## REVIEW

# THE CHALLENGES OF MALARIA ELIMINATION IN YUNNAN PROVINCE, PEOPLE'S REPUBLIC OF CHINA

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**Abstract.** China launched a Malaria Elimination Action Plan for 2010-2020. Yunnan, a province along the western border of China, belongs to the Great Mekong Subregion. Malaria elimination in the Great Mekong Region is a great challenge. We chose Yunnan to analyze the challenges for malaria elimination and how to overcome the barriers for malaria elimination globally.

**Keywords:** border malaria, elimination, challenge, China

## INTRODUCTION

Malaria, a global public health problem, is endemic in 109 countries and territories in tropical and sub-tropical zones, throughout the world except Antarctica and Australia (WHO, 2010). In recent years, malaria control has been strengthened in endemic countries through financial support and technical assistance from the international community. As a result of these interventions, the malaria burden is being reduced (WHO, 2008). The number of malaria cases decreased from 244 million in 2005 to 225 million in 2009 (WHO, 2010). The number of deaths due to malaria decreased from 985,000 in 2000 to 781,000 in 2009 (WHO, 2010). Malaria elimination is on the global health agenda (WHO, 2007).

Prior to 1949, malaria affected most parts of China and there were about 30 million cases per year (MOH, 2009). China has made an impact on malaria disease burden and the incidence had declined to 0.2/10,000 in 2008 (MOH, China, 2009). Large parts of China are malaria free. The 26,873 reported cases of malaria in 2008 were concentrated to a few provinces and endemic *Plasmodium falciparum* was confined to only two provinces (MOH, China, 2009).

It is in this context that China reoriented its National Malaria Control Program. The Ministry of Health presented a Revised National Malaria Strategy 2010-2015 in early 2009, and then a Malaria Elimination Action Plan for 2010-2020 to eliminate malaria by 2020.

Yunnan, located in southwestern China, belongs to the Great Mekong Subregion (GMS), one of the only two provinces with endemic *Plasmodium falciparum* in China. The province shares a 4,061 km long border with Myanmar, Lao PDR, and Vietnam. Yunnan is mountainous, with altitudes ranging from 76.4 m to 6,740 m, and a climate that ranges from tropical to frigid. The border and low altitude areas

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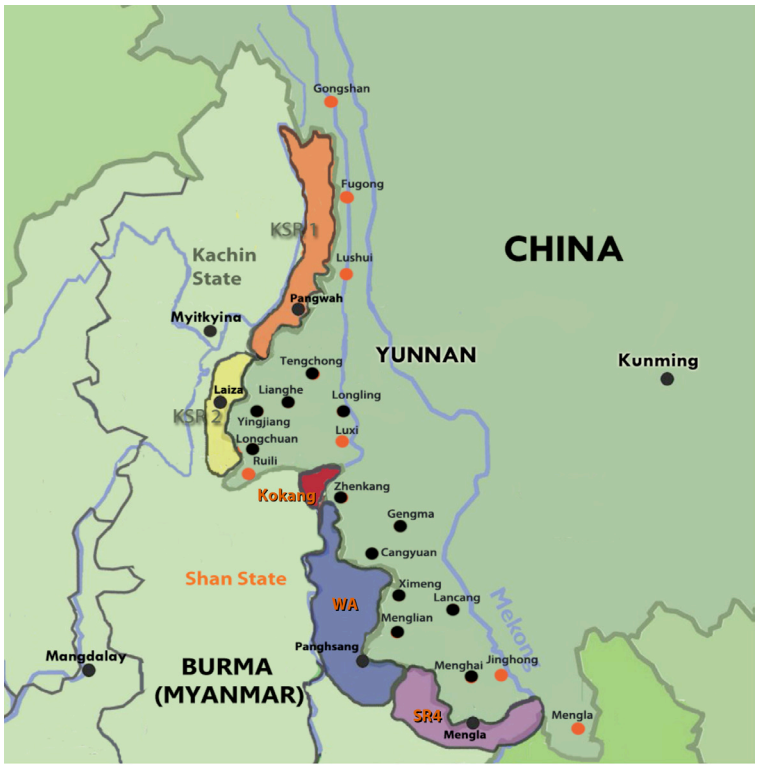


Fig–Five Myanmar special regions (KSR1, Kachin Special Region I; KSR2, Kachin Special Region II, Kokang; Wa, Shan Special Region II; SR4, Shan Special Region IV) along China-Myanmar border.

are the main malaria endemic areas. It has a population of 45 million comprise of 26 ethnic groups. More than 80% of the people in the area are still at risk for malaria infection (Xu and Liu, 1997). These statistics imply the challenges presented for malaria elimination in Yunnan.

## MAIN CHALLENGES

### Reduction of malaria transmission and incidence in border regions

Yunnan has made great achievements in malaria control. The incidence of malaria decreased to 0.06/1,000 by 2009 (MOH, China, 2010). Sixty-eight point eight percent (1,832/2,662) of malaria cases and 75.0% (467/623) of falciparum malaria cases were imported from neighboring countries (MOH, China, 2010). Cross-border spread of malaria is an important problem (Xu and Liu, 1997). Five Myanmar Special Regions (MSR, Fig 1) bordering China have difficulty in accessing the services of the Myanmar National Malaria Control Program. Some communities in these five regions are hyperendemic or holoendemic (MOH, Myanmar, 2005). Reliable epidemiological data is scarce. The parasite rate among febrile patients was 60% (270/453) with 90.7% (245/270) being *Plasmodium falciparum (Pf)* from an active detection in Shan Special Region II (Wa State) in 2007 (Liu *et al*, 2009). A cross sectional survey found 23.3% (36/159) of schoolchildren had parasites, of whom 63.8% (23/36) had *P. falciparum* malaria in Kechin Special Region I in 2009 (Liu *et al*, 2011). Malaria elimination in Yunnan needs to reduce the cross-border malaria burden and help neighboring countries. However it has been challenging to collaborate with neighboring countries because of political, economic and geographic differences.

### Heterogeneity and complexity of malaria epidemiology and vectors

The climate of Yunnan is affected by both monsoons from the Indian Ocean and the Pacific Ocean. The geography

is mountainous, with altitude ranging from 76.4 m in the Red River Valley to 6,740 m in Meili Snow Mountains (Dong, 2010). The climate also varies from tropical regions to cold and frigid regions. This topographical and climatic diversity leads to malaria vector complexity and transmission heterogeneity. Malaria transmission is year round in the low altitude areas (Chen *et al*, 2011). *Anoheles minimus* has been identified as the primary malaria vector and *An. jeyporiensis* is a secondary vector in areas south of 25°N with an altitude below 1,500 m (Dong, 2000). *An. anthropophagus* is the principal vector in the Jinsha River Basin north of 27°N (Dong, 2000). *An. kunmingensis* is the vector north of 24°N above an altitude of 1,700 m (Dong, 2000). *An. sinensis* is a vector from the Jinsha River Basin in the north of Yunnan to the region south of 24° above 1,500 m (Dong, 2000). *An. dirus* has been found to have parasite infections in the southern forested areas (Dong, 2010). *An. pseudowillmori* and *An. maculatus* are potential vectors in the hilly areas of the south (Dong, 2010). The heterogeneity and complexity of malaria epidemiology and vectors is challenging for interrupting malaria transmission locally.

**Health system and human resources**

Malaria elimination requires skillful staff in health facilities at all levels. The facilities that treat malaria are understaffed. At the community level, anti-epidemic staff, whose work includes malaria, are frequently changing due to personal career development, payment and living conditions. New staff may be less familiar with malaria control measures. The system for disease control and prevention is relatively separate from the system for disease treatment (hospitals) in China. The latter is not willing to be involved in the prevention of malaria. Most staff in the treatment system has not been trained in malaria diagnosis and treatment. A survey carried out in early October 2010 showed only 6.40% (50/781) of physicians at provincial and prefecture levels has been trained in malaria diagnosis and treatment (YIPD, 2010). There is a shortage of qualified microscopists in many areas. Malaria microscopy cannot be conducted regularly in most hospitals. In the malaria control program, qualified malaria staff are only available in disease control and prevention areas with intrinsically high malaria transmission. When the malaria program moves from control to elimination, there is a shortage of trained staff in areas with low transmission and in the hospital system. A survey showed that of 32 staffs who work on malaria in the three prefectures with low malaria transmission, only 2 had received training in malaria (YIPD, 2010).

**Detection of cases**

Elimination of malaria requires universal detection and confirmation of malaria. The challenges faced include adequately trained microscopists, legislation implementation and accessibility in mountainous areas to diagnostic and treatment facilities. In 2010, the Yunnan Institute of Parasitic Diseases reread 11,589 slides previously reported as negative for malaria for microscopy quality control. Eighty-four slides (0.73%) were false negative, which is higher than the slide positivity rate of 0.51% for the whole province (YIPD, 2010). In areas where malaria is uncommon, microscopists are faced with losing their skill to detect malaria because of few opportunities to see slides with malaria parasites. According to legislation, the private health sector must report all malaria cases; however it is difficult to monitor their compliance to the requirement. Ninety-four percent of the

topography of Yunnan is mountainous, making malaria active case detection via house-to-house visits difficult during the transmission (rainy) season. The current health service cannot ensure mountainous residents universal access to diagnosis (Xu, 2009a).

**Population movement across common border**

Historically, population movement has contributed to the spread of disease. Failure to consider this factor contributed to failure in malaria eradication campaigns in the 1950s and 1960s (Martens and Hall, 2000). Millions of people cross the border with Myanmar, Lao PDR, and Vietnam each year. From 1999 to 2003, of 3,646 malaria cases reported by Tengchong, one of border counties, 3,556 (97.5%) became infected in Myanmar (Li and Fan, 2005). The movement of infected people from endemic areas to neighboring countries leads to reintroduction of the disease.

**Financing and logistics**

Malaria elimination requires a range of complementary health system investments, all within an environment of declining or negligible malaria burden. From the viewpoint of health economics, elimination may not be cost-effective. The budget required for implementing the Revised National Malaria Strategy for 2011 to 2015 is estimated to be USD786 million. China obtained USD176 million through the National Strategy Application from the Global Fund. The remaining USD610 million is expected to be contributed by the government at all levels. However Yunnan is one of the most underdeveloped provinces in western China (Xu, 2010). The income tax cannot cover the public cost. The local governments are rarely able to contribute any funds to the elimination of malaria, and funds from the central government are limited. Most health facilities in remote areas cannot be assured of receiving adequate quality commodities and supplies.

**Collaboration in border malaria control**

Due to heterogeneity and complexity of socioeconomic, natural and biological factors, Yunnan will be the last province in China for malaria elimination, and the final location for elimination will be the border region of Yunnan. Border area malaria elimination needs collaboration with neighboring countries. However, the border in mountainous areas where ethnic minorities live, especially in most parts of Myanmar, is out of effective management by the Myanmar central government. China has had a joint border malaria control project with Myanmar, Lao PDR and Vietnam since 2005, but the activities have been limited to annual meetings and some training. China is trying to support malaria control in endemic areas of neighboring countries, but this has not been easy.

**Prevention of malaria reintroduction**

Malaria transmission conditions (*eg* the climate and vector population and density) have not changed in malaria endemic areas of Yunnan (Dong, 2010). There are no natural or artificial barriers along 4,061 km border. Most travelers from China to neighboring countries do not present for pre-travel health advice, making preventive measures difficult. Imported malaria parasites can easily result in reintroduction. Molecular tools are recommended to determine genetic characterization and verification of local transmission (WHO, 2007). Malaria parasites may be identical on both sides of the border, not allowing easy identification with molecular tools.

**Implementation of policies and regulation**

Sound policies have been introduced for reporting, surveillance and control of communicable diseases in China. However implementation of these policies has not been intensively enforced or monitored. With a declining malaria burden, government health authorities and facilities (especially hospitals and the private sector) may be neglecting the malaria problem. They may not pay attention to policies or regulations regarding malaria detection, reporting and surveillance. Elimination requires them to pay their attention back on malaria.

## CONCLUSION

Malaria elimination is challenged by the heterogeneity and complexity of the political and natural environments, socioeconomic development, vector biology, health services and transportation. Some factors (*eg*, the natural environment, vector biology, political situation) may not be easy to change in short time. However some factors can be greatly changed through universal effort, such as reducing gap in socioeconomic development between urban and rural areas (especially remote mountainous areas) and between eastern and western regions (Xu *et al*, 2009a). It is important to improve living conditions and work opportunities for poor people in their places of residence and to address population movements across borders. Policies should be reinforced in both public and private health care facilities. There should be adequate coverage with good quality laboratory and clinical services for malaria detection, reporting and surveillance. There should be collaboration between neighboring countries and organizations to decrease malaria prevalence and transmission in endemic areas of neighboring countries. People need to be educated about preventive measures and diagnostic and treatment services should be available (Xu *et al*, 2009b). Even after local transmission is interrupted, efforts should be maintained to prevent reintroduction and reestablishment of local malaria transmission. Malaria can be eliminated through these cooperative efforts.

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