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Original Article

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Care-seeking delay of imported malaria to China: implications for improving post-travel healthcare for migrant workers

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Abstract

Background: Imported malaria cases continue to pose major challenges in China as well as in other countries having achieved elimination. Our study aims to identify the factors influencing the timing of care-seeking after symptom onset among migrant workers with imported malaria, in order to develop innovative interventions to improve access and provision of post-travel healthcare for returning migrants.

Methods: We analysed the timing and types of healthcare service utilization after symptom onset among patients with imported malaria between 2012 and 2019 in Jiangsu Province, China. Moreover, decision tree models were used to explore the factors influencing the care-seeking timing after symptom onset among patients with imported malaria.

Results: A total of 2255 cases of imported malaria were identified from 1 June 2012 through 31 December 2019. Patients with malaria imported into China were mainly male migrant labourers returning from sub-Saharan Africa (96.8%). A substantial number of patients with imported malaria sought healthcare >3 days after symptom onset, which clearly represented delayed healthcare-seeking behaviour. According to the decision tree analysis, initial healthcare seeking from healthcare facilities at higher administrative levels, infection with *Plasmodium vivax* and absence of malaria infection history were significantly associated with delayed healthcare seeking in patients with imported malaria.

Conclusion: The delay in seeking of medical care among migrant workers with imported malaria should be considered and addressed by specific interventions. In addition to increasing awareness about these issues among health care professionals, improved access to healthcare facilities at higher administrative levels as well as improved diagnostic capacity of healthcare facilities at lower administrative levels should be developed. Moreover, education programs targeting populations at risk of malaria importation and delayed healthcare seeking should be improved to facilitate early healthcare seeking and service use.

Key words: China, imported malaria, malaria elimination, prevention of re-introduction, care seeking, migrant workers

Introduction

Tackling malaria remains a high priority internationally, with elimination and eradication back on the global agenda.[1] Although >50 countries have succeeded in eliminating the disease in the past century, these gains are fragile, particularly in countries where social and economic conditions have been disrupted by the coronavirus disease of 2019 pandemic.[2–6] Imported malaria cases continue to pose challenges for diagnosis and management in malaria eliminated areas, as malaria remains an infrequently encountered disease, which can delay diagnosis and result in high mortality.[7,8] Efforts related to imported malaria have been made in malaria-free countries to train general health services providers to maintain their vigilance and to encourage ongoing engagement with community volunteers.[9] However, factors influencing care-seeking timing after symptom onset among the migrant workers with imported malaria have been rarely investigated.

China has made great progress in malaria control over the last century by reducing the annual cases from >30 million in the 1950s to 7855 cases in 2010.[10,11] In 2010, China launched the National Malaria Elimination Programme (NMEP), aiming to achieve the goal of eliminating malaria by 2020.[12] China has been certified as malaria-free by the WHO on 30 June 2021.[13] Similar to other countries, imported malaria cases have become a main challenge to sustaining malaria elimination in China.[14–17] Interestingly and in contrast to the situation in western countries, where citizens with migration backgrounds often import malaria after having visited friends or relatives in their country of origin,[18,19] malaria outbreaks in China were mainly caused by returning migrant workers from endemic countries.[20] Considering that the continuous threat of malarial resurgence it is important to be highly vigilant regarding importing malarial cases and to develop innovative strategies to strengthen and maintain a robust public health infrastructure for disease surveillance.[21]

The challenges with managing imported malaria cases in malaria-free countries often start with the delay of diagnosis, which is a leading cause of death in malaria patients and a risk of secondary local transmission.[22] The delay in diagnosis and treatment among patients with imported malaria is partly due to patient delays (e.g. not seeking health care promptly) and partly due to doctor delays (e.g. not asking for a travel history). In the existing literature, few studies have differentiated between these two types of delays.[23–27] Moreover, interventions to improve care delay of migrant workers with imported malaria are rare and often neglected.[7,26,27]

The current study sought to (i) provide 8-year malaria surveillance data from Jiangsu Province, which has a population of 85 million and achieved malaria elimination while reporting the highest number of migrant workers with imported malaria in China in recent decades; (ii) identify the timing and types of healthcare service utilization after symptom onset among migrant workers with imported malaria in Jiangsu Province and (iii) identify the variables most strongly predictive of patient delay in seeking medical care after symptom onset by decision models among the migrant workers.

Methods

Study setting

Jiangsu Province is situated in eastern China, with a population of 85 million people in 2020.[28] Since 2012, no locally transmitted cases of malaria have been reported in this province. However, the reported number of cases of imported malaria in Jiangsu Province ranked among the highest in China, with an annual number ranging from 198 to 405 from 2012 to 2019.

Study design and data source

We conducted a retrospective analysis of patients with confirmed cases of imported malaria in the period from 1 June 2012 to 31 December 2019 using routine surveillance data from the China Centers for Disease Control and Prevention (CDC). The surveillance data and epidemiological data were collected from the China Information System for Disease Control and Prevention (CISDCP), which is the national internet-based disease reporting system. Information on every malaria case was carefully reviewed and verified by checking the original paper records, including the patient's age, gender, countries visited, purpose of the visits, infection history, date of return to China, date of symptom onset after return to China, date of first attendance of a medical facility, level of medical institution and species of pathogen.

Definition of imported malaria

In China, the following criteria for imported malaria must be simultaneously met: (i) the patient was laboratory-diagnosed with malaria; (ii) the patient had a travel history to malaria-endemic areas outside of China during the malaria transmission season and (iii) the onset of malaria occurred < 1 month after returning to China during the local transmission season.[29] If all of the above criteria were not met, the case was classified as local. All malaria cases were diagnosed and treated according to the national policy. When the infection origin was unclear, e.g. in the patients developing clinical symptoms after 1 month in case of non-falciparum malaria infections, the case classification was determined by during regular routine meetings of provincial or national experts.

Timing of seeking healthcare

The World Health Organization has emphasized that early diagnosis and prompt treatment for malaria should occur within 24 h of the onset of symptoms to decrease the risk of severe complications and onward transmission.[30] However, in this study, considering logistical realities in China, delay in seeking treatment was defined as a period of >3 days having passed between the onset of symptoms and treatment having been sought at a malaria clinic or public hospital.

Statistical analysis and decision tree model

Data were double checked and then imported into SPSS software (Version 23, IBM Corp, Armonk, NY, USA) for data analysis.

Categorical variables were described with numbers and percentages, and continuous variables were described with percentiles, and means.

Decision trees assist in forming a decision by examining each possible course of action and their potential outcomes.[31] Numerical values are attributed at each stage to add or subtract weight to each consideration and thus to substantiate potential outcomes. Whichever potential outcome bears the highest positive numerical value highlights to the decision maker the most potentially beneficial course of action to take.[32] This study adopted chi-squared automatic interaction detection (CHAID) and classification and regression tree (CRT), as they have the highest accuracy and epidemiological plausibility of the structure.[33] The construction of the decision tree model was carried out in two phases. In the first phase, potential variables related to the dependent variable were selected in terms of the temporal sequence, logic and professional reasons. The variables included gender, age, type of malaria parasite, region of travel, infection history and initial health-seeking institutions. In the second phase, both outstanding variables in the tree and significant variables in the table of importance to the model of independent variables were chosen to attempt to construct the most concise and accurate tree. Third, through different methods and parameter adjustments, various variable combinations were tried. The parameters of the final CHAID tree model were set as follows: maximum tree depth of 5, minimum number of cases in the parent node of 10 and in the child node of 5 and significance level of CHAID of 0.05.

Table 1. Basic characteristics of patients with imported malaria in Jiangsu Province, 2012–2019

Characteristics (n = 2255)	Number (%)
Gender	
Male	2194 (97.3)
Female	61 (2.7)
Age (years)	
Median (IQR)	44 (36–49)
***Plasmodium* species of infection**	
P. falciparum	1769 (78.4)
P. ovale	280 (12.4)
P. vivax	113 (5.0)
P. malariae	80 (3.5)
Mixed infection	13 (0.6)
Region of travel	
Sub-Saharan Africa (SSA)	1768 (78.4)
Non-SSA countries in Africa	415 (18.4)
Others	72 (3.2)
History of malaria infection during staying abroad	
Yes	1511 (67.0)
No	738 (32.7)
Missing data	6 (0.2)
The interval between return to China and onset of illness, median (IQR), days	
P. falciparum	8 (3–16)
P. ovale	9 (3–25)
P. vivax	10 (5–20)
P. malariae	11 (14–30)
Mixed infection	10 (8–20)

Ethical aspects

Data were anonymized prior to the statistical analysis. This study was registered as a nationally funded research project with the aim of improving the case management of patients with imported malaria (registration no. 71904165).

Results

Demographic characteristics

A total of 2255 cases of imported malaria from 1 June 2012 through 31 December 2019 were included for analysis. Imported malaria cases were reported throughout the year in Jiangsu Province. The Spring Festival holiday (December–January) and the summer holiday (June–July) are peak seasons. The basic characteristics of the patients infected with different species are presented in Table 1. A total of 96.8% (2171/2255) of the patients were migrant workers, and nearly all were middle-aged males. *Plasmodium falciparum* was the dominant species accounting for 76.1% of the cases in 2017 and 84.4% of the cases in 2019. Sub-Saharan Africa (SSA) was the most frequent region of origin (78.4%, 1768/2255). About 67.0% (1511/2255) of patients were infected at least once during staying abroad. For *P. .vivax* infections, 91% of the patients were identified having a travelling history in African countries, of which Equatorial Guinea was the most frequent travel destination (27/113, 23.9%). The interval between returning to China and the onset of illness was longer for *P. vivax* and *P. malariae* infections than for *P. falciparum* and *P. ovale* infections. During the study period, four imported malaria deaths were reported, all attributed to *P. falciparum* malaria.

Healthcare-seeking timing and patient delay

The characteristics of healthcare-seeking behaviour, defined as the time interval between the onset of symptoms and seeking healthcare after return to China, are summarized in Table 2. The median time between symptom onset and healthcare consultation was 1 day (IQR, 0–3 days). Out of the 2255 patients with imported malaria, most (1619/2255, 71.8%) sought healthcare on the second day after symptom onset or later. Moreover, one-third (577/1619, 35.7%) accessed healthcare >3 days after the onset of the symptoms, clearly representing delayed healthcare seeking.

Half of the patients with imported malaria (1130/2255, 50.0%) initially sought care at county CDCs or county hospitals. Nearly one-third (654/2255, 29.0%) were treated at city/municipal healthcare institutions, including municipal CDCs and municipal hospitals. Notably, 15% of patients were first seen at township clinics (198/2255, 8.7%) or village clinics (132/2255, 5.9%). Moreover, 71 (3.1%) patients initially sought care at private clinics (Table 2). The level of the healthcare facility was determined by the corresponding administrative level, with provinces representing the highest and villages the lowest capacity. The capacity for the diagnosis and treatment of healthcare facilities in China is as follows: province, municipality, county, township and village (Figure 1).[34]

Table 2. Characteristics of healthcare-seeking behaviour among patients with imported malaria in Jiangsu Province, June 2012–December 2019

Characteristics of healthcare-seeking behaviour (n = 2255)	Number (%)
Duration from symptom onset to healthcare seeking	
Within 24 h	636 (28.2)
From 24 to 48 h	641 (28.4)
From 48 to 72 h	401 (17.8)
Longer than 3 days	577 (25.6)
Level of health facilities for initial healthcare	
Provincial healthcare institutions	70 (3.1)
City/Municipal healthcare institutions	654 (29.0)
County healthcare institutions	1130 (50.0)
Township healthcare institutions	198 (8.7)
Village clinic	132 (5.9)
Private clinic	71 (3.1)

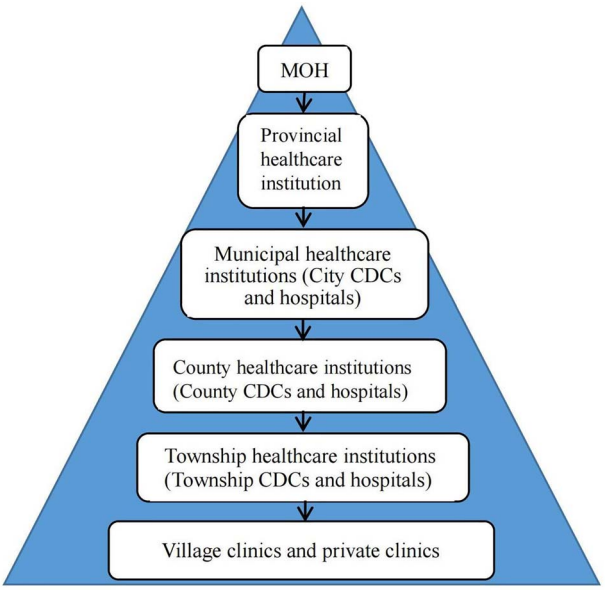

Figure 1. Administrative levels of healthcare facilities in China.

Decision tree models

When seeking healthcare (within 3 days or >3 days) after symptom onset was taken as the dependent variable, four independent variables were found to help build the optimal model by means of CHAID: the level of the healthcare facility for initial healthcare seeking ($P < 0.001$), history of malaria infection while staying abroad ($P < 0.001$), parasite species ($P = 0.027$) and region of travel ($P = 0.043$; Figure 2). The level of the healthcare facility for initial healthcare seeking was represented as the most prominent factor in the model. Apparently, there were significantly more delays in healthcare seeking among malaria patients who initially sought healthcare in health facilities of a higher administrative level than among patients who initially sought healthcare in village healthcare facilities. As shown by nodes 2, 5 and 6, significantly higher percentages of imported malaria patients without infection history delayed healthcare seeking. Moreover, patients infected by *P. falciparum*, *P. malariae*, *P. ovale* or mixed infection were more likely to seek healthcare 3 days after symptom onset than those infected by *P. vivax*.

In terms of the model established by CRT, when seeking healthcare (within 3 days or >3 days) after symptom onset was taken as the dependent variable, the five independent variables were the level of the healthcare facility for initial healthcare seeking ($P = 0.009$), history of malaria infection while staying abroad ($P = 0.005$), parasite species ($P < 0.001$), age ($P < 0.001$) and region of travel ($P = 0.003$; Figure 3). The nodes of this CRT tree model were consistent with some findings described above in the CHAID mode. As shown by nodes 1, 2, 7 and 8, there was significantly more delay in healthcare seeking among malaria patients who initially sought healthcare in healthcare facilities at higher administrative levels. Moreover, as shown by nodes 3 and 4, patients without infection history had a significantly higher probability of seeking healthcare >3 days after symptom onset than those with malaria infection history.

According to the two tree models, the level of the healthcare facility for initial healthcare seeking, parasite species and infection history were the independent variables of most importance to the trees, which meant they were the most significant factors influencing the timing of healthcare seeking among the patients with imported malaria after symptom onset. Overall, data on 2255 patients were included in this model, which had a relatively high classification accuracy of 74.4 and 74.5% in CHAID and CRT, respectively.

Discussion

Maintaining the status of malaria elimination in areas with high receptivity and vulnerability will require effective strategies to prevent the re-establishment, yet there is a dearth of evidence about this phase and the risk groups of migrant workers with imported malaria.[2,35] In addition to establishing a surveillance and response system to rapidly diagnose and treat each potential individual case, patients themselves promptly seeking healthcare after symptom onset is a prerequisite for successful prevention of reintroduction. This is particularly important for China, as chemoprophylaxis is not practiced in its population of oversea labourers. Here, we presented an analysis of the timing and types of healthcare service utilization after symptom onset among migrant workers with imported malaria between 2011 and 2019 in Jiangsu Province, China. Moreover, we explored the factors influencing the timing of care seeking after symptom onset among migrant workers with imported malaria. These findings provide important information for policy makers seeking to develop targeted interventions to improve access and provision of post-travel healthcare for migrant workers.

Patterns of imported malaria in Jiangsu Province were consistent with those of previous provincial and national studies.[36–38] Patients were mainly migrant labourer returning from SSA, with the majority being middle-aged males. A substantial number of patients have sought healthcare beyond days after symptom onset, which is clearly representative of delayed healthcare-seeking behaviour. This finding points to the importance to improve the healthcare-seeking behaviour of travellers returning from malaria-endemic countries, in addition to raising awareness among clinicians regarding imported malaria. Coupled with policy shifts aimed at the prevention of reintroduction in China,

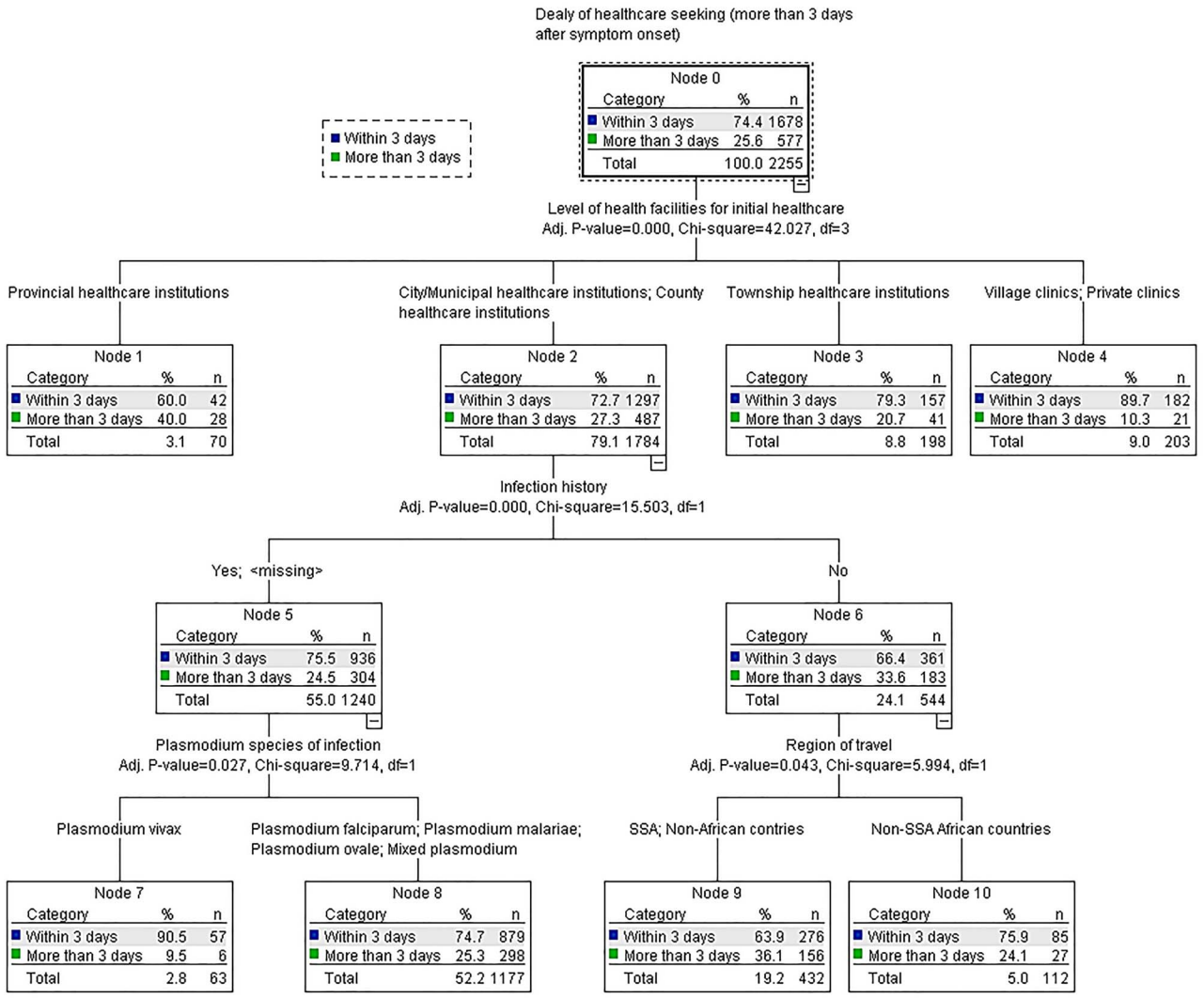

Figure 2. Tree model of care seeking as a dependent variable by the CHAID method.

this should the development of interventions for the neglected group of migrant workers, who are usually a high-risk group for the importation infectious diseases to many countries worldwide.

Level of healthcare facility for initial healthcare seeking

Migrant workers returning home are normally visiting healthcare facilities at their convenience for diagnosis and treatment of illness episodes.[33] Different from previous studies that have demonstrated that provincial and municipal healthcare institutions more frequently serve as the first option for patients with imported malaria,[33,39] this study showed that city and county healthcare institutions received the largest proportion of patients. Preferences to seek healthcare in facilities at higher administrative levels could be explained by the common perception that these healthcare institutions usually have better medical resources and quality. In contrast, village clinics and private clinics are generally of low quality, at least in terms of malaria diagnoses.[33] In addition, village clinics are similar to private clinics in rural China, and most developed from previous 'barefoot doctors', who were farmers who received minimal basic medical and paramedical training and worked in rural villages in China.[33,40]

Interestingly, in our study, both decision tree models suggested that initially seeking healthcare in facilities of a higher administrative level is significantly associated with delayed healthcare seeking for imported malaria cases. In other words, once patients plan to seek healthcare in village clinics or private clinics, they are more likely to access these grassroots health facilities (e.g. village clinis) rapidly and quickly. This may be explained by the flexibility and friendliness of the village clinics and doctors. However, the diagnostic capacity for malaria is limited in these grassroots health facilities and the majority of patients who were initially misdiagnosed were from rural areas.[31,41] Therefore, it seems that provincial and municipal healthcare institutions of higher administrative levels are professional but travellers take a longer time to get access to, while village

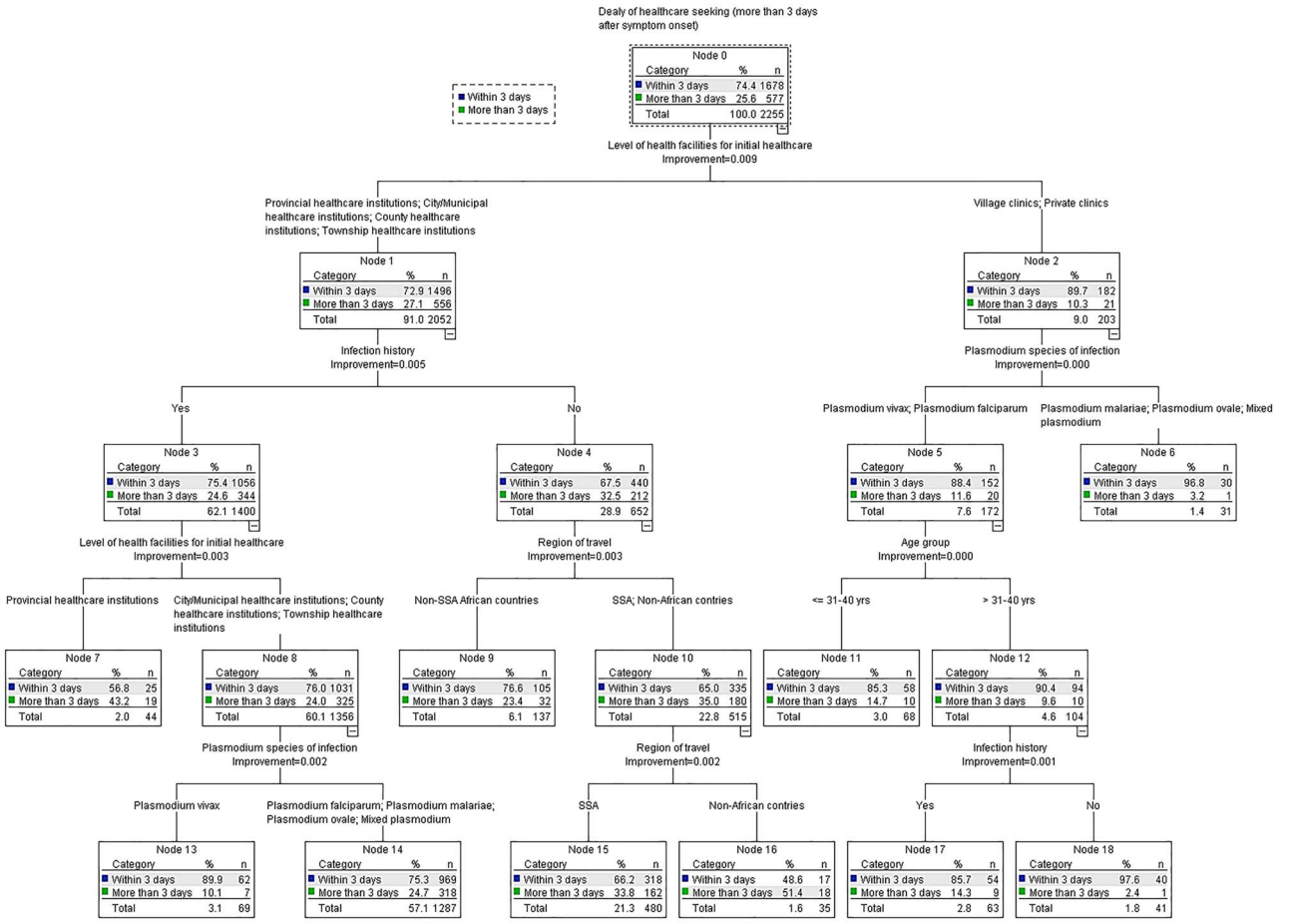

Figure 3. Tree model of care seeking as a dependent variable by the CRT method.

clinics and private clinics are more easier to access but have limited medical resources. This finding points to the need to improve both the accessibility of healthcare facilities at higher administrative levels and the medical capacity of grassroots health facilities.

Parasite species

Our study found that time to initial care seeking of patients infected with *P. vivax* and *P. falciparum* may vary with the levels of healthcare facilities. For example, among patients seeking healthcare initially in village clinics and private clinics, patients infected with *P. vivax* tended to delay healthcare seeking after symptom onset compared with those infected by other species. This supports previous similar finding from a study among malaria patients along Thailand–Myanmar border.[42] *Plasmodium vivax* has the widest geographic distribution of human malaria parasites.[43] Although *P. vivax* has long been considered to have a rather benign course compared with *P. falciparum*, it has recently been shown to also can cause severe and sometimes, fatal infections, resulting in significant global morbidity and mortality.[44–47] In particular because of the dormant liver phase of *P. vivax*, the available methods for preventing and treating infections with *P. vivax* are inadequate.[43,48] In many areas where both *P. vivax* and *P. falciparum* coexist, the incidence of *P. vivax* decreases less rapidly than that of *P. falciparum and P. vivax* persists as the main barrier to achieve malaria elimination.[49–52] Hence, the findings of the timing of care seeking of migrant workers infected with *P. vivax* further provided evidence that these non-falciparum malaria parasites should gain more public health importance and attention.

Infection history

It has been shown that migrant workers with imported malaria tend to self-treat their unexplained fevers as a cold instead of visiting distant healthcare facilities, mostly because they are unaware of malaria.[53] This behaviour may explain our finding that migrant workers without infection history were more likely to delay healthcare seeking, as they may have had less experience with and knowledge of malaria than those who had previously been infected. This finding provides important information for the development of health assessments and the screening of migrants on arrival in their home country. Such screening has also been recognized as a useful tool to better understand the health needs of migrant populations.[54] For example, screening can be systematic or performed on a case-to-case basis, whereupon arrival, each migrant obtains a personal consultation to describe their medical and transit history.[55–57]

Policy implications

The findings of this study provide insights for the development of interventions to improve the healthcare-seeking behaviour of migrant workers with imported infectious diseases, in particular with imported malaria in countries approaching or sustaining malaria elimination. On the one hand, the findings of this study indicate the importance of not only strengthening the diagnostic capacity for malaria in primary healthcare facilities but also improving access to healthcare facilities at higher administrative levels. On the other hand, our study explored the potential determinants that enable or prevent patients with imported malaria from making early healthcare-seeking choices. Previous studies have demonstrated that patients with imported malaria are mainly migrant workers living in rural areas and usually have little knowledge about the association of their febrile symptoms with malaria.[20] Therefore, in addition to the provision of health education to the population, special health education programs targeting migrant workers should be developed to improve early healthcare-seeking awareness. Finally, more efforts should be undertaken to include migrants in programs aiming to monitor high-risk groups for infections.[58] In China, labour service companies, which are mainly responsible for sending migrant workers abroad, should be engaging in the provision of pre-travel health education, in reminding workers of the importance of early and proper post-travel healthcare seeking, and in surveillance and monitoring of migrant workers with malaria. Moreover, the surveillance network could be strengthened by connecting migrants and health facilities through social media tools.

Strengths and limitations

There are some limitations in the present study. First, the time of malaria onset and initial healthcare seeking in the CISDCP were recorded as the number of days and not as the exact number of hours, which would have been more accurate. Second, although good information was available through the 1–3–7 surveillance system in China in recent year, the decisions and timing of seeking healthcare may have been influenced by a variety of socioeconomic variables that were not recorded. Examples are the specific working types of migrants, as well as access to and perceived quality of services. Such information would also be helpful in identifying high-risk groups for imported malaria. Finally, although the overall large sample size of this study ensured the reliability of the analysis, there is still room for improvement in the completeness of the surveillance data.

Conclusions

As China has finally achieved malaria elimination, there is an increasing focus on prevention of reintroduction. The delayed in seeking medical care among patients with imported malaria thus should be considered and addressed by specific interventions. Initial healthcare seeking from healthcare facilities at higher administrative levels, infection with non-falciparum parasites and absence of malaria infection history are significantly associated with delayed care seeking of patients with imported malaria. Therefore, in addition to increasing awareness about these issues among health care professionals, improved access to healthcare facilities at higher administrative levels as well as improved diagnostic capacity of healthcare facilities at lower administrative levels should be developed. Moreover, education programs targeting populations at increased risk of malaria importation and delayed healthcare seeking should be improved to facilitate early healthcare seeking and service use.

Authors' contributions

GYL and JC conceived and designed the study. GYL analysed the data and wrote the first draft. YYC, GZ and JC took charge of collection of all data. OM gave important suggestions on improving the quality of the analysis and monitored the study progress as well as revised the manuscript. QC participated in anonymous data analysis. All authors contributed to the data collection, checking and processing. All authors reviewed the final version of the manuscript. All authors read and approved the final manuscript.

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Conflict of interest: The authors declare that they have no competing interests.

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