% agarose gel and subjected to Sanger sequencing (Shanghai BioTechnologies Co., Ltd., Shanghai, China).

Data analysis

Sequences were analyzed with the Blast program (http://blast.ncbi.nlm.nih.gov/). Statistical analysis was carried out with R software (version 3.2.1). The chi-square test was used to compare the categorical variables among the groups. A P-value of 0.05 was considered statistically significant.

Ethical consideration

This study was reviewed and approved by the ethical committee of the National Institute of Parasitic Diseases, Chinese Centre for Disease Control and Prevention (NIPD, China CDC, No. 2019008).

Results

Demographic study

A total of 108 migrant population returning to Guangxi Province from Vietnam between March 2018 and September 2019 were enrolled in this study. All participants were Vietnamese with 52.8% male (n = 57) and 47.2% female (n = 51). The average age of participants was 32 years ranging from 16 to 54 years. Most were aged at the years of 20-30 (36.1%) and 30-40 (40.7%). The occupations of all participants were mainly migrant workers (50.9%) and farmers (37.0%). The overwhelming majority of participants experienced 1-time journey from Vietnam to China (78.7%), ranging from 0 to 6. There were 26 people (24.1%) who stayed in China for less than a week, 50 people (46.3%) in 1 month, 14 people (13.0%) in one month to 6 months, and 5 people (4.6%) in more than 6 months. Most of them went to Guangxi (80.6%), a small number of them worked in Guangdong (5.6%).

Malaria knowledge and control prevention behaviors

A survey of malaria knowledge among all participants found that knowledge of malaria transmission was only 19.4%, and knowledge of malaria symptoms was 23.2%. Awareness of the risk of death from malaria

was 7.4%, and awareness of prevention methods was 14.8%. No significant difference was found among occupations except for migrant workers, whose knowledge rate were higher than other occupations including farmers and plant workers. In terms of prevention and control conditions, 80.6% of the participants had mosquito nets in their homes and 58.3% had screen doors and windows installed. At night, 73.2% of them had 2 persons who were under the bed net at night, whereas 7.4% was 1 person. The usage rate of bed nets accounted for over 49.1%. In addition, a small proportion (7.4%) of participants had the habit of sleeping rough in summer.

Malaria parasitological study

Of the 108 participants, 5.6% (n = 6) of those infected tested positive for malaria. The positive rate was 7.0% for males (P > 0.05) and 3.9% for females. There were no statistically significant differences in the positive rate among different age, sex, family size, nationality and occupation (Table 1). Further, no statistically significant differences occurred in the number of outbound visits, overseas stay time, entry and exit locations, and the positive detection rate of malaria knowledge (P > 0.05). The positive rate of home without using mosquito net was 4.8% (1/21), the positive rate of home without mosquito net installation was 6.8% (3/44), the positive rate of home without using mosquito coil incense was 3.6% (2/55), the positive rate of having the habit of sleeping rough was 0.0% (0/8), but the differences in positive rate between different behaviors were not statistically significant (P > 0.05) (Table2).

Discussion

Movement of infectious diseases such as malaria and COVID-19 across borders poses a major obstacle to achieving and maintaining elimination [1, 9, 10]. The findings in our study have revealed that 6 asymptomatic infections detected, accounting for 5.6% of all migrant population from Vietnam. Unlikely the China-Myanmar border, which may pose great challenge for malaria elimination to Yunnan Province due to the high prevalence of *P. vivax* and *P. falciparum* in northern Myanmar [11, 12], malaria in the China-Vietnam border seems a “forgotten disease” because of the low incidence in northern Vietnam. Hai Phong, located in the northern Vietnam, the average positive predictive values was 0.10% in 2010-2014 [13]. This was not only in Guangxi-Vietnam border, but also similar in Yunnan-Vietnam border. For example, Hekou County in Yunnan Province, the annual malaria parasite rate was lowered to 0.18 per 1,000 in 2008 and was the first county to achieve malaria elimination in Yunnan-Vietnam border in 2015 [14].

In spite of achieving the goal of malaria elimination in the border counties in Guangxi [7], some challenge could be faced by the frequent mobile population. First, how to detect the asymptomatic infections timely was crucial for the malaria control intervention for both sides in the border. For Vietnam, the high risk of migrant population was proposed as forest goers, who may live in forest borer regions and have poor knowledge of malaria and limited access to preventive and therapeutic services [15, 16]. As malaria transmission decline in Vietnam, the high prevalence of asymptomatic and sub-microscopic infections was the main challenge [17-20]. Asymptomatically infected individuals usually do not seek treatment and generally harbour low parasite density undetectable with microscopy examination. Therefore, parasites could persist in these individuals from one season to the next maintaining local transmission [21]. However,

the asymptomatic infections were reported in the Central and South Vietnam, while in our study, it is noted that the Northern Vietnam, also has become a risk concern for the asymptomatic infections. Second, the susceptibility of both *P. falciparum* to Artemisinin-based Combination Therapy (ACT) and *P. vivax* to chloroquine was declined in Vietnam [22, 23]. The risk of anti-malarial drug-resistance spread to the border, is likely due to importation of multi-drug resistant malaria caused by migrant population [24]. However, the emergence of Kelch 13 mutations associated with increased ring survival rates and parasite clearance delay were found in the China-Myanmar border [25-28], though there is no evidence showing the emergence of resistance *P. falciparum* strain against ACT along the China-Vietnam border, more attention should be paid to the pathogen population to monitor and evaluate the potential emergence of ACT resistance. Third, the malaria knowledge rate was low in our study among the migrant population. It is noted that the border residents, especially for the young adults and women have poor malaria knowledge [29, 30]. In our study, only 19.4% of the surveyed population understanding malaria transmission through mosquito biting and 23.2% of them understanding malaria symptoms.

The study has some limitations. First, not all the questionnaires in the survey were obtained from the participants, possibly due to the language only used in English version. Second, the study was conducted in Ningming County, one of the 8 border counties in Guangxi, the results obtained from this study may not represent the whole status in the China-Vietnam border.

Conclusions

In summary, the study indicated the low malaria knowledge among the migrant population around the China-Vietnam border, also the asymptomatic infections were detected, which suggesting the risk of re-establishment of malaria facing post-elimination stage in the border. The findings of this study have shown that the health education focus on those high risk population such as migrant workers and forest goers should be strengthened. In an area like Guangxi where literacy and language could be a barrier, health education based on verbal communication such as web, radio, and mobile phone may be required under the COVID-19 pandemic situation. Further proactive case detection should also be carried out, not only in Ningming County, but also in other border counties in Guangxi, which aimed to timely detect the patients, as well as the asymptomatic infections that could cause the re-establishment of malaria.

Declarations

Funding

The work was supported by the key techniques in collaborative prevention and control of major infectious diseases in the Belt and Road (Grant No. 2018ZX10101002-004).

Ethics approval and consent to participate

This study was reviewed and approved by the ethical committee of the National Institute of Parasitic Diseases, Chinese Centre for Disease Control and Prevention (NIPD, China CDC, No. 2019008).

Consent for publication

Not applicable.

Availability of data and materials

The data was collected through paper-based questionnaire and recorded in the private computer with strictly protected ID and password, only can be accessed by the team member of co-authors.

Competing interests

The authors declare that they have no competing interests.

Author's Contributions

HT conceived the study and drafted the manuscript. LZ, and CHY analyzed the data and provided suggestions for improving the quality of the data. KML, PYW, SMX, LYL, and JL have conceived the field work. JF initiated the study and made major contributions to drafting the manuscript. HY carried out molecular biological experiments. All authors contributed to the writing of the manuscript and approved the submitted version of the manuscript. All authors read and approved the final manuscript.

Acknowledgements

We want to thank all the CDC staff at Ningming County CDC for their participations in sample collection and questionnaire.

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Tables

Table 1 Demographic and positive infection for the participants.

General	Participants		Positive infection		X^2	*P*
	N	%	N	%		
Gender						
Male	57	52.78	4	7.02	0.492	0.483
Female	51	47.22	2	3.92		
Age						
-20	8	7.41	0	0.00	1.486	0.476
20-30	39	36.11	2	5.13		
30-40	44	40.74	2	4.55		
50-	17	15.74	2	11.76		
Family population						
0-4	68	62.96	4	5.88	1.001	0.606
4-	39	36.11	2	5.13		
Nationality						
Jing	33	30.56	4	12.12	0.486	0.496
Han	35	32.41	1	2.86		
Other	30	27.78	1	3.33		
Occupation						
farmer	40	37.04	2	5.00	0.153	0.926
Worker	55	50.92	4	7.55		
Other	13	12.04	0	0.00		

Table 2 Awareness difference of factors contributing to the malaria transmission, hazards, control and prevention and symptom for the participants.

Table 3 Difference of positive infections among malaria behavior, attitudes, and practice for the

General	Participants	Awareness rate of malaria transmission		Awareness rate of malaria hazards		Awareness rate of malaria control and prevention		Awareness rate of malaria symptom	
	N	N	%	N	%	N	%	N	%
Gender									
Male	57	13	22.81	5	8.77	11	19.3	15	26.32
Female	51	8	15.69	3	5.88	5	9.8	10	19.61
Age									
-20	8	0	0	0	0	0	0	0	0
20-30	39	11	28.21	2	5.13	8	20.51	13	33.33
30-40	44	7	15.91	3	6.82	6	13.64	8	18.18
40-	17	3	17.65	3	17.65	2	11.76	4	23.53
Family population					0.00		0.00		0.00
0-4	68	12	17.65	4	5.88	8	11.76	14	20.59
4-	39	9	22.50	4	10.00	8	20.00	11	27.50
nationality					0.00		0.00		0.00
Jing	33	8	18.18	4	9.09	5	11.36	11	25.00
Han	35	6	16.67	3	8.33	4	11.11	6	16.67
Other	30	7	25.00	1	3.57	7	25.00	8	28.57
Occupation					0.00		0.00		0.00
Farmer	40	3	7.50	2	5.00	1	2.50	2	5.00
Worker	55	17	30.91	5	9.09	15	27.27	22	40.00
Other	13	1	7.69	1	7.69	0	0.00	1	7.69

participants.

Behavior, attitudes, and practice	Participants		Positive infection		X^2	*P*
	N	%	N	%		
Number of customs visits per year in recent 3 years						
1	85	78.70	6	7.06	1.719	0.423
≥2	23	21.30	0	0.00		
How long did you stay in China						
One week	26	24.07	1	3.85		
One month	50	46.30	4	8.00	0.377	0.828
A month to half one year	14	12.96	1	7.14		
Half one year to one year	5	4.63	0	0.00		
Destination of entry and Exit						
Guangxi	87	80.56	4	4.60	1.599	0.450
Guangzhou	6	5.56	1	16.67		
Vietnam	15	13.89	1	6.67		
Knowledge of malaria						
How is malaria transmitted						
Right	21	19.44	2	9.52	0.782	0.376
Wrong or not knowing	87	80.56	4	4.60		
What are the main symptoms or symptoms of malaria?						
Right	25	23.15	2	8.00	0.370	0.540
Wrong or not knowing	83	76.85	4	4.82		
is malaria a direct threat to life if untreated?						
Right	8	7.41	1	12.50	0.794	0.373
Wrong or not knowing	100	92.59	5	5.00		
How to prevent malaria?						
Right	16	14.81	2	12.50	1.726	0.189
Wrong or not knowing	92	85.19	4	4.35		

Behavior to prevent malaria						
Do you have mosquito nets at home?						
No	21	19.44	1	4.76	0.031	0.860
Yes	87	80.56	5	5.75		
Have you installed screens for doors and windows?						
No	44	40.74	3	6.82	0.207	0.649
Yes	63	58.33	3	4.76		
how many people sleep under mosquito nets?						
0	21	19.44	2	9.52	0.136	0.712
1	8	7.41	0	6.90		
2	79	73.15	4	5.06		
Have you used mosquito coil incense?						
No	55	50.93	2	3.64	0.787	0.375
Yes	53	49.07	4	7.55		
Do you have the habit of sleeping rough in summer?						
No	98	90.74	6	6.12	0.519	0.471
Yes	8	7.41	0	0.00		

Figures

Figure 1

Study sample site of Ningming County (blue), Guangxi. The imported source including ports and cities of migrant population was labelled with triangle in the map using ArcGIS 10.1.