Migration and Malaria Infection in Myanmar-Thailand border area of Tanintharyi Region, Myanmar: A Case-Control Study

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การอพยพย้ายถิ่น และการติดเชื้อมาลาเรียบริเวณชายแดนเมียนมา-ไทยในเขตทะนินทะยี ประเทศเมียนมา: การศึกษาแบบย้อนหลังจากผลไปหาเหตุ

นายโซ ลิน ตู

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรมหาบัณฑิต
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โซ ลิน ตู : การอพยพย้ายถิ่น และการติดเชื้อมาลาเรียบริเวณชายแดนเมียนมา-ไทยในเขตทะนินทะยี ประเทศเมียนมา: การศึกษาแบบย้อนหลังจากผลไปหาเหตุ (Migration and Malaria Infection in Myanmar-Thailand border area of Tanintharyi Region, Myanmar: A Case-Control Study) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ดร. เทพนาฏ พุ่มไพบูลย์, 158 หน้า.

ปัจจุบันมาลาเรียไม่ได้เป็นเพียงโรคที่มีความสัมพันธ์กับป่าไม้เท่านั้นแต่ยังได้รับผลกระทบจากการเคลื่อนย้ายถิ่นโดยเฉพาะการย้ายถิ่นไปยังบริเวณแนวชายแดน แรงงานอพยพและรูปแบบในการอพยพมีผลต่อการแพร่กระจายของเชื้อมาลาเรีย การศึกษานี้มีวัตถุประสงค์ที่จะระบุรูปแบบการอพยพเคลื่อนย้ายของผู้อพยพย้ายถิ่นในแนวชายแดนและปัจจัยที่เกี่ยวข้องกับการติดเชื้อมาลาเรียในแนวชายแดนพม่า-ไทย โดยเฉพาะในเขตทะนินทะยี ประเทศเมียนมา การศึกษาเป็นแบบย้อนหลังจากผลไปหาเหตุ แบบไม่จับคู่ โดยเก็บข้อมูลจากผู้อพยพที่อาศัยในเมืองทวาย ทาเยทเชา และพาลอว์ จำนวน 320 คน โดยแบ่งเป็นผู้ติดเชื้อมาลาเรีย 160 คน และผู้ไม่ติดเชื้อมาลาเรียเป็นกลุ่มควบคุม 160 คน ตามผลการวินิจฉัยการติดเชื้อมาลาเรียด้วยชุดตรวจ จากนั้นเก็บข้อมูลด้วยการสัมภาษณ์ตามแบบสอบถาม วิเคราะห์ความสัมพันธ์ระหว่างรูปแบบของการย้ายถิ่นและปัจจัยอื่นๆ ที่เกี่ยวข้องกับการติดเชื้อมาลาเรียด้วยการวิเคราะห์ความสัมพันธ์ระหว่างตัวแปร 2 ตัว และการวิเคราะห์ความถดถอยโลจิสติค

มากกว่าครึ่งหนึ่งของผู้ตอบแบบสอบถามมีการเคลื่อนย้ายถิ่นระหว่างหมู่บ้านในเขตชายแดน ร้อยละ 19.4 มีการเคลื่อนย้ายถิ่นระหว่างเมือง และร้อยละ 27.8 มีการเคลื่อนย้ายถิ่นระหว่างภูมิภาค การเคลื่อนย้ายถิ่นระหว่างภูมิภาค (OR=1.82, 95%CI=1.11-2.99) การเคลื่อนย้ายถิ่นตามฤดูกาล (OR=2.99, 95%CI=1.44-6.24) และแรงงานแบบไม่จ้างเหมา (OR=2.60, 95%CI=1.30-5.21) มีความเสี่ยงต่อการติดเชื้อมาลาเรียอย่างมีนัยสำคัญทางสถิติที่ 5 เปอร์เซ็นต์ นอกจากนี้การมีพฤติกรรมการป้องกันโรคมาลาเรียที่ไม่ดี (AOR=8.85, 95%CI=2.82-27.80) การเข้าถึงสถานบริการตรวจรักษาโรคมาลาเรียที่ยากลำบาก (AOR=34.28, 95%CI=4.37-268.48) เป็นปัจจัยเสี่ยงต่อการติดเชื้อมาลาเรียอย่างมีนัยสำคัญทางสถิติเมื่อวิเคราะห์ความถดถอยโลจิสติคเชิงพหุในช่วงความเชื่อมั่นที่ 95 เปอร์เซ็นต์

จากผลที่ได้พบว่าความเสี่ยงของการติดเชื้อมาลาเรียนั้นแปรผันตามรูปแบบของการเคลื่อนย้ายถิ่น และมีปัจจัยเสริมได้แก่ พฤติกรรมการป้องกันโรค และการเข้าถึงบริการการตรวจรักษาโรคมาลาเรีย ด้วยเหตุนี้เจ้าหน้าที่ผู้มีอำนาจในด้านสุขภาพระดับท้องถิ่นควรพุ่งเป้าไปที่ผู้อพยพย้ายถิ่นซึ่งเป็นกลุ่มเสี่ยง และควรจัดให้มีการบริการการตรวจรักษาโรคมาลาเรียตามบริเวณชายแดนพม่า-ไทยที่เข้าถึงได้ง่าย

สาขาวิชา สาธารณสุขศาสตร์ ลายมือชื่อนิสิต .....

ปีการศึกษา 2560 ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

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Nowadays, malaria did not exist as a forest-dependent disease and mainly impacted by migration, mostly to border areas. Migrant workers are distributor of *Plasmodium* species and their patterns of migration affected on malaria transmission. The study aimed to identify migration pattern of border migrant people and the factors associated with malaria infection in Myanmar-Thailand border area especially in Tanintharyi region, Myanmar. An unmatched case-control was conducted among 320 migrant people living in Dawei, Thayetchaung and Palaw Townships, 160 cases and 160 controls. Cases and controls were confirmed by rapid diagnostic test and data collection was done by using structure questionnaires through face to face interview. Bivariate analysis and logistic regression was used to determine the association between migration pattern and also associated factors with malaria infection.

More than half of respondents conducted interrural migration and the rests were intermunicipal migration (19.4%) and interregional migration (27.8%). Interregional migration (OR=1.82, 95%CI=1.11-2.99), seasonal migration (OR=2.99, 95%CI=1.44-6.24) and non-contract migration (OR= 2.60, 95%CI=1.30-5.21) were risk factors for malaria at 5% significance level. Moreover, poor protective behavior (AOR=8.85, 95%CI=2.82-27.80), difficult to access malaria health services (AOR=34.28, 95%CI=4.37-268.48) were risk factors for malaria infection in multiple logistic regression at 95% confidence interval.

The findings of this study suggest that malaria risk was varied with migration status and was influenced by protective behavior and ability to access malaria health services. Therefore, local health authorities should target high risk migrant people and provide easy available of malaria health services in Myanmar-Thailand border area.

Field of Study: Public Health Student's Signature .....

Academic Year: 2017 Advisor's Signature .....

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ACT	Artemisinin-based Combination Therapy
ADB	Asian Development Bank
AOR	Adjusted Odd Ratio
ARM	Artemisinin Resistant Malaria
BHS	Basic Health Staff
CDC	Centre for Disease Control
DOT	Directly Observed Treatment
EDAT	Early diagnosis and appropriate treatment
GMS	Greater Mekong Sub-region
GP	General Practitioner
HH	Household
IEC	Information, education, communication
IRS	Indoor residual spray
ITN	Insecticide treated net
LLIN	Long-lasting Insecticide Treated Net
MMP	Mekong Malaria Program
MMP	Mobile and Migrant Population
MMW	Mobile Malaria Workers
NMCP	National Malaria Control Program
NSP	National Strategic Plan
NMTG	National Malaria Treatment Guideline
OR	Odd Ratio
PMI	President Malaria Initiative
QA	Quality Assurance
QC	Quality Control
RAI	Regional Artemisinin Initiative
RDTs	Rapid Diagnostic Tests
UHC	Universal Health Coverage
USAID	United States Agency for International Development

VBDC	Vector Borne Disease Control
VMWs	Village Malaria Workers
WHO	World Health Organization

CHAPTER I

INTRODUCTION

1.1. Background and Rationale

Over recent years, remarkable progress has been conducted in reduction of global malaria burden and some countries achieved malaria elimination but there are many challenges to reach malaria free world (Roll Back Malaria, 2015). Although overall malaria situation has great success, impact from elimination and control efforts proves more difficult in areas near international borders. The specific environmental (including physical, social and geopolitical), anthropological, administrative and geographic characteristics of border areas impact uniquely on the epidemiology and control of malaria, resulting in coinage of the terms 'border malaria' and 'cross border malaria'(Wangdi et al., 2015). Moreover, resistance of malaria parasite, *Plasmodium falciparum* strain against artemisinin and other antimalarial drugs has reached alarming levels in certain areas of the Greater Mekong Sub region (GMS). In the area straddling Thailand-Myanmar border and Cambodia–Thailand border, *P. falciparum* is becoming resistant to artemisinin which is last effective drug for malaria treatment and then it could become untreatable within a few years. The only solution is Malaria Elimination. The quandary is that multidrug resistance is both an impediment to elimination and a reason for pursuing it (World Health Organization, 2015a).

Nowadays, malaria did not exist as a forest-dependent disease and mainly impacted by population movements/ migration, mostly to border areas. Most countries suffer different impact of migration including internal and transnational migration, however both types of migration take place for the same reasons such as economic and safety (Jitthai, 2013). During migration, they carry malaria parasite including drug resistant strain from place to place and may cause growing of drug resistant problem. Moreover, GMS countries are official approved for malaria elimination at 2030 (World

Health Organization, 2015a). So, drug resistant and malaria migration problems would be difficult for malaria elimination.

In 2013, malaria caused about 198 million cases and 584,000 malaria death happen in worldwide (World Health Organization, 2014). According to world malaria report 2016, malaria generated about 212 million cases (UI: 148–304 million) and malaria mortality was 429,000 (UI: 235 000–639 000) in 2015 (World Health Organization, 2016). Approximately half of the world population is at the risk of malaria. *Plasmodium falciparum* is main cause of malaria death and it takes place nearly one million deaths per year (Murray et al., 2012). With the extension of malaria intervention programs between 2000 and 2015, it aided for reduction malaria incidence by 37% globally, 60% declination of malaria mortality rates globally and 66% reduction in Africa. Then, under-five mortality rates have also reduced about 65% globally, and by 71% in Africa (World Health Organization, 2015b). With the significant reduction of malaria morbidity and mortality, drug resistant malaria problem is coming out. WHO targeted more than 90% for reduction of malaria morbidity and mortality rates globally at 2030 compared with 2015 (World Health Organization, 2016).

In Myanmar, there was 81.1% reduction of reported malaria incidence (from 1341.8 cases per 100,000 population to 253.3 cases per 100,000 population) and 93.5 % reduction in reported annual malaria mortality (from 3.79 deaths per 100,000 population to 0.25 deaths per 100,000 population) and 87.2 % reduction in the proportion of malaria hospitalizations (7.8 to 1.0 %) in comparison of 2005 to 2014 (Mu. et al., 2016). Although the total number of malaria cases and deaths had decreased dramatically, malaria remain relatively most prevalent along the border area especially at Myanmar-Thailand borders. Malaria burden is particularly high in hard to reach area and migrant, who attempt to find economic opportunities in border area because it has a lot of economic development activities including trade market, forestry, industry, charcoal & gold mining, rubber plantation and road building. Therefore, border areas still creating high malaria prevalence (Jitthai, 2013).

No single intervention or package of interventions will achieve malaria elimination in all countries. Health education and malaria health promotion was the essential portion of the malaria elimination. Previous study reported that malaria education and awareness campaigns are vital in malaria prevention and control because

it promote malaria knowledge and health related behaviors of community and increasing social support and inter-sectoral collaboration (Tang et al., 2016).

The number of non-registered cross-border migrants and refugees along the Myanmar-Thailand border area are increasing due to economic development and migrants from central dry zone of Myanmar are searching for job opportunities in Thailand especially in border area. In Myanmar-Thailand border area, there are many types of migration like internal migration, transnational migration and refugees. These migrated people carry malaria parasite from malaria endemic area to non-endemic area and cause imported and indigenous cases in area which have *Anopheles* without malaria. Due to much border migration, border area is become main sources of malaria distributing and importing area and creating drug resistance problem (Jitthai, 2013).

In malaria elimination, addressing of malaria issues in migrant population has been regarded as critical element for evaluation of elimination progress and for covering of various populations. In some countries nearing elimination, a high proportion of malaria cases are found among mobile migrant populations living in hard-to-reach areas, especially near international borders. In this situation, most of infections are imported by visitors and migrants and then, distributed to non-endemic area. Therefore, Surveillance system are very important to catch malaria imported case and it must be identified cases and treated well rapidly (World Health Organization, 2015b, World Health Organization, 2015a).

Therefore, National Malaria Control Program (NMCP) trying to eliminate malaria with multisectorial involvement. The National Malaria Control Program in Myanmar is closely linked with World Health Organization's Global Malaria Program and coordinating with other partners to reach malaria elimination. The main goal of the NMCP is the reduction of malaria cases and malaria deaths, diminish the size of malaria transmission areas, restraining and eliminating artemisinin-resistant parasites with collaboration of neighboring countries. Vision of National Malaria Control Program is that *Plasmodium falciparum* elimination at 2025 and *Plasmodium vivax* elimination at 2030 (Thi, 2017).

Tanintharyi Region is located in Southern most part of Myanmar and is flanked by Mon State in the North, Thailand border is related to the East and Andaman sea is

located to the West. Tanintharyi Region provide better favorable ground for malaria because the climate alternates between a cool-dry from December to March and Hot & humid season from April to November with a heavy torrential rain falls in May to September. Dawei, Thayetchaung and Palaw townships have been included in Tanintharyi Region and border with Kanchanaburi, Ratchaburi and Phetchaburi Province, Thailand (United Nations Development Programme, 2014).

Tanintharyi Region is involved in Regional Artemisinin Initiative (RAI) area which is also known as Artemisinin resistant area. Regional Artemisinin Initiative is responsible for maximizing the contribution to the elimination of falciparum malaria from the Greater Mekong Sub region (GMS), and to prevent the emergence or spread of artemisinin resistance to new areas. Therefore, National Malaria Control Program conducting special intervention in these areas with the support/combination of Global Fund to achieve these objectives. Although malaria elimination is overall goal, special intervention method is needed to achieve specific targets and new strategy is required. The existing intervention activities in Tanintharyi region are (1) well conducting of malaria post (Volunteer Malaria Worker/Health Facility) and screening point, (2) mobile clinic for intensified case findings and treatment, (3) Long lasting insecticide treated net (LLIN)/ Insecticide treated net (ITN) distribution in the targeted area, (4) Directly Observed Treatment (DOT) for *Plasmodium falciparum* malaria case, (5) Day 3 *Plasmodium falciparum* positive cases management, (6) case investigation and response, (7*)* focus investigation and response, (8) malaria death investigation, (9) migrant mapping and (10) indoor residual spray (IRS) for targeted villages (National Malaria Control Program, 2017).

Dawei district is notable as a trade Hub and Deep-sea port project area. In this district, a lot of job opportunities are attracting to the migrant workers. Moreover, some migrant workers from other areas of Myanmar come to these border areas and migrated to Thailand due to easy available of border crossing. Therefore, Tanintharyi Region has not only internal migration and transnational migration but also many immigrants who have no immunity to malaria. These migrant workers have high risk of malaria infection and then, they may suffer more severe compared with local resident if they get malaria infection (Jitthai, 2013).

In Tanintharyi Region, there are a lot of vulnerable population who are working in rubber plantations and fruit orchards, people who spend the night in the forest (including the military), ethnic minority groups and refugees in camps who are living in the bestride of these border areas. Due to labor shortages, Thailand has been drawing large numbers of migrant workers from Myanmar. These migrant workers live and work along border districts and provinces where malaria is still endemic while others move back and forth between home communities and various work destinations in Thailand (Jitthai, 2013). The situation poses a risk for transporting malaria from place to place as imported malaria. These migrant people imported malaria & drug resistant malaria parasites and border area remain as pocket area. So, these areas are important for malaria elimination. Therefore, Myanmar National Malaria Control Program (NMCP) and Thailand National Malaria Control Program (NMCP) are well collaborated for malaria elimination by conducting cross border meeting (Thi, 2017).

The main objective of this study is to identify the migration pattern of border migrant people and the factors associated with malaria infection in Myanmar-Thailand border area because these areas have high malaria prevalence, different pattern of migration and no study was done in these border areas especially in Myanmar side. If we know border migration pattern and associated factors for malaria infection, malaria health services will be more targeted to these migrant workers and will be controlled associated factors in border area. Then, most of Thailand and Myanmar townships are free of malaria. Therefore, if we will create free malaria border area, our goal to malaria elimination is not too far.

According to these reasons, it is reasonable to investigate between border migration and Malaria infection in Myanmar-Thailand border area.

1.2 Research Questions

- What are the migration patterns of migrant workers/people residing in Myanmar-Thailand border area especially in Dawei, Thayetchaung and Palaw Townships, Tanintharyi Region, Myanmar?
- Is there any association between border migration pattern and malaria infection in this region?

- Is there any association between sociodemographic of migrant people and malaria infection in this region?
- Is there any association between knowledge on malaria of migrant people and malaria infection in this region?
- Is there any association between protective behavior of migrant people and malaria infection in this region?
- Is there any association between treatment seeking behavior of migrant people and malaria infection in this region?

1.3 Research Objectives

General Objective

- To identify the migration pattern of border migrant people and the factors associated with malaria infection in Myanmar-Thailand border area especially in Dawei, Thayetchaung and Palaw Townships, Tanintharyi Region, Myanmar.

Specific Objectives

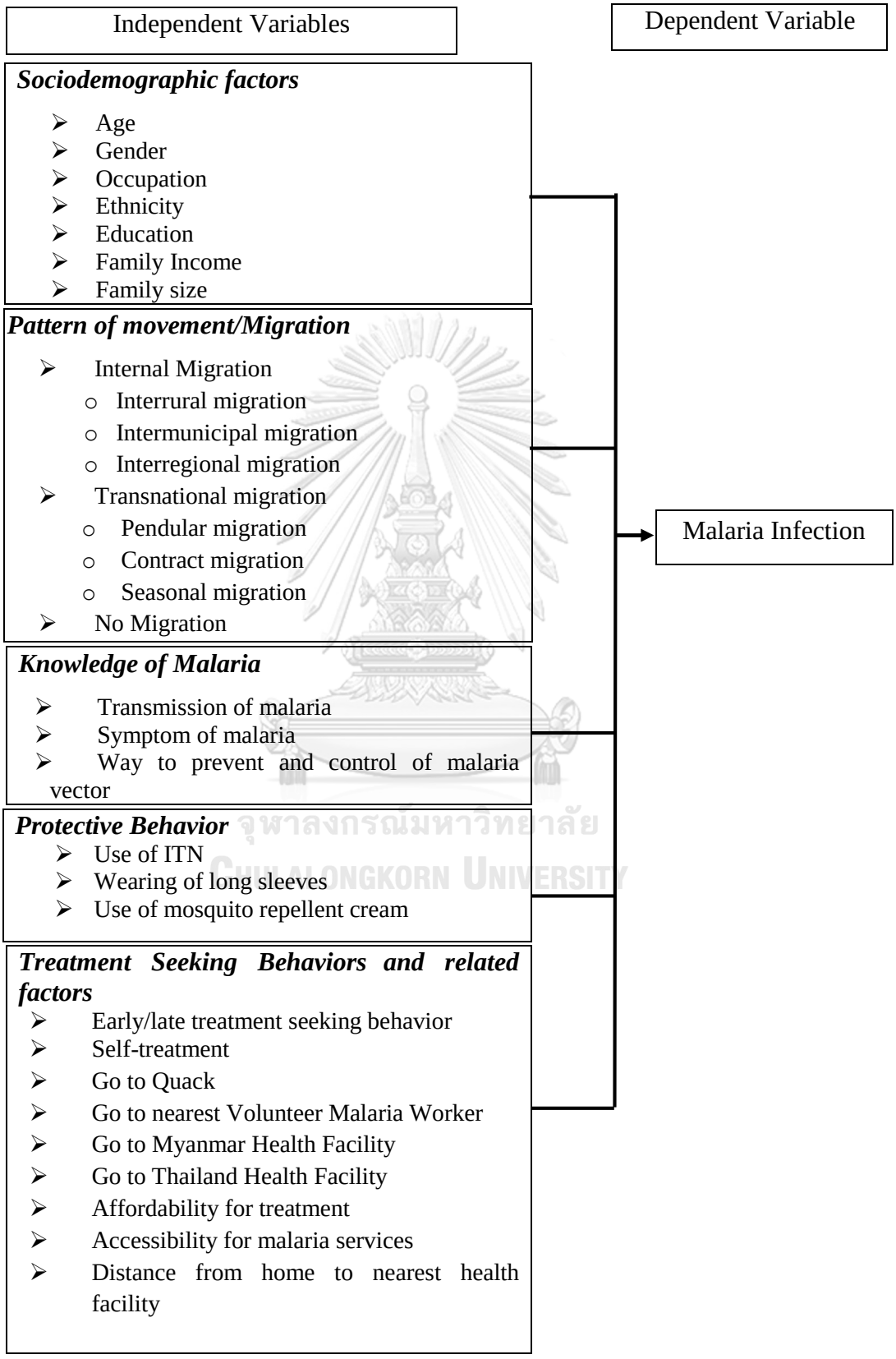
- To identify the migration pattern of border migrant people in Myanmar-Thailand border area especially in Dawei, Thayetchaung and Palaw Townships, Tanintharyi Region, Myanmar.
- To investigate an association between border migration pattern and malaria infection in this region.
- To investigate an association between sociodemographic of migrant people and malaria infection in this region.
- To investigate an association between knowledge on malaria of migrant people and malaria infection in this region.
- To investigate an association between protective behavior of migrant people and malaria infection in this region

- To investigate an association between the seeking behavior for malaria treatment of migrant people and malaria infection in this region.

1.4 Research Hypotheses

- There is an association between border migration pattern and malaria infection in Myanmar-Thailand border area especially in Dawei, Thayetchaung and Palaw Townships, Tanintharyi Region, Myanmar.
- There is an association between sociodemographic of migrant people and malaria infection in this region.
- There is an association between knowledge on malaria of migrant people and malaria infection in this region.
- There is an association between protective behavior of migrant people and malaria infection in this region.
- There is an association between seeking behavior for malaria treatment of migrant people and malaria infection in this region.

1.5 Conceptual Framework



1.6. Operational Definition

Malaria case is defined as a person with malaria related symptom like fever, chills and rigor and it is confirmed by mainly rapid diagnosis test (RDT).

Malaria infection refers to *Plasmodium* species especially *Plasmodium falciparum*, *Plasmodium vivax* and mixed infection in this study and this *Plasmodium* species are transmitted to human through the bite of malaria infected female *Anopheles* mosquito.

Migration refers to one people or group of people who are moving from other region of Myanmar to Myanmar-Thailand border area especially Tanintharyi region or from Thailand to Tanintharyi region due to economic, social, education reason and seasonal variation.

Sociodemographic refers to general information of targeted population especially migrated people in this study and it included age, gender, occupation, ethnicity, education and family size (Woldu, 2013).

Pattern of movement/migration refers to movement of people in Myanmar-Thailand border area due to their economic, social, education reason and seasonal variation. There are 3 types of pattern of movement/ migration:

1. Internal migration
2. Transnational migration
3. No migration/ no movement

Internal Migration refers to movement of people from one place to another place within one country without crossing the border. There are 3 types of internal migration (Baggio, 2011).

1. **Interrural migration**: people migrate from one countryside to another or one village to another village or village to forested area and spend overnight (migration at border endemic area).
2. **Intermunicipal migration**: people migrate from one municipality to another municipality or one township to another township.
3. **Interregional migration**: people migrate from one region to another region.

Transnational migration/border migration refers to migration of people from one country to another country with crossing the border area. There are 3 types of transnational migration (Baggio, 2011).

1. **Contract migration**: labor migration regulated by a temporary workers program, in which duration of contract migration depend on the period of temporary employment contract of this program.
2. **Seasonal migration**: duration of seasonal migration is less than one year and it can repeat over time. Seasonal migration is associated with working condition and job nature (eg. agriculture, farming, harvest, rubber plantation, etc.).
3. **Pendular migration**: This migration is usually less than 24 hours (one day) and the migration can repeat.

No movement refers to people who are living in their village which is located at malaria endemic area of Myanmar-Thailand border area and these people do not migrate to another village or cross the border area.

Knowledge of malaria refers to people knowledge dealing with malaria such as transmission of malaria infection, breeding site, resting place and highest biting time of malaria vector, symptom of malaria, knowing protection method against malaria mosquito biting and prevention method of malaria infection (Guthmann et al., 2001).

Symptom of malaria refers to the symptom like fever, chill and rigor, headache, vomiting, weakness, sweating and backache and these are created by malaria (Centers for Disease Control, 2017).

Protective behavior refers to self-protection methods from biting of malaria mosquito like using of LLIN, wearing of long sleeves, mosquito repellent cream/sprays and screening of windows.

Treatment seeking behavior refers to proactively seeking for treatment by people if they are suspected for malaria infection. Migrant people seek treatment by different ways like

1. Self-treatment
2. Treatment from non-health facility
    - ✓ Go to quack
3. Treatment from health facility

- ✓ Go to nearest volunteer malaria worker
- ✓ Go to Myanmar side health facility
- ✓ Go to Thailand side Health facility

Self-treatment refers to people who treated by self and not received expert treatment.

Go to quack refers to people who received malaria treatment from unqualified medical person.

Go to nearest volunteer malaria worker refers to people received malaria treatment from volunteer malaria worker who is already trained for malaria diagnosis and treatment by recognized health organization or Ministry of Health and Sport.

Go to Myanmar side health facility refers to people received treatment from health facility which is under Myanmar Ministry of Health and Sport. Health service provider from these health facilities provide general or specialist health care, emergency care and referral treatment. This is the main difference from volunteer malaria worker.

Go to Thailand side health facility refers to people received treatment from health facility which is under Thailand Ministry of Public Health by crossing Myanmar-Thailand border.

Malaria Health Services refer to provision of health services dealing with malaria infection which includes early diagnosis and appropriate treatment of malaria (active case detection and passive case detection), refer of severe malaria patient to hospitals, symptomatic treatment and health education (World Health Organization, 2010).

CHAPTER II

LITERATURE RIVEW

2.1 Malaria

2.1.1. Malaria Infection

Malaria is still remaining as a life-threatening disease with severe complication and recognize as important public health problem. It is also a common infectious disease which contribute globally and then half of the total world population have chance to expose to the malaria infection. Malaria is endemic mainly in the tropical and subtropical area of the world. The developing countries have been suffered main impact of this disease and Africa have heaviest burden (Prothero, 2001).

Malaria is caused by *Plasmodium* species- single cell organisms that cannot survive outside the host which are mainly transmitted from people to people through the bite of female *Anopheles* mosquito. It can be transmitted by blood transfusion, vertical transmission or through the infected needle but it is not significance. There are many *Plasmodium* species in the world but 5 species of *Plasmodium* parasites cause malaria in Greater Mekong Sub regions. These parasites are *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, Plasmodium malariae* and *Plasmodium knowlesi* (Medicine for Malaria Venture, 2017).

Among these *Plasmodium* species, *Plasmodium falciparum* is accountable for malaria death (cerebral malaria) worldwide and occupied as highest prevalence in sub-Saharan Africa. However, the other *Plasmodium* species are not significantly as severe as *Plasmodium falciparum*. Then, *Plasmodium vivax* is second highest prevalence parasite of malaria disease and it is common causes of malaria in Southeast Asia and Latin America. *Plasmodium vivax and Plasmodium ovale can be reactivated without mosquito bite which contribute to clinical symptom of malaria due to hypnozoite. Plasmodium ovale* and *Plasmodium malariae* have less prevalence in Southeast Asia.

The fifth parasites, *Plasmodium knowlesi* infect to primates and cause human malaria but it is not clear for mode of transmission (Medicine for Malaria Venture, 2017).

People who vulnerable to malaria disease are young children, pregnant women, forest related workers, non-immune visitors from malaria free area to malaria endemic area and people who spend most of time in the forest. Although malaria has usually less risk to human at altitudes above 1500 m, it can survive at altitudes up to almost 3000 m in favorable climatic conditions. The risk of infection may also vary according to the seasonal variation like rain fall pattern, temperature and humidity and being highest before and after the rainy season (World Health Organization, 2017a).

2.1.2. Greater Mekong Sub Region Malaria situation

Greater Mekong Sub region (GMS) is a natural economic area bound together by the Mekong River, covering 2.6 million square kilometers and a combined population of around 326 million. The countries included in Greater Mekong Sub Region area are Thailand, Myanmar, Cambodia, Lao, Vietnam and the People's Republic of China (PRC, specifically Yunan Province and Guangxi Zhuang Autonomous Region (Asian Developnment Bank, 2017).

Malaria elimination in GMS encounter many challenges and it is different from western countries. In the late 1950, the origin of antimalaria drug resistance is started at GMS area with chloroquine resistance, followed sulfadoxine-pyrimethamine resistance, mefloquine resistance, and then declined quinine sensitivity. At the time of 2000, artemisinin resistance emerged in Thailand- Cambodia border in which chloroquine resistance had been emerged 50 year ago and this drug resistance spread to other area of the GMS countries. It is of great concern as artemisinin-based combination therapies (ACTs) are the last remaining simple, efficacious, well-tolerated treatment for *Plasmodium falciparum.*

Besides drug resistance, GMS faces largely unquantified delivery of malaria services in private sector, infiltration of substandard medication, inadequate malaria services to mobile migrant population, substandard antimalaria drug in the market and political instability & conflict in border area. Among GMS countries, malaria situation is complicated and differ from one country to another and some countries have high

prevalence of *Plasmodium vivax* than *Plasmodium falciparum* and at least 10 species of *Anopheles* mosquito are present there. Some borders area has more complex vector variation and malaria burden and endemicity are highest (Figure 1).

According to WHO recommendation and approval of GMS countries, artemisinin-based combination therapy (ACT) are first line recommended drug for *Plasmodium falciparum* species. GMS countries achieved significant progress in reducing of malaria morbidity and mortality. GMS countries reported that they reduced 81% of malaria death from 1998 to 2010. Mortality and morbidity of malaria are also impacted from environmental changes like deforestation, increasing of border trade, easily transportation, improving of national health system and distribution of health services delivery to remote area.

Then, GMS counties are officially approved for malaria elimination at 2030 and they are more emphasized to eliminate malaria by more investment and effort to National Malaria Control Program, strengthening of political will, collaboration of cross border malaria control activities and well technical input to respective organization (President's Malaria Initiative, 2015).

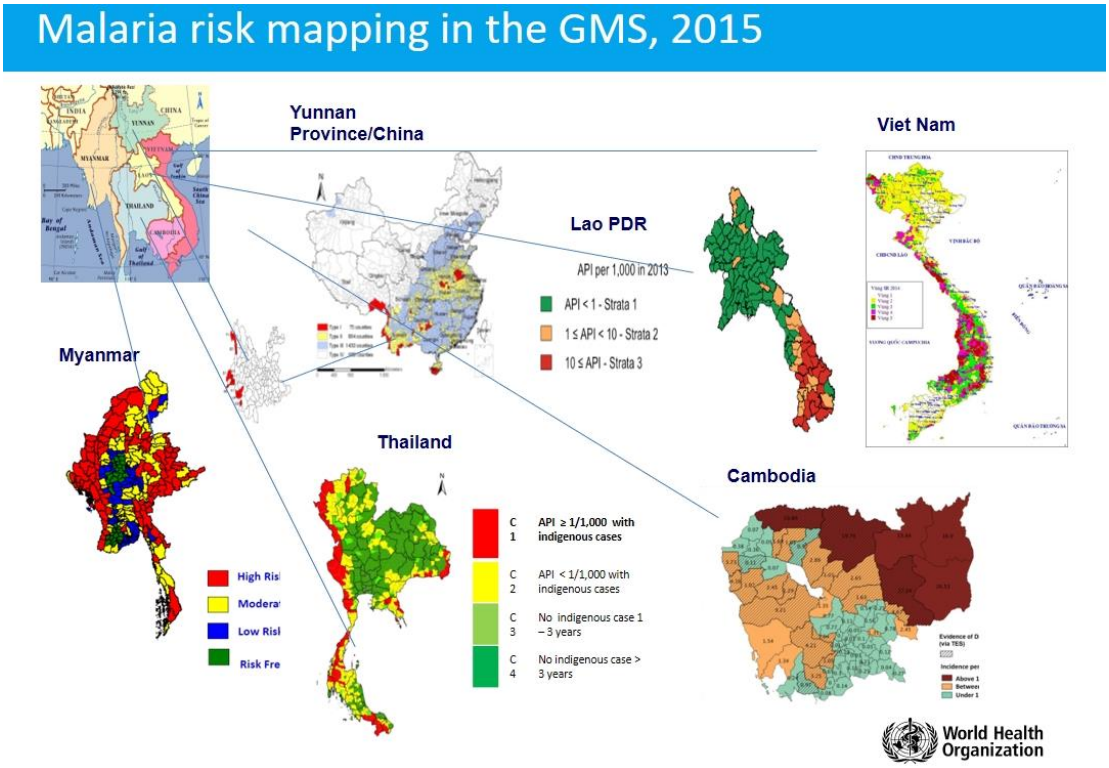


Figure 1 Malaria risk mapping of the Great Mekong Subregion in 2015 (World Health Organization, 2015e)

2.1.3. Life Cycle

Malaria parasite are circulating in two types of host by different form of parasite. (Figure 2). These two hosts are human and female *Anopheles* mosquitos. Life cycle of malaria parasite can be categorized as asexual life cycle (Human) and sexual life cycle (mosquito). Asexual life cycle begins with infected female *Anopheles* mosquito bite, ten to few hundred sporozoites are introduced into human blood stream and these sporozoites reach the liver cells within few mins to hours and multiply in the liver cells, releasing merozoites into the blood stream, also known as pre-erythrocytic phase. This phase lasts about 5-16 days depending on species. This phase is also called silent phase (single cycle) and no symptoms occur. In *Plasmodium vivax* and *Plasmodium ovale* species, some of the sporozoites may remain dormant in the liver for few weeks to months, also known as hypnozoites. It can be reactivated without mosquito bite and create malaria sign & symptoms and this process is called relapses.

Erythrocytic phase begin when releasing merozoites invades red blood cells and multiply in red blood cells. After rupture of RBC, new generation merozoites are released and invade again to other red blood cells (new cycle), creating parasitaemia and clinical manifestation appear.

When female *Anopheles* mosquito have blood meal, it picked up gametocytes from human and then, it begins again different life cycle of malaria parasite in mosquito and it is called sexual life cycle. This phase lasts about 8-15 days. The gametocytes transformed to zygote, ookinete and released again sporozoites and then, these sporozoites travel to salivary gland of mosquito. When mosquito has blood meal, these sporozoites are injected to human and start again malaria life cycle in human.

By this way, mosquito acts as a main vector for carrying malaria parasite from one human to another. But, mosquito never suffers malaria disease with the presence of parasites. It is main differences of mosquito from human (Srinivas, 2015a).

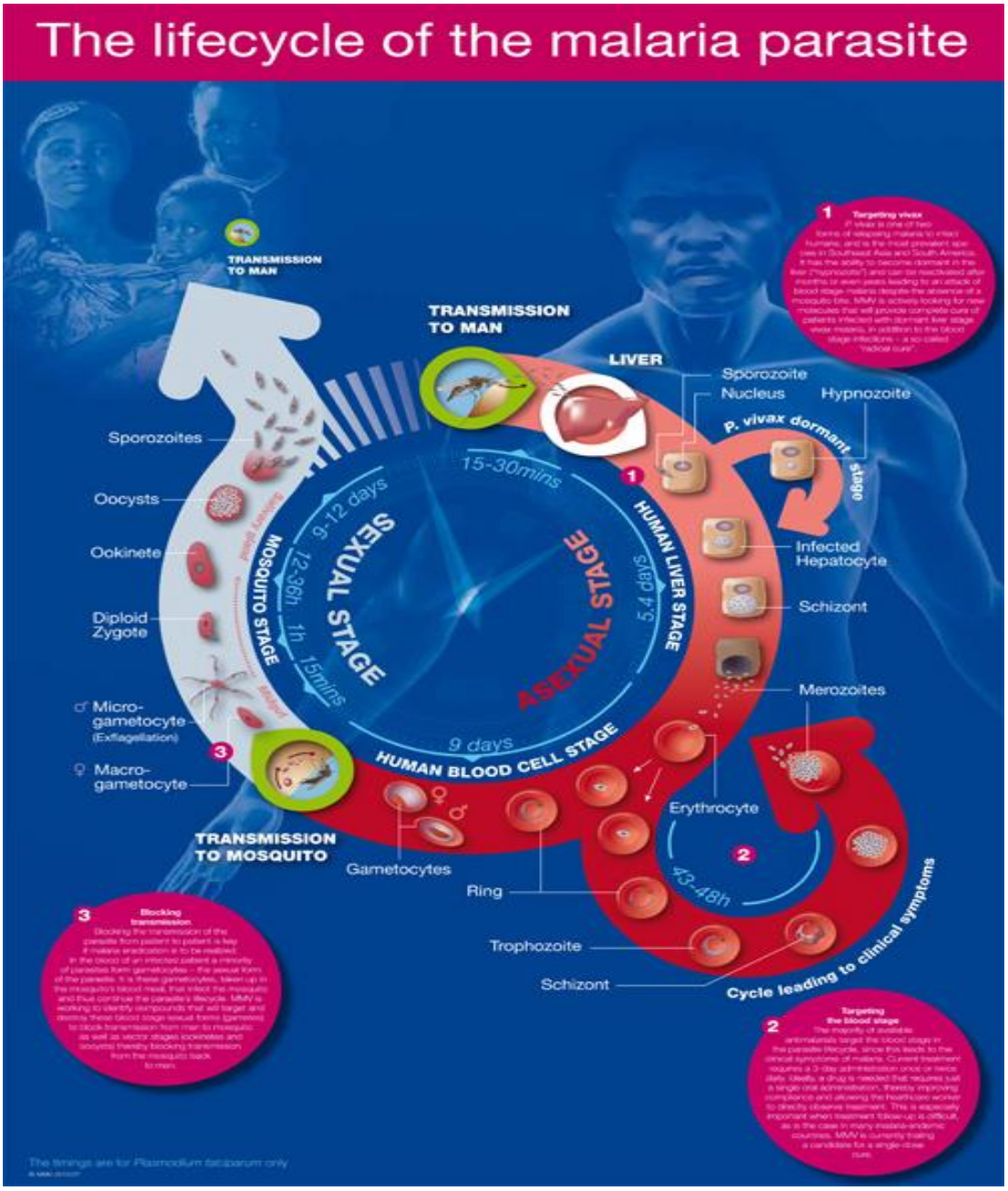


Figure 2 Life cycle of malaria parasite (Medicine for Malaria Venture, 2017)

2.2. Mosquito vector

2.2.1. *Anopheles* Mosquito

Anopheles mosquito is the primary vector for malaria disease. Except Antarctica, *Anopheles* mosquito can be found all over the world (Figure 3). There are about 400 different species of *Anopheles* mosquitoes, but only 30 of these are vectors

of major importance (World Health Organization, 2015b). Female *Anopheles* mosquito transmits malaria not only in endemic area but also in the area which are already malaria eliminated. So, the area even malaria had been eliminated have the risk of reintroduction of malaria. *Anopheles* have 4 stages throughout their life i.e. egg, larva, pupa and adult. The first 3 stages duration may vary about 5-14 days depend on species and environment temperature. Final stages, most of the adult anopheles don't survive more than 1-2 weeks in nature but sometimes they can live up to one month. Main features of *Anopheles* mosquito can be identified from other mosquito are palps which are as long as proboscis and discrete blocks of black and white scales on the wings. Adult *Anopheles* mosquitos have typical resting position: male and female *Anopheles* mosquito rest with their abdomen sticking up in the air rather than parallel to the surface on which they are resting (Centers for Disease Control, 2015a).

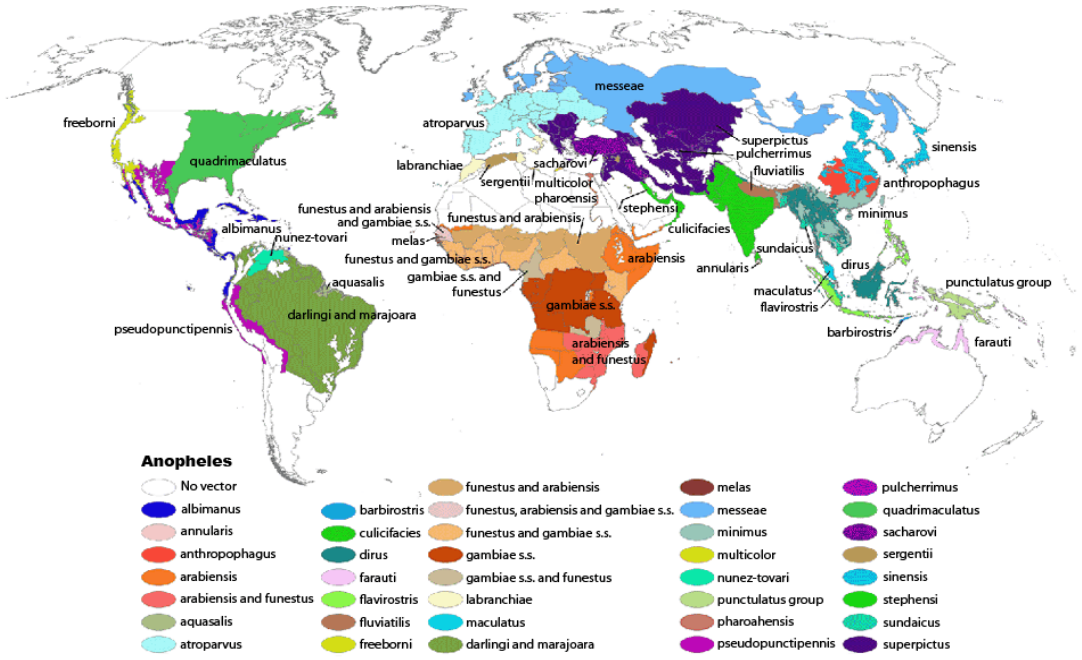


Figure 3 *Anopheles* distribution over the world (Centers for Disease Control, 2015a)

2.2.2. Life Span

Life span of mosquito cannot be measured directly in nature. Generally, malaria parasite is ingested by female *Anopheles* mosquito, this malaria parasite must take time for their developmental process before infectious to humans. The developmental process usually ranges from 10 to 21 days and it mainly depends on parasite species, environment temperature and humidity. In nature, *Anopheles* mosquito usually doesn't survive more than 1-2 weeks and extrinsic period is longer than mosquito life, therefore she will not able to distribute malaria parasite to human.

But indirect measurement is available for several *Anopheles* species by estimating of daily survivorship. For example, in Tanzania, estimation of daily survivorship of *An. gambiae* ranged from 0.77 to 0.84. It mean that 77% to 84% of this *Anopheles* will survive at the end of one day (Centers for Disease Control, 2015a).

2.2.3. Patterns of feeding and resting

Most *Anopheles* mosquitos are active at dusk or dawn in nature and which is called as crepuscular. Some *Anopheles* are active at night (nocturnal). Endophagic is that *Anopheles* mosquitos are indoor biting and rested at indoor area called as endophilic. Some *Anopheles* are biting at outside the home called as exophagic and prefer to rest at outside (Exophilic).

To control vector density, indoor residual insecticides spray, insecticide treated nets and preventing of mosquito entry to home (e.g. window screen) are effective for reduction of endophilic vector. In contrast, the best control measure for exophilic mosquito is removing of mosquito breeding sources. Mosquito repelling cream and long sleeves shirt are preventive method of exophagic mosquito (Centers for Disease Control, 2015a).

2.2.4. Breeding sites

Normally, Adult female *Anopheles* mosquito can lay directly on water and 50-200 eggs per oviposition. Hatching of *Anopheles* mosquito may differ upon climate condition. In cold climate, mosquito may take up 2-3 weeks for hatching process whereas it last 2-3 days in dry season. Clean and unpolluted water are favourite

breeding sites for most species even though they have wide range of breeding sites. The breeding sites of *Anopheles* mosquitoes are in fresh or salt-water marshes, rice fields, grassy ditches, mangrove swamps, the edges of streams and rivers, and small, temporary rain pools. Some *Anopheles* species like vegetation habitats but other didn't like this condition. Some mosquitos are found in open, sun-lit lake while others prefer to breed in shaded area of forests. Then, Some mosquito breed in the leaf axils of plants or tree holes (Centers for Disease Control, 2015a).

2.2.5. Mode of transmissions

Malaria is transmitted normally by the bite of female *Anopheles* mosquito with malaria parasites. The intensity of transmission depends on parasite, vector, host and environment. A blood meal is need for female *Anopheles* mosquito to foster its eggs. The female *Anopheles* mosquito carry malaria parasite (sporozoites) in their salivary glands and introduced to host when the mosquitos take a blood meal. These sporozoites affect human and will be experience about malaria symptom after several weeks. Infected blood transfusion, maternal to child transmission and sharing of syringe and needle with infected contaminated blood are also mode of transmission of malaria but it has less potential (Centers for Disease Control, 2015a).

2.3. Diagnosis of Malaria

2.3.1. Sign and Symptom of Malaria

According to WHO, common symptom of malaria infection is acute febrile illness. Malaria can begin with flu like symptom. Sometimes, malaria can show no symptom or symptoms that are less severe if patient have partial immune to malaria. Symptom may appear in a week (mostly 10-14 days) especially in non-immune people after biting of infective female *Anopheles* mosquito.

The common symptoms of malaria infection are fever with chills and rigor, headaches, sweating, fatigue, nausea and vomiting and sometimes abdominal pain, muscular aching and weakness, cough and diarrhoea may show as malaria symptoms. If it is being not treated within 24 hours after having symptom, parasite can reach to

brain and cause cerebral malaria and deaths especially *Plasmodium falciparum*. Therefore, early diagnosis and treatment with 24 hours is the most important factor in malaria control and prevention. Pregnancy and children are most vulnerable person to malaria. Children with severe malaria show the symptom of respiratory distress which are related to metabolic acidosis and finally get cerebral malaria. Some people living in malaria endemic area have asymptomatic malaria infection due to partial immunity (World Health Organization, 2017b).

2.3.2. Diagnosis and treatment

A. Diagnosis

Early diagnosis and treatment are the most essential intervention in controlling of malaria morbidity and mortality and reduction of transmission. There are 5 different methods for malaria diagnosis. These are

1. Clinical diagnosis
2. Microscopic diagnosis
3. Antigen detection
4. Molecular diagnosis
5. Serology

- **Clinical diagnosis**

Clinical diagnosis is made by expert depend on patient symptoms and physical finding during physical examination. These sign and symptoms vary depend on severity of malaria and patient immune status. Clinical diagnosis should be confirmed by laboratory test.

- **Microscopic diagnosis**

Microscopic diagnosis is the gold standard for malaria diagnosis under ideal condition. The sensitivity and specificity of this diagnosis vary with quality of reagent, microscopy and experience of laboratory technician.

- **Antigen detection**

Antigen detection diagnosis is most popular method of malaria diagnosis. It is detected to antigen derived from malaria parasite by test kit. Various test kits are available in the market and it have many advantages like easy to use, rapid result and no need for instrumentation and refrigeration. WHO recommended that rapid diagnosis test is being suitable for malaria diagnosis.

- **Molecular diagnosis**

Molecular diagnosis is detection of parasite nucleic acids using polymerase chain reaction technique. It has limited utility for malaria diagnosis due to high cost and special technical issues, even this technique has more sensitive than microscopy and RDT.

- **Serology**

Serology is detection of antibodies against malaria parasites using immunofluorescence (IFA) or enzyme-linked immunosorbent assay (ELISA). It is detection of post exposure of malaria and not in current infection. It is not useful in diagnosis of malaria (Centers for Disease Control, 2015a).

B. Treatment

There are many drugs for malaria treatment but some drugs have been resistant to malaria. So, WHO recommended treatment guideline for malaria depend on country situation, severity and resistant strain of malaria. Artemisinin based combination therapy (ACT) is first-line recommended treatment for malaria infection especially *Plasmodium falciparum* in GMS countries. Primaquine is effective in prevention of relapses and reduce transmission by gametocidal action. Pregnant women and G6PD patient are contraindication for primaquine (World Health Organization, 2015d).

2.3.3. Treatment Seeking Behavior

Treatment seeking behaviors is the most important part of the malaria control intervention. Well understanding of malaria treatment seeking behavior help to improve strategies for malaria elimination. Even many malaria health care facility and health

service delivery are present, people didn't have sufficient knowledge about health seeking behavior and it may be ineffective. If community delays to find malaria health services, the severity of diseases and adverse consequences will increase. Treatment seeking behavior is mainly a subjective awareness which may affect perception of community. If community has enough awareness to seek health care facility, it may be one of the most effective intervention to eliminate malaria. Treatment seeking behavior varies with these factors (Borah, 2010).

A. Awareness and perception
B. Self-treatment
C. Affordability
D. Sources of information

A. Awareness and perception

Health care seeking is viewed as time requirement for problem assessment and decision making to seek appropriate health services and it is labelled as "procrastination" but some factors may interfere about delay in health care seeking without patient/family control. These factors are socio-economic status, family support, income, previous access to health facility and transportation. The knowledge of causation, spread and prevention of the disease and perception of the community may shape the treatment seeking behavior of the people when people suffer fever in malaria endemic area. Most of the patient from remote area report lately to health care provider. They try to find treatment firstly from traditional healers and quack due to their social culture and believe. Some study report that the main cause of delay to seek health service delivery is traditional healer and quack. In hard to reach area, traditional healer and quacks are easily assessible for community and patients prefer to go to these providers compared to urban area. In a study in Northeast India, it was found that treatment seeking for febrile illness was self-medication (17.8%), traditional healer (Vaidya 39.2%), government (29.3%) and private (19.7%) health services. Therefore, community awareness and perception to malaria was important factor for distribution of proper malaria services delivery (Borah, 2010).

B. Self-treatment

People presented with fever is a common symptom for suspected malaria cases in endemic area. Fever is not important symptom for patients who are living in endemic area and they take treatment themselves at home by taking anti-pyretic drug (paracetamol). But they go to health service center when they suffer fever for a long time and more severe and disturb their usual work. Patients are more likely to start with self-treatment at home as this allow them to minimize expenditure. This have some benefits for them like reducing of time loss and cost but it is the main reason of delay of seeking health service delivery and create unnecessary disease consequences (Borah, 2010).

C. Affordability

Financial cost is one of the main important factors to find reliable health care service delivery. Even government given free health care services delivery to the community, people have to spend money for transportation. The loss of money from work and time loss due to illness are important determinant for reliable treatment seeking behavior. In a study conducted in Philippines, it reported that financial determinants were the main cause of failure to seek proper health service delivery even community have well awareness of treatment seeking behavior and well health services center. Therefore, financial requirements are important role to decide to seek well proper health care facility (Espino E, 1992)

D. Sources of information

Information of health care service center and how to seek health care delivery are one of the most important factors for improving treatment seeking behaviors. In rural area, patient may find difficulties about finding of malaria services, even patient have enough awareness and sufficient financial budget because they didn't know about the information of malaria services. So, providing of well information about malaria services is one of the health determinant for malaria control and prevention (Mozumder et al., 2007).

Early/late treatment seeking behavior

Treatment seeking behavior is the most essential part of malaria control and prevention. Treatment seeking behavior is influenced by several factors such as patient level of education, perception of community, disease severity, socio-economic status of household (Mwenesi, 2005). WHO recommended that all malaria patients should be received early diagnosis and effective treatment within 24 hours after onset of symptom. By conducting early treatment seeking behavior, it causes the reduction of severe malaria complication, mortality and morbidity rate and decline onward transmission. The risk of death due to severe malaria (Cerebral malaria) is highest within 24 hours after onset of fever, but some people didn't seek malaria treatment and delay for the start of antimalarial treatment especially in endemic area (World Health Organization, 2015b)

Some people especially from rural area had delay treatment seeking behavior and most of the delay patient are far away from health facilities. So, easily access to health services is main determinant factor for appropriate treatment seeking behavior. Moreover, children and poorest economic status household have improper treatment seeking behavior and delay of appropriate treatment due to financial problem and lack of knowledge of caregivers on malaria symptoms in malaria case of children (Romay-Barja et al., 2016).

Moreover, way of appropriate treatment seeking behavior is vital in malaria elimination. Migrant people should be received appropriate treatment from health facility or well-trained volunteer health workers regardless of their migrant status. If they will receive treatment from unqualified medical person or self-treatment, they will be severe and may death.

2.4. Prevention and control of malaria

Although early diagnosis and effective treatment is critical component in malaria elimination, the significance of protective measures and vector as well as parasite density control must not be neglected. These measures can diminish malaria infection in the community and prevent further transmission. Preventive and control measures include (1) early diagnosis and effective treatment, (2) personal protective

measures, (3) chemoprophylaxis, (4) indoor residual sprays and (5) mass drug administration (World Health Organization, 2003).

2.4.1. Personal protective measure

Personal protective measure is a protection of mosquito bite and it also reduces time of human mosquito contact. These measures include uses of insecticide treated nets (ITN), wearing of long sleeves, uses of mosquito repellent cream and chemoprophylaxis. ITN usage is a basic and popular method in malaria prevention and control strategy. Insecticide treated net is a net which are treated with insecticide and it is made from polyester, polyethylene, or polypropylene. Although ITN kill not only mosquito but also other insects, it advantages is very low health risk to human. ITN reduce number of mosquito in the community as well as parasite density. Nowadays, some study reported some mosquito have resistance to ITN but it is still successful and effective preventive measures in malaria control (Centers for Disease Control, 2015b).

Another personal protective measure is mosquito repellent cream. Normally, mosquito find human by detecting carbon dioxide which comes from human breath as well as skin. Mosquito repellent cream includes synthetic and natural substances which inhibit detection of mosquito to human and then, mosquito biting to human also reduced. Although mosquito repellent cream is effective preventive measures, it can't decline mosquito and parasite density. Therefore, another intervention measure is needed to reduce parasite and mosquito density (Srinivas, 2015c).

Moreover, other methods for prevention of mosquito bite are use of window screen in the house, mosquito coil uses and wearing of long sleeve shirt. Mosquito coil usage can prevent from mosquito bite but it causes respiratory disease. Wearing of long sleeve is effective preventive measures especially in children and it reduce human mosquito contact area (World Health Organization, 2006).

2.4.2. Indoor residual spray

Indoor residual spray is popular method of vector and parasite control measures and National Malaria Control Program is currently using this method in some area. Indoor residual spray is coating of insecticide to the wall and other surfaces of the household and it has killing effect to mosquito and other insect when they rested on

these insecticide spray areas. The most important point is that insecticide should be sprayed more than 80% of targeted area. The negative impact of this measures is that emerging of drug resistance to this insecticide is coming out again (Centers for Disease Control, 2012b).

2.4.3. Chemoprophylaxis

Chemoprophylaxis, seasonal malaria chemoprevention is taking of full course antimalarial treatment especially in children during high seasonal transmission time in endemic area to prevent malaria infection. According to WHO Seasonal Malaria Chemoprevention guideline, drug of choice for chemoprophylaxis is sulfadoxine-pyrimethamine plus amodiaquine and it is 3 days regimen. It is quite effective in Africa but it has different effectiveness in chemoprophylaxis depend on region or country (World Health Organization, 2013). National adaption of chemoprophylaxis is different with national malaria control program of each country. In Myanmar, National Malaria Control Programme did not practice chemoprophylaxis as preventive measures.

2.5. Malaria Immunity

Malaria immunity can be defined as the ability of human to resist malaria infection through the different processes which included destroying of *Plasmodium* species and limiting multiplication in human. Malaria immunity can be classified two types; Natural/ innate immunity and Acquired immunity (Doolan et al., 2009).

Natural/innate immunity is an inherent possession of host in which human genetic conducted immediate inhibitory response to parasite introduction and this process is naturally present in the host and not related with previous malaria infection. Then, people with sickle cell trait have protection effect to malaria infection especially *Plasmodium falciparum* species because sickle cell trait (abnormal hemoglobin) prevent the infiltration of *Plasmodium* species to red blood cells and this process can be frequently found in Africa. Moreover, other hemoglobin related disorders have relatively protected against malaria infection and these disorders are Thalassaemias, G6PD deficiency, Hemoglobin C, Hemoglobin E and ovalocytosis. People with Duffy

blood group negative are also against to *Plasmodium vivax* (Centers for Disease Control, 2012a)

Acquired immunity is immunity against malaria infection which develops after getting of malaria infection and its protective effect vary with characteristics of host/community, period of stay in endemic area, number of malaria attack and severity of disease. There are two types of acquired immunity; Active acquired immunity and Passive acquired immunity. Active acquired immunity is the development of host defense mechanism or production of antibodies against malaria infection as a result of previous experience of parasite. Passive acquired immunity is injection of protective substance to the host or transfer of mother malaria protective antibodies to children during prenatal or postnatal period. Then, acquired or adaptive immunity have been classified again as antidisease immunity, antiparasite immunity and premonition. Antidisease immunity is protection against clinical disease with affecting risk and extent of morbidity. Antiparasite density is protection against high parasitemia which affect parasite density and premonition, also known as sterilizing immunity, is protection against new infection with generally asymptomatic parasitemia. Here, Protection is defined as objective evidence of a lower risk of clinical disease which allowed parasitemia without symptom.

Acquired immunity usually develops in adult but it is not occurred in infant and young children. The particular features of acquired/adaptive immunity were (i) effective in adult after uninterrupted lifelong heavy exposure which allowed accumulation of antigenic memory to plasmodium, (ii) lost after cessation of exposure, (iii) species and stage specific and (iv) acquired rate depend on degree of exposure. Therefore, efficacy and effectiveness of acquired immunity vary with several factors. For development of acquired immunity, people need to expose frequent and multiple infection which allow accumulation of antigenic memory to plasmodium species that result very low or undetectable parasitemia (Doolan et al., 2009).

The duration of acquired immunity to malaria infection is not too long. When people leave malaria endemic area or absence of reinfection for six months to one year, the already developed acquired immunity become ineffective and they are vulnerable to malaria infection when they exposed again. The effect of immunity also reduced in

pregnant women due to physiological immunosuppression and this is also the reason why pregnant women are more vulnerable to malaria infection (Srinivas, 2015b).

2.6. Malaria Vaccine

Multidimensional approach is required in the route of malaria elimination. Malaria vaccination will be one of the effective intervention methods in the way of malaria elimination but it is still in progress. Regarding malaria vaccine, there are 3 types of vaccines; (i) Pre-erythrocytic vaccine (ii) Blood stage vaccine and (iii) Transmission blocking vaccine. Pre-erythrocytic vaccine is successfully produced and already finished phase III trial but the remaining vaccines are step in laboratory (Philadelphia, 2017).

Pre-erythrocytic vaccine, RTS, S/AS01 malaria vaccine is the world's first and, to date, the only malaria vaccine which offer partial protection effect to *Plasmodium falciparum* in children. RTS, S/AS01 is combination of circumsporozoite protein and hepatitis B surface antigen which inhibit introduction of sporozoite to liver cells. Recently, the RTS, S/AS01 vaccines was tested in phase III trial in 11 different countries and this vaccine has been shown protective effect to malaria infection.(Schuerman, 2017) Moreover, WHO allowed that this vaccination program will be started in Ghana, Kenya, and Malawi countries as routine immunization program of young children in 2018 (pilot introduction / Phase IV study). Therefore, malaria vaccination will be effective intervention method of malaria elimination strategies in the future (Malaria Vaccine Initiative, 2017).

2.7. Migration

2.7.1. Population Movement

In general, people movement occur when they think that this environment cannot provide their requirement. Even this environment is enough to satisfy, some people believe that movement to new place will provide new, challenging and attractive opportunities. This movement can be understood by the two factors: "push and pull factors". "Push factor" mean that lack of employment, environmental degradation,

economic instability, conflict, population pressure on land and disaster. “Pull factor” could be explained by better economic situation, improve living condition, economic, or social opportunities, political stability and improvement for career. Most of push and pull factors perform simultaneously; for example, people can be pulled by better economic situation and improvement for career at new environment and people can be pushed by lack of employment, political instability, conflict and environmental deterioration (Martens et al., 2000).

Regarding malaria migration, population movements are categorized as two types: spatial and temporal dimensions. Spatial dimension can be defined as people move from place to place which have epidemiologic importance differences such as malaria free area or endemic area. There are two types in spatial dimensions: active transmitter and passive acquirers. Active transmitter is defined as people from endemic area carry *Plasmodium* species and move to low or sporadic transmission area and distributes disease. Passive acquirers mean that people have been increased risk of disease when they move to high endemic area because they may have no immune or low level of immunity.

Temporal dimensions include two types of movement: circulation and migration. Circulation makes no significantly change of local residence although it comprises a different kind of movements, which are usually short-term and cyclical. Circulation can be divided into 4 categories; daily, periodic, seasonal, and long term. Daily circulation means that people leave from their place up to 24 hours. Although periodic circulation is usually shorter than seasonal circulation, it can range from 1 night to 1 year. When the duration of circulation is marked by seasonality (physical or economic), this circulation is called seasonal circulation. Long term circulation is that people will leave from their community more than one year and it is associated with their socioeconomic reasons and then, they have planned to return. Laborers and traders are included in this group. Even circulation cause population movement from place to place, but it can’t make significant change of population density. However, migration creates a permanent change of residence/ population density. This is main differences of circulation and migration (Martens et al., 2000).

2.7.2. Border Malaria Epidemiology

Border malaria has more complex and complicated epidemiological setting and it include forest and migration related malaria, both supporting for certain transmission in border area which possibly causing a trend of increased incidence along Myanmar-Thailand border area. Then, this perform interconnection between human colonization and migration activities, cross-border migrations and malaria partial immunity, vector density, ecological changes, and multidrug resistance (Bhumiratana et al., 2013).

Local resident lives along the Myanmar-Thailand border area have increased risk of malaria infection because their villages are located in the forests or near the borders which are highly associated with high vector and parasite density. Among local resident who are living along the Myanmar-Thailand border area, adulthood malaria is more prevalence than childhood malaria due to nature of forest worker activities like farming, rubber plantation, logging, bamboo cutting, foraging, charcoal and goal mining, and hunting. Most of these forest workers spend and stay the whole night/ week at the forests.

The vulnerable population, migrant worker usually practiced malaria risk behavior like improperly method of preventive measures during staying in high endemic area or crossing the border area and then, they have chance to expose malaria infection due to occupational exposure such as agriculture, gold or charcoal mining, forestry, road construction, and tourism. Although malaria can transmit to all people, it seems to be dynamic between migrant worker and local resident of endemic community due to immunity difference. Then, some migrant workers come from central dry zone of Myanmar and migrated to Thailand as host country. Economic typically accelerated for population movement from place to place, while politics stability and human securities perform some minority group and refugees' migration. Therefore, a lot of population movement occurring in the border area. They are important role in transmission of malaria especially drug resistant malaria in border area and operate as importer of malaria infection from endemic area to non-endemic area at the same time as contributing to the entanglement of public health efforts between Myanmar-Thailand border area (Bhumiratana et al., 2013).

2.7.3. Global Migration

Nowadays, Global population is increasing and population density distribution is different. Migration is one of the three demographic components of population change in the world and it has often been described as the most difficult to measure, model and forecast. Migration is complex and complicated event in which most of the migrant workers moving with different time, different route of travel and different designation place. Migration is also permanent move or complex series of backward or onward movements. Moreover, the global migration system has changed over recent decades with regard to the origins and destinations, as well as the volume and types of migrants. Countries that were once origins of migration became destinations of migrants and vice versa. Both countries have suffered the effect of immigration and emigration (United Nations, 2013).

Globally, there were an estimated 258 million international migrants in 2017. Among these migrants, nearly 57 percent of migrant worker lived in the developed countries and 43 percent of migrant worker stay in developing region. The number of worldwide migrant workers increased by 105 million between 1990 and 2017. Most of this increasing migration are took place during 2005 to 2017. Asia and Europe contributed over 60 percent of all international migrants worldwide in 2017 and 80 million of international migrant workers living in Asian and 78 million in Europe. Since 2000, the fastest growth of migrant population in world is occurred in Asian and followed by Europe and Africa as second fastest growth. Moreover, Asian experienced the largest regional migration (Asian to Asian) in the world, with 63 million of international migrant workers moving from one countries to another within the Asian region in 2017 (United Nations, 2017).

The main driver of migration is economic and most of the migrant workers move to better economic situation and developed countries. Most of the developed countries focused on highly skilled migrant workers and technical expert from developing countries and then, these make to boost productivity through innovation and specialization in their countries. This is one of the reasons for brain drain in the developing countries. Global migration produces different impact depends on country and nature of migration. These migration effect on economic of both countries, climate changes, domestic institution and politics, values and attitudes on gender, conflict and

criminal activities of both countries. Therefore, Immigration and border control policies are need to prevent the negative consequence of migration (World Bank, 2010).

2.7.4. Migration in Greater Mekong Sub-region countries

Migration has been occurring in Greater Mekong Sub-region countries for centuries, most of this migration are informal and causal event. There are difficulties to get reliable information on true size of migration flow in GMS countries due to irregular and informal process. Recent year, cross border migration is increasing significantly due to development of border trade and opening up of border. The migration flow will continue to grow in coming year due to different demographic transition and uneven patterns of development in GMS countries. The increasing of migrated people and migration flow is likely to increase and irregular with negative consequences for both sending and receiving countries, unless government will conduct with greater efforts for migration policy and management of this migration flows. Generally, the sending countries lack the capacity for properly management of the mass export of labor and protection the rights of their migrant-nationals in abroad. Receiving countries have fairly weak migration policy frameworks, which often have been implemented hastily as an 'after-the-fact' response to the arrival of large numbers of migrants (World Bank, 2006).

With the most advance technology and transition from an agricultural to industrial base production and export driven economy, Thailand achieve better economic situation among GMS countries and becoming main receiving country of migrant worker in GMS countries. The higher incomes and wage levels, fast growth, more favorable social and political climate and better education make Thailand act as magnet for people in surrounding countries and it favoring for migrating to Thailand. Migrant represent an important reservoir of cheap and flexible labor and it make a boost to its competitiveness in certain sectors of Thailand. Infrastructure & technology development and the related growth of the transportation sectors also affect for increasing of labor flow. Then, migration to Thailand is further strengthened by demographic difference within the GMS countries because youth population of Thailand is less than neighboring countries. So, most of the Myanmar migrant worker crossing the border area and migrate to Thailand with opening of Myanmar-Thailand border (Caouette et al., 2007).

Migration is mostly irregular in the region, and there are very few ways to capture this. An estimated 5 million of migrant workers are moving within the GMS countries. Some migrant workers are official and some are illegal and so, they have difficulties to access full coverage of health services. Moreover, Universal Health Coverage are achieving in Thailand and government give health services for the register migrant in Thailand (Asian Developnment Bank et al., 2013).

2.7.5. Migration Pattern in Thailand-Myanmar border area

Migration is now popular in basic workers and many migrant people are passing through the Myanmar-Thailand border and moving to better economic situation. With much border migration, migrant worker transport malaria from place to place and supposing to be increased risk of malaria in malaria free/less risk area. Therefore, understanding of population movement pattern in border area, socioeconomic, environment and seasonal changes as well as political changes are critical for malaria control, prevention, containment and elimination (Jitthai, 2013). In Myanmar-Thailand border area, a lot of people are moving from place to place by different pattern of migration. Generally, Migration can be divided in two forms of migration.

(1) Internal Migration

(2) Transnational migration

As internal migration, the main reason of migration is economic and millions of people are migrating from place to place to find out better economic opportunities. In Myanmar, most of the internal migrant worker are coming from central dry zone and migrated to Yangon and Mandalay which have a lot of economic development area. Then, a huge population, from the central dry zones and costal area of Myanmar move to border area especially Myanmar-Thailand border area as transnational migration due to well formation of border trade and many developmental projects in this border area. Then, International migration is migration of people from one country to another country through the crossing of one's country border to a neighboring country, but this process is quite complicated. Migration processes are very common in GMS countries which act as sending, transit, and receiving countries. For instance, some Myanmar

migrant pass through Thailand and designate to Malaysia. Migrant group is small but involve large number of population, spontaneous and most of these migrant workers are illegal. Therefore, this makes it difficult to give appropriate health services to them and it is also most vulnerable part of the community

Moreover, some factors are encouraging for migration not only internal but also transnational. These factors are

- Infrastructure and rural development
- Deforestation due to logging and farming
- National development plans and demographics change
- Political factors affecting migration
- Natural disasters
- Socio-economic situation.

According to these situation, migration workers moving from place to place are popular and volume of migration are becoming larger (Jitthai, 2013). With expanding of migration, danger of malaria and drug resistant problem are broadened.

In international migration, the pattern of migration in Myanmar border area can be classified according to malaria transmission.

- People cross Myanmar-Thailand border and work at Thailand/Myanmar for a certain period
- People cross Myanmar-Thailand border and work at Thailand/Myanmar for seasonal variation
- People crossing the border daily
- People did not pass the border and stay at their village
- People did not pass the border but they go to forest or another village

Risk of malaria infection may vary with pattern of migration due to variation of source of infection, breeding sites, vector density, treatment seeking behavior and protective behavior.

2.7.6. Treatment seeking behaviour of migrant people in border area

The success of malaria elimination strategies is closely linked with treatment seeking behavior of people especially migrant workers. They are more vulnerable

community and easily to get malaria and difficult to control. In Thailand-Myanmar border area, there are large volume of Myanmar migrant worker, ethnic group, internally displaced persons (IDP) and refugees in camps. These people are lack of health services and most of migration are solved their health problem by self-treatment and some crossed the border and receive medical services at Thailand side. Incomplete treatment course, self-treatment, financial problem and difficult access to health services are main problems of migrant people which cause emerging of drug-resistant malaria and difficulty to control malaria.

Most of the people cross the border and seek treatment at Thailand site due to easily pass through the border crossing point. For examples, many patients from Myanmar border area cross the border and receive treatment from Thailand hospital because health facility in Thailand are easily assess, well equipped, easy transportation compared with Myanmar health facility. Migrant workers are less likely to get early diagnosis and radical treatment than the general population (Hiwat et al., 2012).

Migrant workers and local border resident have practiced improper health-seeking behaviors, purchasing of antimalarial drug from drug store without malaria and self-treatment like tepid sponging, taking paracetamol. Moreover, inadequate health services in border area encourage local resident to conduct health seeking behavior from quacks and then, they provide arteminisinin monotherapies, unqualified antimalarial drug, resulting in an increased risk of antimalarial drug resistance (Wangdi et al., 2015).

Efforts to solve these issues should be done by improving of migrant health information system which should involve advocacy to local authority and community, migrant mapping to catch malaria positive mobile migrant patient and strengthening of surveillance system. All migrant workers regardless of their migrant status should easily receive malaria health education and information, malaria preventive and protective measures, early diagnosis and effective treatment. Migrant information system should be ensured that all migrant workers are provided with appropriate malaria knowledge and sufficient protective measures, all positive cases must be treated with national treatment guideline and then, surveillance system captured to all positive migrant patient (Wangdi et al., 2015).

2.8. Review of relevant finding

In case control study which was conducted to determine association between socio-demographic and behavioral factors and malaria infection among migrant foreign nationals. This study targeted to migrant foreign nationals who are over 15 years of age and living along the Myanmar-Thailand border area (malaria endemic area) between June and December 2002, two hundred seventeen malaria positive cases and 217 malaria negative patients attending the malaria clinic in Kanchanaburi Province and in Chiang Rai Province were interviewed by well-trained interviewer in local language.

The result showed that major type of malaria was *Plasmodium falciparum* (60.8%), second common type was *Plasmodium vivax* (36.4%) and mixed infection was the least (2.8%). Major occupation was forest related workers which are accounted for 65.2%. There are significantly higher proportion of the malaria negative people were attended to primary schools ($p = 0.009$). Race, marital status, occupation and family income have no significant difference of malaria infection. According to logistic regression analysis (with control of cofounding factors), residence stayed in the forest had increased risk of malaria infection by a factor of 6.29 (OR = 6.29, 95% CI = 1.56-25.42); outdoor stay < 7 and ≥ 7 days also increased malaria risk by a factor 4.34 and 4.13 respectively (OR = 4.34, 95% CI = 1.05-17.99; OR = 4.13, 95% CI = 1.29-13.13) (Chaveepojnkamjorn et al., 2004).

World Health Organization has recommended that all malaria patient should be receive early diagnosis and appropriate treatment within 24 hours after showing of the symptoms to reduce the consequences of severe malaria and spread to another transmission (World Health Organization, 2015d). In malaria elimination, all various people must assess malaria health services and appropriate health seeking behavior should be done. WHO recommended that all malaria patients should seek health services immediately when they suffer symptom of malaria like fever. Most of the delays in seeking treatment may be self-treatment. This delay may encourage to patients develop severe complications within 3 to 7 days. In contrast, *Plasmodium falciparum* patient may suffer these complications within few hours of onset of symptoms and lead to death. Previous study had reported that delay in seeking malaria treatment occur about 79.4% of malaria patient in the five districts of Tak Province along Thailand-

Myanmar border. Cross sectional study was conducted to know factor affecting delay in seeking of malaria treatment among malaria patient.

64% of respondents had conducted self-treatment like taking an antipyretic available at home, purchasing of antimalarial drug and tepid sponge before seeking treatment. Respondents had previously sought health seeking behavior at a malaria clinic, public hospital, sub-district health promotion hospital, and malaria post (20%, 11.0%, 3.3% and 1.1%, respectively). Moreover, some patients who attended to malaria clinic were malaria negative (parasitological method), even these patients showed symptom of malaria. 79.4% of patients seek malaria treatment from health facility beyond 24 hours after onset of symptom. The median time for treatment seeking behavior is three days. In multiple logistic analysis, delay in health seeking behavior was significantly associated with hill tribe ethnicity (adjusted OR=2.32, 95% CI: 1.34-4.04), *P. vivax* malaria (adjusted OR = 2.02, 95% CI: 1.19-3.41), self-treatment (adjusted OR = 1.73, 95% CI:1.04-2.85), and with low social support (adjusted OR=2.58, 95% CI: 1.24-5.35) (Sonkong et al., 2015).

Nowadays, National Malaria Control Program (NMCP) emphasized upon cross-border malaria transmission because it is an important issue in the way of malaria elimination. Moreover, among malaria endemic area, epidemiology of cross-border endemic area is quite complicated and difficult to solve. Previous study reported that on the northwestern Thailand-Myanmar border, *P. falciparum* is likely regarded as imported malaria whereas *P. vivax* is also locally transmitted *Plasmodium* species.

In this study, between 2011 and 2014, Malaria case data collection were done from malaria clinics in Suan Oi village, Tak Province, Thailand and microscopy was conducted to confirm diagnosis. Recent migrant worker had almost four-time risk for malaria infection (*Plasmodium falciparum*) compare with local resident (OR= 3.84, $p < 0.001$) and seasonal migration had significantly association with malaria cases. Then, the *Anopheles* mosquito capture rate was not associated with *P. falciparum* infection and this indicated *P. falciparum* is predominantly imported infections. However, recent migrants and mid-term migrants had equally chanced in getting of *Plasmodium vivax*. Local Thailand resident had less twice likely to get *Plasmodium vivax* in compared with recent migrant and mid-term migrant (OR= 1.96 and OR= 1.94, respectively). Then, *Plasmodium vivax* were strongly associated with mosquito capture rate especially two

major local vector species; *Anopheles minimus* and *Anopheles maculatus* (OR= 1.23 and OR= 1.33, respectively), supposing that *Plasmodium vivax* be main causes of high level of local transmission (Sriwichai et al., 2017).

Knowledge, attitude and practice are important part of malaria control. Khaing Nyan Lin conducted a study at Palaw township, Tanintharyi region regarding malaria knowledge, attitude and practice. This study showed that 50.7% of respondent had good knowledge, 16.3% of community distributed good attitude but good practice contributes only 6.5% of respondent. This study reported that knowledge of malaria is significantly associated with prevention practice ($p<0.001$) and attitude regarding environment prevention, treatment seeking behavior is also significantly correlated with prevention practice ($p<0.001$). Therefore, Palaw township residents have enough knowledge and attitude dealing with malaria but prevention practice is a little insufficient (Linn et al., 2017).

Countries moving toward the malaria elimination must face and solve imported malaria infection and this imported malaria can create most of the cases, again transmission, resurgences and reintroduction of malaria inside the countries which already free of malaria. Imported malaria is defined as any malaria infection whose origin is outside the country and this infection is carried by traveler or migrant worker. Therefore, to solve the imported malaria issue, multiple strategies and many supports are needed.

Improve health infrastructure is one of the essential requirement in malaria elimination. To prevent onward transmission of imported malaria, early diagnosis and effective treatment should conduct among the migrant worker and traveler by establishing of health facility at the border crossing point and along the migration route, border malaria screening (traveler who come from malaria endemic area), should conduct at entry of country like border checkpoint, ferry terminals and airport. Active surveillance system should be catching all malaria positive patients. All the imported malaria infection must be rapidly reported to national malaria control program or local health authority for conducting of necessary intervention to prevent onward transmission. Then, visitor or migrant worker traveling to and from malaria endemic area must be received malaria related information, preventive measures and prophylactic drug (Sturrock et al., 2015).

GMS countries regarded as mobile migrant population is a key population in the route of malaria elimination in Southeast Asia's Greater Mekong Sub-region. With the development of border trade, mobile migrant worker joined to agriculture and road construction site, most of these sites are located in hard to reach area where has high malaria prevalence rate. Those workers have lack of experience with malaria infection, inadequate malaria health services and improper prevention practices. Their native communities, malaria free area have risk of malaria infection when they come back to their home by carrying of malaria parasites with them (Control and Prevention of Malaria, 2014).

One study conducted at India showed the factors affecting treatment seeking behavior for febrile illness in Malaria endemic area. Most of the respondent sought treatment by different way from different provider. 37% of respondent sought treatment at government health center and 24.3% of respondent went to community health volunteer. Some people (32.3%) went to unqualified medical provider even community health workers are present at their village. Then, community choose health care provider by different reason. Two third of respondent choose nearest health provider as proximity reason and the other reason were low cost of care, faith on provider and attitude of the health care provider

The most common factor for delay of appropriate treatment seeking behavior is negligence. Although malaria health services are easily accessible in the community, some people did not take any medical treatment and would carry their routine work until they are unable to conduct their function any longer. The other factor for delay treatment is children. Children cannot be able to recognize the symptom of malaria and caregiver also did not notice symptom of malaria in children. Women are regular victim of inappropriate medical care because they neglect their symptom due to household activities and care to their children and then, no one to go to health center with her. Although people already received appropriate medical treatment from health center, they went to unqualified medical providers who apply injection of analgesic, antibiotics and sometimes they use sedatives (Das et al., 2010).

CHAPTER III

RESEARCH METHODOLOGY

3.1 Study Design

This study was unmatched Case Control study targeting people who lived in Myanmar-Thailand border area especially in Dawei, Thayetchaung and Palaw townships, Tanintharyi region. This study was conducted to know the odd ratio and association between border migration, knowledge, protective behavior, treatment seeking behavior and malaria infection. Face to face interview was conducted for data collection.

3.2 Study Area

This study was conducted in Dawei, Thayetchaung and Palaw townships of Tanintharyi Region, Myanmar. These three townships are bordered with Kanchanaburi, Ratchaburi and Phetchaburi Province, Thailand and a lot of migrant workers were moving along the border area with or without crossing the border. These areas are still main sources of remaining malaria infection and distributing & importing malaria with mobile migrant workers to non-endemic area. Although malaria morbidity and mortality rate was declined significantly, these townships remained as malaria pocket area and difficult to control.

Forest related workers, refugee camp, ethnic group and mobile migrant workers were living along the border area especially in these three townships. The reason of selected these three townships were 1) these areas are border with Thailand, 2) mobile migrant workers were passing through these townships and designated to Thailand, 3) political instability of border area and 4) malaria prevalence was still high.

Tanintharyi region is located in Southern most part of Myanmar and is flanked by Mon State in the North, Thailand border is related to the East and Andaman sea is located to the West (Figure 4). Tanintharyi Region provides better favorable ground for

malaria infection. Tanintharyi region is covering 16,735 square miles and population of this region is 1,445,639.

In 2015, total annually reported malaria cases were 9,859 and total annually reported tested rate was 307,572 according to Myanmar annual malaria report 2015. There were 1,607 malaria positive cases in Dawei township, 443 malaria positive cases in Thayetchaung township and 791 positive cases in Palaw township in 2015 (Unpublished data).

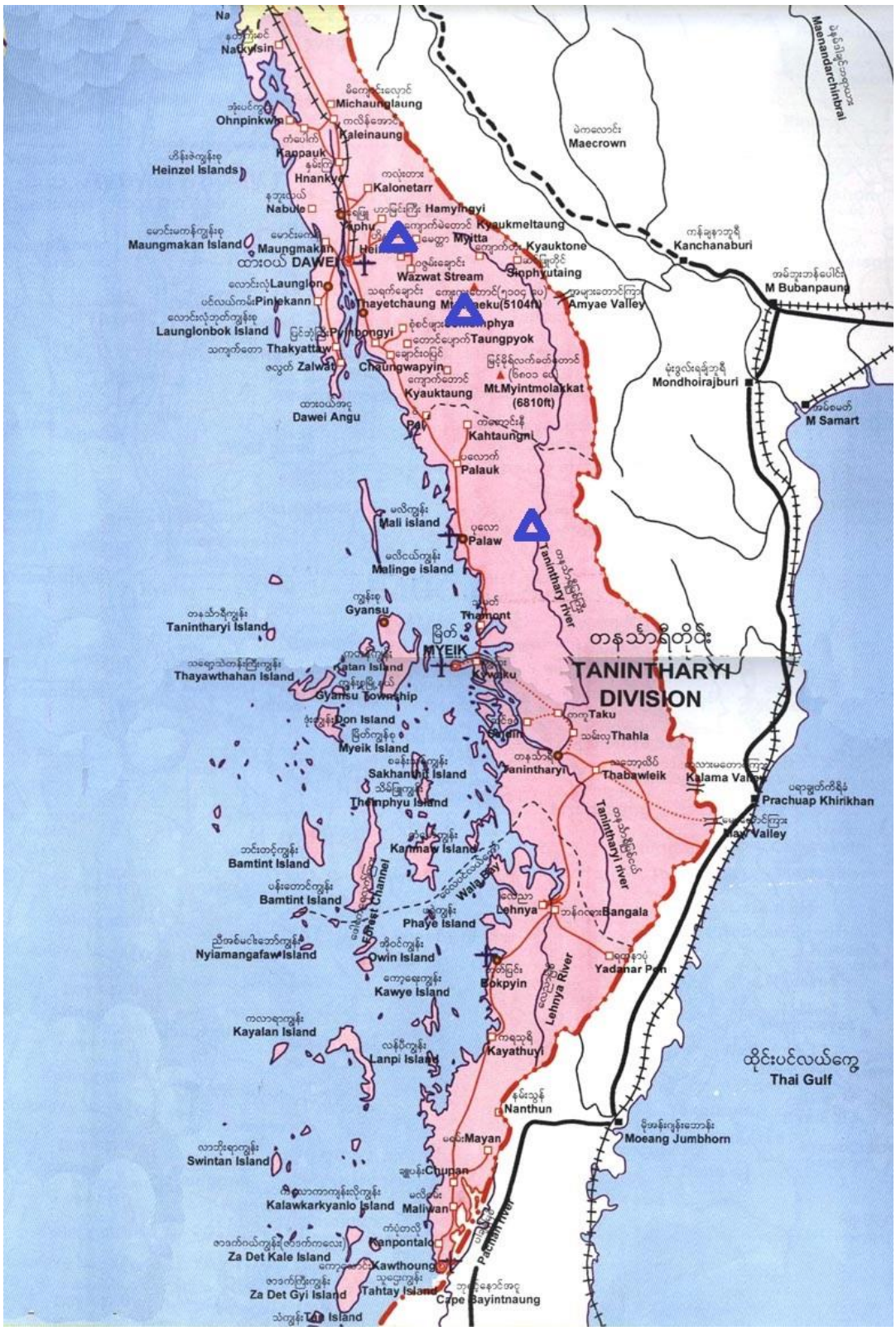


Figure 4 Map of Dawei, Thayetchaung and Palaw Townships in Tanintharyi Region

(Δ indicate study sites)

3.3 Study Population

This study was conducted among the migrant people more than 18 years of age (both male and female were included) who living in Dawei, Thayetchaung and Palaw townships which is located at Myanmar-Thailand border area (Figure 5).

Figure 5 Migrant workers crossing Myanmar-Thailand border area

3.4. Sample Size Calculation

This formula was used for sample size calculation and this formula was described in (Kelsey et al., 1996)

$$n = (\frac{r+1}{r}) \frac{(\bar{p})(1-\bar{p})(Z_{\beta} + Z_{\alpha/2})^2}{(p_1 - p_2)^2}$$

Z_{β}= desired power = 0.84 (80% of power)

$Z_{\alpha/2}$ = statistical significance= 1.96 (0.05 significance level)

P_1-P_2= Effect size (proportion difference)

r= 1 (ratio of control to cases)

The estimated proportion of exposed in the control group is 30%

Odd Ratio (Travel in last 4 weeks) = 1.9 (Lynch. et al., 2015)

To get proportion of cases exposed;

$$P_{case\ exp} = \frac{OR * p_{control\ exp}}{p_{control\ exp}(OR-1)+1}$$

$$P_{case\ exp} = \frac{(1.9)(0.30)}{(0.30)(1.9-1)+1} = \frac{0.57}{1.27} = 0.45$$

$\bar{p}$ =Average proportion exposed = $\frac{(0.45+0.30)}{2} = 0.375$

$$n = 2\frac{(0.375)(1-0.375)(0.84+1.96)^2}{(0.45-0.30)^2}$$

$$n = 2\frac{(0.375)(0.625)(7.84)}{0.023}$$

$$n = 2\frac{1.84}{0.023} = 160$$

Therefore, the number of total participants was 320,160 cases and 160 controls.

3.5. Sample selection

3.5.1 Case and Control Selection

A malaria case was a person living currently in the study area and Rapid Diagnosis Test was positive at the time of examination.

A malaria control was a person living currently in the study area and Rapid Diagnosis Test was negative at the time of examination.

3.5.2 How to determine Cases and Controls in this study

Case: A person went to volunteer malaria workers or mobile clinic for malaria screening during March, April and May 2018 and Rapid Diagnosis Test was positive.

Control: A person went to volunteer malaria workers or mobile clinic for malaria screening during March, April and May 2018 and Rapid Diagnosis Test was negative.

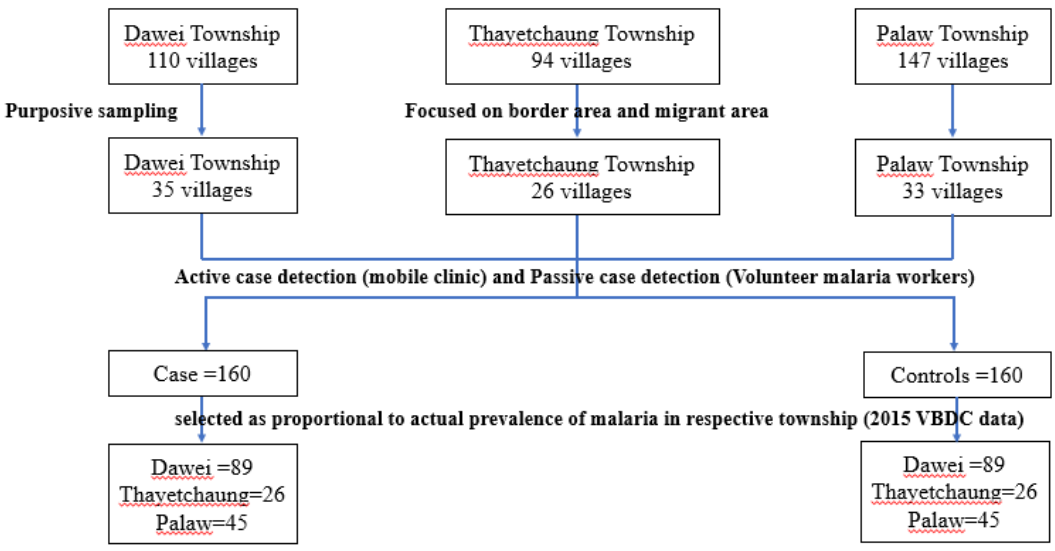


Figure 6 Sampling flow diagram

According to data from Vector Born Disease Control unit 2015, total positive cases for Dawei township were 1,607 cases, for Thayetchaung township were 443 cases and for Palaw township were 791 cases and the percentage of positive case detection in these three townships were 56%, 16% and 28% respectively. Cases and controls were selected as proportional to actual prevalence of malaria to respective townships. Therefore, 89 cases and 89 controls were selected from Dawei township, 26 cases and 26 controls were selected from Thayetchaung township and 45 cases and 45 controls were selected from Palaw township.

Malaria is related with seasonal variation and malaria prevalence is high in Myanmar before and after rainy season. The peak malaria seasons are May to June and October to November. Data collection was conducted during March to May. So, it was closely related with malaria peak season in Myanmar.

3.5.3. Inclusion criteria of the Case

- ✓ Respondents who were screening for malaria by Volunteer Malaria Workers or Mobile Clinics
- ✓ Respondents who were currently living in this study area.
- ✓ Respondents must be migrant population regardless of their migration status
- ✓ Respondents who were 18 years old or above
- ✓ Both female and male were included
- ✓ Respondents who were positive for Malaria Rapid Diagnosis Test
- ✓ Respondents who can communicate with Myanmar language
- ✓ Respondents who had willingness to answer the questionnaires

3.5.4. Exclusion criteria of the Case

- ✓ Respondents who were unconscious, extremely ill or severe stage of malaria or need of immediate medical attention at the time of testing

3.5.5. Inclusion criteria of the Control

- ✓ Respondents who were screening for malaria by Volunteer Malaria Workers or Mobile Clinics

- ✓ Respondents who were currently living in this study area.
- ✓ Respondent must be migrant population regardless of their migration status
- ✓ Respondent who were 18 years old or above
- ✓ Both female and male were included
- ✓ Respondents who can communicate with Myanmar language
- ✓ Respondents who were negative for Malaria Rapid Diagnosis Test

3.5.6. Exclusion criteria of the Control

- ✓ Respondents who had unwillingness to answer the questionnaires

3.6. Research Instruments

There were two steps procedures in this study. First step was identification of case and control and second step was face to face interview. As research instrument, Rapid Diagnostic Test was used for identification of case and control and constructed questionnaire was used for face to face interview.

3.6.1. Rapid Diagnostic Test

Rapid Diagnosis test (RDT) (Figure 6) is antigen (protein) detecting diagnosis test which provide rapid and accurate result. WHO recommend that rapid diagnosis test is most reliable test when malaria microscopy (gold standard) was not easily available. RDT is test kit which will use client blood and will give result within 15 to 30 min. RDT detect histidine rich protein II (HRP 2) in *Plasmodium falciparum* species and Plasmodium lactate dehydrogenase enzyme (pLDH) in *Plasmodium vivax* species. This test kit (RDT) which was used in this study detected *Plasmodium falciparum, Plasmodium vivax,* mixed infection and no malaria infection. The sensitivity of RDT is 99.7% and specificity is 99.3% (World Health Organization, 2015c). This RDT confirmed case and control in this study.

Figure 7 Rapid Diagnosis Test

3.6.2. Questionnaires

The questionnaires were constructed with review of previous malaria research studies which were related to conceptual framework and literature review. It was used to identify migration pattern, sociodemographic of migrant people, their knowledge on malaria, protective measures, treatment seeking behaviors and history of malaria infection. These questionnaires were composed of five parts.

3.6.2.a Part A: Socio demographic factors

This part was assessment of socio demographic factors related to malaria infection. The questionnaires of socio demographic factors covered general migrant population of age, gender, occupation, ethnicity, nationality, education, marital status, income and house-hold member. These sociodemographic factors of respondents were classified as follow: (1) Age: (a) age 15-24 (those just entering labor market), (b) age 25-54 (those in their prime working lives) and (c) age 55 to 64 (those passing the peak of their career and approaching retirement) (Organization for Economic Co-operation and Development employment rate by age group classification), (2) Sex: Male and Female, (3) Occupation: (a) farmer, (b) rubber and oil palm planation workers, (c)

forested worker, (d) merchant, (e) road construction, (f) dependent and (g) other including fisherman, factory worker, teacher, bishop, building construction worker, coal mine worker, car driver and betel farmer, (4) Ethnicity: (a) Burma (b) Kayen and (c) others including Mon and Thai, (5) Nationality: (a) Myanmar and (b) Thailand, (6) Marital Status: (a) single (b) married (c) widowed (d) divorced and (e) separated, (7) Education: (a) No education (b) primary education (c)secondary education (d) high school education and (e) graduate/post graduate, (8) Family income: (a)less than 1,200,000 Kyats (b) 1,200,001 to 2,600,000 Kyats (c) more than 2,600,001 Kyats and (9) Family size: (a) small family – 3 people (b) large family- more than 3 people). The questionnaires were constructed with review of national malaria survey and previous malaria research studies (Htike, 2015, Zambia, 2009).

3.6.2.b Part B: Pattern of movement/Migration

This part was assessment of pattern of movement among migrant workers in border area. The questionnaires related to migrant workers covered about the pattern of internal migration, transnational migration and no movement of migrant worker along the border area. These patterns of migrations of respondents were classified into 3 main groups; (1) Internal migration: (a) interrural migration (b) intermunicipal migration and (c) interregional migration, (2) Transnational migration: (a) pendular migration (b) contract migration and (c) seasonal migration and (3) No migration. The questionnaires were constructed with review of previous malaria research studies in migrant workers (Lynch. et al., 2015, Guyant et al., 2015).

3.6.2.c Part C: Knowledge of Malaria

This part was assessment of knowledge regarding to malaria of the migrant population in border area. These questionnaires covered about the malaria knowledge of migrant worker i.e. malaria transmission, symptom of malaria and severe malaria, diagnosis and treatment of malaria, drug resistant malaria and preventive measures dealing with environment. The questionnaires were constructed with review of national malaria survey and previous malaria research studies dealing with knowledge, attitude and protective behaviors (Linn et al., 2017, Zambia, 2009).

This portion consisted of 11 items and 49 sub questions. The correct answer was regarded as “1” score mean while wrong or uncertain answer was regarded as “0”. Therefore. The possible score of each respondent ranged from 0 to 49 score. Then, levels of knowledge of each respondent were classified as three levels; good, moderate and low. Good level of knowledge was more than 80% of total score (40-49), moderate level of knowledge was between 60% and 80% (30-39) and poor level of knowledge was less than 60% (0-29). (Bloom’s cut off point).

3.6.2.d Part D: Protective Behavior

This part was assessment of protective behavior of the migrant population in border area. These questions covered about protective behavior i.e. ITN usage, wearing of long sleeves, mosquito repellent cream apply and mosquito coil usage. The questionnaires were constructed with review of national malaria survey and previous malaria research studies dealing with knowledge, attitude and protective behaviors (Linn et al., 2017, Zambia, 2009).

This part consisted of 7 items related to protective practice behavior and 5 Likert’s scale was used in order to analyze. The respondent rated how often they performed in each statement. Five score of Likert’s scale was used to measure as follow;

Always (7 times/week)	was scored	5
Often (5-6 times/week)	was scored	4
Sometimes (2-4 times/week)	was scored	3
Once (1 time/week)	was scored	2
Never (didn’t perform)	was scored	1

In this part, the possible score of each respondent ranged from 7 to 35 score. It was classified into three level by using mean and SD. Mean of protective behavior was 6.09 and SD was 4.07.

Good protective behavior = more than 10.16 score
Moderate protective behavior = between 10.16 and 2.02 score
Low protective behavior = less than 2.02 score

3.6.2.e Part E: Treatment seeking behavior

This part was assessment of treatment seeking behavior among migrant population in border area. These questions covered about factors and way of treatment seeking behavior of migrant workers like distance from home to nearest health facility, malaria related information, accessibility, self-treatment, treatment seeking at quack, treatment seeking at nearest health facility/VMW, treatment seeking at Thailand health facility and Myanmar health facility and affordability of migrant worker. This treatment seeking behavior of respondents were classified as follow; (1) early/late treatment seeking behavior: (a) within 24hour after onset of fever (early) (b) after 24 hours of onset of fever (late), (2) choice of provider: (a) self-treatment (b) quack (c) volunteer malaria worker (d) Myanmar health facility and (e) Thailand health facility, (3) affordability: (having financial difficulties/ not financial difficulties), (4) accessibility: (easy access/difficult access) and (5) duration to go nearest health facility: (a) within 30 min (b) more than 30 min. The questionnaires were constructed with review of previous malaria research studies dealing with treatment seeking behavior (Romay-Barja et al., 2016, Dida et al., 2015).

3.7. Validity and Reliability

For validity of content of this study, three experts comprised two academic experts and one local expert checked the developed questionnaires to achieve validity by using the formula Index of item objective congruence (IOC). Two academic expert opinions were obtained from Assoc. Prof. Ratana Somrongthong, Ph.D. and Assist. Professor Naowarat Kanchanakhan, Ph. D. One local expert was obtained from Prof. Saw Lwin, Special Advisor to the Union Minister on Disease Control (Malaria Elimination) in Myanmar. The average IOC result from 3 experts was 0.94. Questionnaires were translated to local language (Myanmar). Questionnaires translations, English to Myanmar and back translation was checked by local expert, Dr. Bo Bo Thet Ko, Regional Field Director (Tanintharyi) of Defeat Malaria Project, University Research Co., LLC.

The reliability of developed questionnaires was tested after conducting of validity. The pilot study for reliability was conducted among 30 people in Myeik

township, Tanintharyi region. The internal consistency scale of the questionnaires (knowledge part) was tested with Kuder–Richardson 20. The average value for Kuder–Richardson 20 (knowledge part) was 0.78.

3.8. Data Collection method

In this study, data collection was conducted during March, April & May 2018 at Myanmar-Thailand border area, Dawei, Thayetchaung and Palaw Townships. The methods of data collections were as follow.

- Data collection was done by 2 steps procedures; RDT testing and face to face interview by using questionnaires.
- There were 2 methods for data collection; active case detection via mobile clinic and passive case detection via volunteer malaria workers.
- Case and control of this study were confirmed by RDT result.
- Active case detection and passive case detection were conducted by researcher and research assistants.
- Before data collection, researcher requested to volunteer malaria workers and field health staffs in border area to assist my research as research assistant.
- The researcher hired 10 research assistants; 4 people from Dawei, 3 people from Thayetchaung and 3 people from Palaw townships for data collection.
- During hiring research assistants, researcher selected volunteer/field health staffs from malaria high risk area/ border area and one research assistant was responsible for 9-10 villages. Therefore, 10 research assistants covered 94 villages (all study sites).
- Firstly, researcher invited these research assistants to Dawei township and gave orientation session with standardize procedures to these research assistants for 1 day dealing with research objectives, questionnaires and procedure of this study.
- The training for RDT testing procedure was not conducted because all these research assistants got well training of malaria diagnosis and treatment and this process was their routine procedure.

- These research assistants were also malaria health volunteers/field health staffs of selected villages of Dawei, Thayetchaung & Palaw townships.
- After orientation session, they went to the villages and tested RDT to the participants (their routine procedure) and conducted data collection.
- During data collection, each research assistant conducted data collection among 9-10 villages to cover all study sites (94 villages). Therefore, research assistant went from one village to another village (within their responsible villages) and conducted data collection.
- Researcher monitored these research assistants frequently and checked about data collection process.
- Then, Researcher conducted active case detection through mobile clinic.
- Researcher collaborated with non-governmental organization (Malaria project) because this organization opened malaria mobile clinic in malaria risk area weekly and this mobile clinic was routine activities of this organization.
- Researcher followed this organization and conducted data collection during their mobile clinic.
- Research assistants also joined to these mobile clinics.
- During data collection, researcher and research assistants explained to the respondent about research objectives and procedures of this study.
- After fully explanation, interviewer (researcher and research assistants) took written consent from respondent.
- After taking consent, researcher and research assistants tested RDT and made data collection by face to face interview.
- This interviewing time took about 15-30 minutes for each respondent.
- After interview, the researcher and research assistant provided a soap and drinking water as incentive to take part in the research.

3.9. Data Analysis

All data analysis was performed by SPSS version 22.

Descriptive statistics: Descriptive statistics had been used to summarize and described the sociodemographic, migration pattern, knowledge on malaria, protective behavior and treatment seeking behavior of migrant people and it were expressed by number, percentage, frequency, standard deviation, means for normally distributed data and median and interquartile range for non-normally distributed data.

Analytical statistics: Inferential statistics had been done to answer the research questions. Bivariate analysis was used to calculate crude odd ratio and assess the association between sociodemographic, migration pattern, knowledge on malaria, protective behavior and treatment seeking behavior of migrant people and malaria infection. Multivariate logistic regression was used to calculate adjusted odd ratio at 95% confident interval. The coefficients in logistic regression indicate the change in the logic for each unit change in the independent variable. This might not be intuitive and coefficient from the regression model was presented as odd ratios. Then, two by two table was constructed to identify risk factor or protective factors (independent variables) of malaria infection through the Odd Ratio (OR) with 95% Confident Interval. All risk factors with $p< 0.20$ on bivariate analysis were considered for inclusion in the multivariable logistic model (Hosmer Jr et al., 2013). All risk factors with $p<0.05$ were considered as significant.

3.10. Ethical Consideration

Under the guidance of College of Public Health Sciences, the ethical approval of this study was sought ethical approval from ethical review committee for Research Involving Human Research Subjects, Health Science Group, Chulalongkorn University. Ethical approval no was COA No.079/2018 and date of approval was March 26, 2018. Researcher conducted data collection after receiving of ethical approval. Researcher explained about objectives, process and benefit of this study before taking written consent from interviewees.

Researcher explained to respondents about the consideration of this study.

- ✓ Respondents willingness
- ✓ Freedom of withdrawal without any reason
- ✓ Confidentiality
- ✓ Convenience

This data was described by code and secured about respondent's information

3.11. Expected Benefit & Application

The information from this study were needed for confirmation of association between migration and malaria infection and then which type of migration had highest prevalence of malaria. This information helped to health policy maker determining of which health services were appropriate for migration people in cross border area. In addition, this study provided strategy information for implementation of malaria elimination such as regular screening of malaria for specific migration population, well distribution of LLIN and special preventive measures for highly associated migrant people.

CHAPTER IV

RESULTS

This study was an analytical case-control research to study about migration and malaria infection in Myanmar-Thailand border area of Tanintharyi Region, Myanmar. The data were collected from 320 migrant people, 160 malaria infected person and 160 non-malaria infected person as controls, from Dawei, Thayetchaung and Palaw townships along Myanmar-Thailand border of Tanintharyi region. Rapid Diagnostics Test (RDT) was used to identify malaria cases and controls. Data were collected from cases and control through face to face interview using structured questionnaires during March, April and May 2018. This chapter presented about data analysis of this study in the following orders.

4.1. Descriptive characteristics of respondents

4.1.1. Sociodemographic characteristics of malaria cases and controls

4.1.2. Migration pattern of malaria cases and controls

4.1.3. Knowledge of malaria cases and controls

4.1.4. Protective behavior of malaria cases and controls

4.1.5. Treatment seeking behavior of malaria cases and control

4.2. Association between malaria infection and characteristic s of migrant people

4.2.1. Association between sociodemographic characteristics of migrants and malaria infection

4.2.2. Association between migration pattern of migrants and malaria infection

4.2.3. Association between knowledge of migrants and malaria infection

4.3.4. Association between protective behavior of migrants and malaria infection

4.2.5. Association between treatment seeking behavior of migrants and malaria infection

4.3. Multivariate model of association between significance variables and malaria infection risk

4.1. Descriptive characteristics of respondents

The univariate analysis was used to describe the frequency and percentage of characteristics of migrant people (160 malaria infected cases and 160 controls). These characters included socio-demographic characteristics, pattern of migration, knowledge on and protective behavior for malaria and treatment seeking behavior of migrant people who are living at Dawei, Thayetchaung and Palaw townships, Tanintharyi region, Myanmar.

4.1.1. Sociodemographic characteristics of malaria cases and controls

Out of 160 malaria infected cases, 28 (18%) participants were infected with *Plasmodium falciparum.* More than three quarter of malaria cases was *P. vivax* (78%) and only 4% of malaria cases was mixed infection as shown in **Table 1**.

Table 1 Number & percentage distribution of malaria cases by *Plasmodium* species

Malaria Infection	Number	Percentage
Plasmodium falciparum	28	18%
Plasmodium vivax	125	78%
Mixed Infection	7	4%

Table 2 showed the sociodemographic characteristics of migrant people who were living in Myanmar-Thailand border area. The sociodemographic characteristics of migrant people included age, sex, occupation, ethnicity, nationality, marital status,

education, yearly income, family size, residential status and duration of stay for non-local residents.

The age of migrant people was ranged from 18 to 64 years and it was grouped to three groups according to OECD employment rate by age group classification (Organization for Economic Cooperation and Development, 2018). The first age group was from age 18 to 24 years (those just entering labor market), second group was from age 25 to 54 years (those in their prime working lives) and third group was from age 55 to 64 years (those passing the peak of their career and approaching retirement). Most of migrant workers were from second age groups (66.3%), second highest migrant workers were from first age group (23.1%) and the last group (largest age group) had only 10.6% of migrant worker. In malaria case and control, the majority of participants were aged range from 25-54 years.

The amount of male and female of migrant workers were nearly equal, 53.4% and 46.6% respectively. However, male had higher malaria positive rate (63.1%) than female (36.9%). Nearly half of the respondents were in the sector of forest worker (42.2%) and the rest of the occupation were not significant different and it occupied nearly same proportion about 10% each. Moreover, 63.8% of cases were also found in the occupation sector of forest worker whereas 20.6% of controls were also found in forest worker occupation group and percentage distribution of controls were not significance difference among different sector of occupation.

In term of job related with forest, when participants were asked whether their job related to forest, majority of migrant people worked at forest related job (69.7%). Moreover, 90.6% (145) of malaria cases are came from forested related migrant workers. For control, the number of who did forest related job and not related job was nearly the same.

Majority of respondents were Kayen (60.9%) and second highest number of respondents was Burma (35%). Other ethnicity included Mon and Thai were few number (4.1%). Moreover, 62.5% of total malaria cases was found among Kayen ethnicity, 32.5% in Burma and other ethnicity had very low number of malaria cases (5%).

Majority of respondents were Myanmar nationality (98.7%) and only 4 people were included as Thai nationality. All malaria cases were found in Myanmar

Nationality. Most of the respondents surveyed were married (73.4%). There were 19.4% single, 3.1% separated, 2.2% widowed and 1.9% divorced. Among this, 70% of total positive cases were came from married migrant workers and the rest were few amounts.

Education status of migrant people were not too much different except high school education and graduated/post-graduate education. Around 22.8% of migrant workers didn't attend school, 37.8% of migrant workers achieved primary education, 27.5% achieved secondary education, 9.1% achieved high school education and only 2.8% achieved graduated/post-graduated. Case control proportion of these migrant workers who never attend school were 35 and 38, primary education was 62 and 59, secondary education was 48 and 40, high school education was 12 and 17 and graduated/post-graduated education were 3 and 6. Then, cases & controls proportion of education status were not too much different.

Table 2 Number and percentage distribution of respondents by sociodemographic factors of malaria cases and controls

Sociodemographic factors	Cases		Controls		Total	
	n	%	n	%	n	%
Age						
18 to 24 years	44	27.5%	30	18.8%	74	23.1%
25 to 54 years	107	66.9%	105	65.6%	212	66.3%
55 to 64 years	9	5.6%	25	15.6%	34	10.6%
Mean=36, Median=35, SD=12.862						
Sex						
Male	101	63.1%	70	43.7%	171	53.4%
Female	59	36.9%	90	56.3%	149	46.6%
Occupation						
Farmer	10	6.2%	22	13.8%	32	10.0%
Rubber & oil palm plantation	20	12.5%	13	8.1%	33	10.3%
Forest worker	102	63.8%	33	20.6%	135	42.2%
Merchants	4	2.5%	31	19.4%	35	10.9%
Road construction	9	5.6%	16	10.0%	25	7.8%
Dependent	5	3.1%	19	11.8%	24	7.5%
Others[1]	10	6.3%	26	16.3%	36	11.3%
Forest related job						
Not related	15	9.4%	82	51.2%	97	30.3%
Related	145	90.6%	78	48.8%	223	69.7%
Ethnicity						
Burma	52	32.5%	60	37.5%	112	35.0%
Kayen	100	62.5%	95	59.4%	195	60.9%
Others[2]	8	5.0%	5	3.1%	13	4.1%

Others[1]*-Fisherman, Factory worker, Teacher, Bishop, building construction worker, Coal mine worker, car driver and betel farmer;*

Others[2]*-Mon and Thai*

Table 2 Number and percentage distribution of respondents by sociodemographic factors of malaria cases and controls (Continued)

Sociodemographic factors	Cases		Controls		Total	
	n	%	n	%	n	%
Nationality						
Myanmar	160	100.0%	156	97.5%	316	98.7%
Thai	0	0.0%	4	2.5%	4	1.3%
Marital Status						
Single	35	21.9%	27	16.8%	62	19.4%
Married	112	70.0%	123	76.8%	235	73.4%
Widowed	5	3.1%	2	1.3%	7	2.2%
Divorced	4	2.5%	2	1.3%	6	1.9%
Separated	4	2.5%	6	3.8%	10	3.1%
Education						
Never attend school	35	21.8%	38	23.7%	73	22.8%
Primary education	62	38.8%	59	36.9%	121	37.8%
Secondary education	48	30.0%	40	25.0%	88	27.5%
High school education	12	7.5%	17	10.6%	29	9.1%
Graduated/post-graduated	3	1.9%	6	3.8%	9	2.8%
Income						
≤1,200,000 MMK	52	32.5%	46	28.8%	98	30.6%
1,200,001 to 2,600,000 MMK	65	40.6%	77	48.1%	142	44.4%
>2,600,001 MMK	43	26.9%	37	23.1%	80	25.0%
Median=1,800,000						
Interquartile range=1,750,000						
Range= 110,000-4,500,000						
Family size						
Up to 3 family members	83	51.9%	79	49.4%	162	50.6%
More than 3 family members	77	48.1%	81	50.6%	158	49.4%

Table 2 Number and percentage distribution of respondents by sociodemographic factors of malaria cases and controls (Continued)

Sociodemographic factors	Cases		Controls		Total	
	n	%	n	%	n	%
Residential Status						
Non-local resident	85	53.1%	66	41.3%	151	47.2%
Local Resident	75	46.9%	94	58.7%	169	52.8%
Duration of stay for non-local residents (n=151)						
Less than 6 months	41	48.2%	15	22.7%	56	37.1%
Between 6 months and 1 year	18	21.2%	9	13.6%	27	17.9%
Between 1 year and 3 years	14	16.5%	16	24.3%	30	19.9%
More than 3 years	12	14.1%	26	39.4%	38	25.1%

The level of economic status of migrant workers was assessed on the basic of total yearly family income. Total yearly family income was ranged from 110,000 to 4,500,000 MMK and which were grouped into three groups. First income group was up to 1,200,000 MMK, second income group was 1,200,001 to 2,600,000 MMK and third income group was more than 2,600,001 MMK. Nearly 45% of migrant workers earned between 1,200,001 and 2,600,000 MMK while 30.6% and 25% obtained up to 1,200,000 MMK and more than 2,600,000 MMK respectively. Majority of malaria cases and controls also had yearly income between 1,200,001 and 2,600,000 MMK.

Family member in the household of migrant workers were grouped into two groups; first group- up to 3 family members and second group- more than 3 family members. The number of participants who had up to 3 members in their household and who had family member more than 3 were nearly the same proportion (50.6% and 49.4%). For malaria cases and controls, the proportion of the participants who possess up to 3 family members and those who possess more than 3 family members were not too much difference.

More than half of migrant workers (52.8%) were local residents. Nevertheless, a little number of malaria infected cases higher found in non-local residents. For non-local residents, there were four groups depend on their duration of migration. First group was less than 6 months, second group was between 6 months and 1 year, third

group was between 1 year and 3 years and last group was more than 3 years. More than half of respondents arrived the border area less than 1 year duration. Malaria positive rate was highest in the group migrants who resides in this border area less than 6 months (48.2%) and this positive rate was slowly declined with duration of migration and more than 3 years groups had lowest (14.1%) malaria positive cases. In vice vasa, malaria infection in control group was highest (39.4%) in migrants living in this area for more than 3 years and lowest (13.6%) in migrants living in between 6 months and 1 year.

4.1.2. Migration pattern of malaria cases and controls

Table 3 revealed patterns of movement of migrant workers from other areas in the country to live in Myanmar-Thailand border of Tanintharyi region where malaria is endemic. These patterns include (i) interrural migration; migration within township, (ii) intermunicipal migration; migration from one township to another township within Tanintharyi Region and (iii) interregional migration; migration from one region to another region within Myanmar.

Interrural migration was occupied more than half of total migration (52.8%) but other migration like intermunicipal migration and interregional migration were 19.4% and 27.8% respectively. Interrural migration had relatively low malaria positive cases (46.9%) compared to non-interrural migration (53.1%). Case and control proportion of interrural migration was 75 cases and 94 controls while the proportion of non-interrural migration was 85 cases and 66 controls.

Among intermunicipal migration, malaria cases and control were equally occurred (31 cases and 31 controls). The township involving in intermunicipal migration of Tanintharyi region were Dawei, Thayetchaung, Launglon, Yebyu, Palaw, Pa Lauk, Myeik and Bokepyin. The highest malaria positive cases came from Myeik township and lowest were Bokepyin township.

Among interregional migration, malaria cases were higher than controls and cases of interregional migration were 54 (33.7% of total cases) and controls were 35 (21.8% of total controls). The region involving in interregional migration were Ayyawaddy, Bago, Kayin, Magway, Mon, Yangon and Thailand. Among interregional migration, about two third of total cases were occurred in the migrant workers who came from Bago and Ayyawaddy, 32.6% and 29.2% respectively.

Table 3 Number and percentage distribution of respondents by internal migration patterns of malaria cases and controls

Pattern of migration	Cases		Controls		Total	
	n	%	n	%	n	%
Interrural migration						
Interrural	75	46.9%	94	58.8%	169	52.8%
Non-interrural	85	53.1%	66	41.2%	151	47.2%
Intermunicipal migration						
Intermunicipal	31	19.4%	31	19.4%	62	19.4%
Non-intermunicipal	129	80.6%	129	80.6%	258	80.6%
Township (n=62)						
Dawei	2	6.5%	3	9.7%	5	8.1%
Thayetchaung	4	12.9%	3	9.7%	7	11.3%
Launglon	2	6.5%	5	16.1%	7	11.3%
Yebyu	5	16.1%	4	12.9%	9	14.5%
Palaw	4	12.9%	5	16.2%	9	14.5%
Pa Lauk	6	19.4%	6	19.4%	12	19.3%
Myeik	7	22.5%	2	6%	9	14.5%
Bokepyin	1	3.2%	3	10%	4	6.5%
Interregional migration						
Interregional	54	33.7%	35	21.8%	89	27.8%
Non-interregional	106	66.3%	125	78.2%	231	72.2%
Region (n=89)						
Ayyawaddy	15	27.8%	11	31.4%	26	29.2%
Bago	18	33.3%	11	31.4%	29	32.6%
Ka Yin	2	3.7%	1	2.8%	3	3.4%
Magway	6	11.1%	3	8.6%	9	10.1%
Mon	8	14.8%	0	0.0%	8	9.0%
Yangon	5	9.3%	8	22.9%	13	14.6%
Thailand	0	0.0%	1	2.9%	1	1.1%

Table 4 revealed about patterns of transnational migration of migrant worker living in Myanmar-Thailand border area of Tanintharyi Region and came across the border. Transnational migration included (i) pendular migration; migration cross the border regularly, (ii) seasonal migration; migration depend on seasonal job and (iii) contract migration; labor migration regulated by their work program with contract.

Only 16.6% (53) of total migrant people conducted pendular migration. Among pendular migration, malaria cases were 20 and controls were 33. For frequency of border crossing among pendular migration, highest malaria cases crossed the border quarterly (45%) whereas highest controls crossed the border monthly (33.4%).

Few numbers of migrant worker (12.5%) conducted seasonal migration. Among this migration, malaria cases were 29 and controls were 11. The highest proportion of malaria cases and controls worked in summer season whereas the lowest in winter season. Moreover, malaria cases were not too much different depending on type of seasonal job.

Contract migration were also small number of total migration and it occupied just 13.4%. Number of malaria cases was only one-fourth of this contract migrants. Road construction workers had highest malaria cases (61.5%) compared to other contract jobs. More than 95% of contract migrant workers stayed at Myanmar side in previous 3 months. All malaria cases also stayed at Myanmar side in previous 3 months.

Table 4 Number and percentage distribution of respondents by transnational migration patterns of malaria cases and controls

Pattern of migration	Cases		Controls		Total	
	n	%	n	%	n	%
Pendular migration						
Non-pendular	140	87.5%	127	79.4%	267	83.4%
Pendular	20	12.5%	33	20.6%	53	16.6%
Frequency of border crossing (n=53)						
Daily	1	5.0%	0	0.0%	1	1.9%
Weekly	0	0.0%	6	18.2%	6	11.3%
Monthly	4	20.0%	11	33.4%	15	28.3%
Quarterly	9	45.0%	8	24.2%	17	32.1%
Yearly	6	30.0%	8	24.2%	14	26.4%
Seasonal migration						
Non-seasonal	131	81.8%	149	93.1%	280	87.5%
Seasonal	29	18.2%	11	6.9%	40	12.5%
Season (n=40)						
Summer season	14	48.3%	6	54.5%	20	50.0%
Rainy season	11	37.9%	4	36.4%	15	37.5%
Winter season	4	13.8%	1	9.1%	5	12.5%
Seasonal job (n=40)						
Rubber Plantation	7	24.1%	1	9.1%	8	20.0%
Oil palm plantation	4	13.8%	0	0.0%	4	10.0%
Farmer	7	24.1%	4	36.4%	11	27.5%
Gold mine worker	5	17.3%	0	0.0%	5	12.5%
Others[1]	6	20.7%	6	54.5%	12	30.0%

Others[1]- *Bamboo cutter, Coal Mine worker, Fisherman*

Table 4 Number and percentage distribution of respondents by transnational migration patterns of malaria cases and controls (Continued)

Pattern of migration	Cases		Controls		Total	
	n	%	n	%	n	%
Contract migration						
Non-contract	147	91.8%	130	81.2%	277	86.6%
Contract	13	8.2%	30	18.8%	43	13.4%
Type of contract migration (n=43)						
Road construction	8	61.5%	15	50.0%	23	53.4%
Building construction	3	23.1%	7	23.3%	10	23.3%
Factory workers	2	15.4%	8	26.7%	10	23.3%
Place of work for past 3 months						
Myanmar	160	100.0%	147	91.8%	307	95.9%
Thailand	0	0.0%	13	8.2%	13	4.1%

4.1.3. Knowledge of malaria cases and controls

Table 5 showed knowledge level of migrant workers with malaria cases and control. The knowledge questionnaires had 49 sub questions, correct answer was regarded as "1" score and wrong answer was regarded as "0" score. Therefore, the possible score of each respondent ranged from 0 to 49 score. Then, level of knowledge of each respondent was classified as three level; good, moderate and low. Good level of knowledge was more than 80% of total score (40-49), moderate level of knowledge was between 60% and 80% (30-39), and poor level of knowledge was less than 60% (0-29).

Majority of respondents (44.1%) had moderate knowledge, 37.5% of them had poor knowledge and 18.4% of them had good knowledge. Migrant workers with poor knowledge was the largest group suffering from malaria infection (48.2%) while those workers with good knowledge on malaria was the smallest group with malaria infection (13.7%). The proportion of good, moderate and poor knowledge of migrants in case and control were 22 cases/ 37controls, 61cases/ 80controls and 77cases/ 43controls, respectively. Most of the incorrect answers came from questions related to breeding site and resting place of malaria mosquito, drug resistant malaria, usage of larvicides and most migrant workers didn't know backache and joint weakness as malaria symptom (Appendix).

Table 5 Number and percentage distribution of respondents by knowledge of malaria cases and controls

Knowledge	Cases		Controls		Total	
	n	%	n	%	n	%
Good Knowledge	22	13.7%	37	23.1%	59	18.4%
Moderate Knowledge	61	38.1%	80	50.0%	141	44.1%
Poor Knowledge	77	48.2%	43	26.9%	120	37.5%

4.1.4. Protective behavior of malaria cases and controls

Table 6 showed protective behavior of migrant workers with malaria cases and controls. Protective behavior questionnaires included 7 items and 5 Likert's scale was used in order to analyze. Then, level of protective behavior was classified as into three levels by using mean and SD. Mean of protective behavior score was 6.09 and SD was 4.07. Thus, scores more than 10.16 was classified as good protective behavior, scores between 10.16 and 2.02 was classified as moderate protective behavior, and scores less than 2.02 was classified as low protective behavior.

More than half of respondents (58.4%) had moderate protective behavior, 28.4% of them had poor protective behavior and 13.2% of them had good protective behavior. Among the malaria cases, 59.4% of them (95cases) had moderate protective behavior and 35.6% of them (57 cases) had poor protective behavior. Only 5 % of malaria cases had good protective behavior. Among controls, respondents with good protective behavior and poor protective behavior had same number (21% of each) while the rest (57.5%) had moderate protective behavior. Most of the poor protective behaviors were dealing with wearing of long sleeves, usage of mosquito repellent creams, cleaning of larvae near your home and LLIN use in outside and forest (Appendix).

Table 6 Number and percentage distribution of respondents by protective behavior of malaria cases and controls

Protective Behavior	Cases		Controls		Total	
	n	%	n	%	n	%
Good protective behavior	8	5.0%	34	21.3%	42	13.2%
Moderate protective behavior	95	59.4%	92	57.5%	187	58.4%
Poor protective behavior	57	35.6%	34	21.2%	91	28.4%

4.1.5. Treatment seeking behavior of malaria cases and controls

This part described treatment seeking behavior of migrant people both infected and non-infected with malaria in term of treatment seeking place, reason for choosing health service providers, most frequently use of service provider, drug of choice in case of self-treatment, and other factors which influent or hinder for health facility usage i.e., duration of travel to health facility, ability to access malaria health services and financial difficulties of migrant workers. Most of the respondents practiced different form of treatment seeking behavior as shown in Table 7.

Table 7 showed different treatment seeking behavior of migrant workers with malaria cases and controls. Majority of the migrant workers sought malaria treatment from Myanmar Health facility (40.9%) and some migrant workers went to nearest volunteer malaria workers (38.8%) and few number of migrant worker crossed the border and received treatment from Thai health facility (3.9%). Some of respondents practiced self-treatment (102, 15.9%). They took paracetamol, antimalarial drug and traditional medicine. Among self-treatment, the percentage of paracetamol drug taken migrant workers was 62.8%, traditional medicine was 22.5% and anti-malaria drug was 14.7%. Case and control proportion of taking these drugs were not too much different. More than 80% of malaria cases sought treatment from Myanmar health facility and nearest volunteer malaria workers.

Most migrant workers gave different reasons for choosing of health provider. Most migrant workers chose the provider for nearest reason (37.8%) and some gave free of charge reason (29.7%), getting best services (13.9%), suggestion of relative or friend (11.4%) and inexpensive cost was lowest (7.2%). Case and controls proportion of these reasons were not too much different.

Most of the migrant workers received health services from different health providers. In dealing with most use health services, more than half of respondents (58.1%) mostly used health services from Myanmar health facility and 38.8% of migrant workers received from nearest volunteer malaria workers. Only 3.1 % of migrant workers crossed the border and received treatment from Thai health facility. Cases and controls proportion of these health services were not too much different.

Most of migrant workers stayed at different places and they always changed depend on their job. Therefore, duration of travel to health facility is important factor for malaria infection. Its duration was grouped into two groups; (i) first group was less than 30 minutes and (ii) second group was more than 30 minutes. More than half of the respondents (68.1%) went to health facility which was far away from their household about less than 30 minutes duration by motor cycle whereas 31.9% of respondents living far away from health facility for more than 30 minutes. Case and control proportion of migrant worker for duration of travel by motor cycle less than 30 minutes was 95 cases and 123 controls, and more than 30 minutes was 65 cases and 37 controls. Among more than 30 minutes duration, number of cases was higher than controls.

Nearly 80% of migrant worker thought that they could easily access to malaria health services but the rest of migrants had difficulties to access malaria health services. Then, 45 malaria cases and 21 controls thought that they could not get easily to malaria health services. Dealing with financial difficulties for getting of malaria health services, majority of respondents (86.6%) did not have financial difficulties for getting of malaria health services. However, 13.4% of migrant workers had financial difficulties for travel cost and other costs even malaria health services are free of charge in this area. In this border area, Myanmar health facility and well-trained volunteer malaria workers gave malaria health services with free of charges. Among respondents who had financial difficulties (43 people) in which two third (28 people) were malaria cases and one third (15 people) was malaria controls.

Table 7 Number and percentage distribution of respondents by treatment seeking behavior of malaria cases and controls

Treatment seeking behavior	Cases		Controls		Total	
	n	%	n	%	n	%
Treatment seeking place (multiple answers)						
Go to nearest VMW*	131	40.9%	117	36.5%	248	38.8%
Self-treatment	46	14.4%	56	17.5%	102	15.9%
Go to Quack	0	0.0%	3	1.0%	3	0.5%
Go to Myanmar health facility	131	40.9%	131	40.9%	262	40.9%
Go to Thai health facility	12	3.8%	13	4.1%	25	3.9%
Reason of provider choice (multiple answers)						
Nearest	121	37.8%	121	37.8%	242	37.8%
Free of charge	89	27.8%	101	31.6%	190	29.7%
Inexpensive cost	23	7.1%	23	7.1%	46	7.2%
Suggestion of relative or friend	37	11.6%	36	11.3%	73	11.4%
Getting best services	50	15.7%	39	12.2%	89	13.9%
Most used health services						
Nearest VMW*	65	40.6%	59	36.9%	124	38.8%
Myanmar Health Facility	89	55.6%	97	60.6%	186	58.1%
Thai health facility	6	3.8%	4	2.5%	10	3.1%
Drug choice in case of self-treatment (n=102)						
Paracetamol	30	65.2%	34	60.7%	64	62.8%
Anti-malaria drug	5	10.9%	10	17.9%	15	14.7%
Traditional medicine	11	23.9%	12	21.4%	23	22.5%

** Volunteer malaria workers*

Table 7 Number and percentage distribution of respondents by treatment seeking behavior of malaria cases and controls (Continued)

Treatment seeking behavior	Cases		Controls		Total	
	n	%	n	%	n	%
Accessibility to the services						
Duration of travel to health facility						
Less than 30 Minutes	95	59.4%	123	76.9%	218	68.1%
More than 30 minutes	65	40.6%	37	23.1%	102	31.9%
Median=20, Interquartile range=20						
Easy access	115	71.8%	139	86.8%	254	79.4%
Difficult access	45	28.2%	21	13.2%	66	20.6%
Financial difficulties						
No financial difficulties	132	82.5%	145	90.6%	277	86.6%
Having financial difficulties	28	17.5%	15	9.4%	43	13.4%

History of malaria infection and their treatment seeking behavior in last infection

Table 8 showed about history of malaria infection and their treatment seeking behavior in the past malaria infection. More than half of the respondents (51.6%) had experience of malaria infection. Among malaria cases, migrant workers with past history of malaria infection have relatively higher numbers compared with migrant worker those did not have history of malaria infection, 58.1% and 41.9% respectively. Among controls, number of migrant people with no history of malaria infection were relatively higher than migrant worker with history of malaria infection.

Three quarter of respondents (76.6%) sought malaria health services after 24 hours and only one quarter of respondents (23.4%) sought treatment within 24 hours. Moreover, among migrant workers with past malaria infection, 36.4% of respondents had *Plasmodium vivax* infection, 27.9% of respondents had *Plasmodium falciparum* infection and 5.5% had mixed infection. One third (30.2%) did not know the parasite

species of their past infection. Dealing with drug compliance, majority of respondents (83%) responded that they took antimalarial drug completely and 17% said that they did not take full course.

Migrant worker with no history of malaria infection was 155 people. Among this, 63.2% of migrant worker did not have experience of taking antimalarial drug whereas 36.8% had this experience.

Table 8 Number and percentage distribution of respondents by history of malaria infection and their treatment seeking behavior of malaria cases and controls

Treatment seeking behavior	Cases		Controls		Total	
	n	%	n	%	n	%
Seeking malaria treatment (n=320)						
Within 24 hours	29	18.1%	46	28.7%	75	23.4%
After 24 hours	131	81.9%	114	71.3%	245	76.6%
History of malaria infection (n=320)						
Never get infection	67	41.9%	88	55.0%	155	48.4%
Ever get infection	93	58.1%	72	45.0%	165	51.6%
Malaria infected species (n=165)						
Plasmodium falciparum	20	21.5%	26	36.1%	46	27.9%
Plasmodium vivax	40	43.0%	20	27.8%	60	36.4%
Mixed Infection	4	4.3%	5	6.9%	9	5.5%
Don't know	29	31.2%	21	29.2%	50	30.2%
Drug compliance (n=165)						
Good	72	77.4%	65	90.3%	137	83.0%
Not good	21	22.6%	7	9.7%	28	17.0%
Experience of taking antimalarial drug without infection (n=155)						
Never	37	55.2%	61	69.3%	98	63.2%
Ever	30	44.8%	27	30.7%	57	36.8%

4.2. Association of malaria infection and migrant people in Myanmar-Thailand border area

Bivariate analysis was used to analysis the association between malaria infection and migrant people. The independent variables of these associations were socio-demographic factors of malaria cases & controls, migration pattern of malaria case & controls, knowledge & protective behavior of malaria cases & controls and last variable was treatment seeking behavior of malaria cases and control. The dependent variable was malaria infection.

4.2.1. Association between sociodemographic factors of cases and controls and malaria infection

Table 9 showed the association between sociodemographic factors of migrant people (160 cases and 160 controls) and malaria infection. These sociodemographic factors included age, sex, occupation, forest related job, ethnicity, marital status, education, income, family size, residential status and duration of stay for non-local residents. All of significance variables were at 95% confidence interval.

Age of migrant people was grouped into three group. The age group (18 to 24) years group and (25 to 54) years group were statistically associated with malaria infection (Crude OR=4.074, p value=0.002 and crude OR=2.831, p value=0.012 respectively). Therefore, the migrant workers in age group 18 to 24 and 25 to 54 years old had high risk of malaria infection about 4.07 times and 2.83 times than the migrant workers age group 55 to 64 years (reference group). Male was also statistically associated with malaria infection with crude OR= 2.201 at p value=0.001. Thus, male had superior risk for malaria infection than female for 2.2 times.

Migrant worker conducted different occupation in the border area. Forested worker, was associated with malaria cases and control and it increased malaria risk statistically. Forested worker group (farmer, rubber and oil palm planation and forest worker) increased malaria risk about 7.118 times than non-forested worker group including merchant, road construction and dependent (reference group) (Crude OR=

7.118, p value <0.001) at 5% significant level. The other groups were not statistically associated with malaria infection at 5% significance level. Others group involved fisherman, factory worker, teacher, bishop, building construction worker, coal mine worker, car driver and betel farmer. The main job of migrant workers which related to forest was significantly associated with malaria infection at 5% significance level (crude OR=10.162, p value<0.001) and it was risk factor for malaria infection. The main job of migrant workers which related to forest increased risk of malaria infection about 10.16 times than migrant workers who main job was not related to forest. Ethnicity involved 3 ethnic groups such as Burma, Kayen and other ethnicity including Mon and Thai and they were not associated with malaria infection at 5 % significance level.

There was no statistically association between marital status, education and yearly total family income and malaria infection at 5% significance level.

Family size was not statistically associated with malaria infection at 5% significance level. Residential status was significantly associated with malaria infection (crude OR=1.614, p value=0.034). The non-local residents gained risk for malaria infection about 1.614 times than local residents.

Among non-local resident, duration of stay in this border area since their arrival was associated with malaria infection. Non-local resident with under 6 months duration, and between 6 months and 1 year duration were significantly associated with malaria infection at 95% significance level (Crude OR=5.922, p value<0.001 and crude OR=4.333, p value=0.006, respectively). Therefore, non-local resident with under 6 months duration and between 6 months and 1 year duration were prone to be infected with malaria about 5.922 times and 4.333 times higher than non-local resident resided for more than 3-years. Duration of stay between 1 year and 3 years was not associated with malaria infection at 5% significance level.

Table 9 Association between sociodemographic factors of cases and controls and malaria infection

Sociodemographic factors	Case	Control	Crude OR	95% CI		P- value
	n (%)	n (%)		Lower	Upper	
Age						
55 to 64 years	9 (26.5%)	25 (73.5%)	1			
18 to 24 years	44 (59.5%)	30 (40.5%)	4.074	1.670	9.942	**0.002***
25 to 54 years	107(50.5%)	105 (49.5%)	2.831	1.262	6.351	**0.012***
Sex						
Female	59 (39.6%)	90 (60.4%)	1			
Male	101 (59.1%)	70 (40.9%)	2.201	1.406	3.445	**0.001***
Occupation						
Non-forested worker	18 (21.4%)	66 (78.6%)	1			
Forested worker	132 (66.0%)	68 (34.0%)	7.118	3.915	12.939	**<0.001***
Other[1]	10 (27.8%)	26 (72.2%)	1.410	0.575	3.456	0.452
Forest related job						
Not related	15 (15.5%)	82 (84.5%)	1			
Related	145 (65.1%)	78 (34.9%)	10.162	5.492	18.804	**0.001***
Ethnicity						
Burma	52 (46.4%)	60 (53.6%)	1			
Kayen	100 (51.3%)	95(48.7%)	1.215	0.762	1.935	0.413
Others[2]	8 (61.5%)	5 (38.5%)	1.846	0.569	5.993	0.307

**Statistically significant at p value <0.05*

Forested workers- Farmer, Rubber and oil palm plantation, Forest worker
Non-forested worker- Merchant, Road Construction, Dependent
Others[1]- Fisherman, Factory worker, Teacher, Bishop, building construction worker, Coal mine worker, Car driver and Betel farmer
Others[2]-Mon and Thai

Table 9 Association between sociodemographic factors of cases and controls and malaria infection (Continued)

Sociodemographic factors	Case	Control	Crude	95% CI		P-value
	n (%)	n (%)	OR	Lower	Upper	
Marital Status						
Single	35 (56.5%)	27 (43.5%)	1			
Married	112 (47.7%)	123 (52.3%)	0.702	0.400	1.234	0.219
Others[1]	13 (56.5%)	10 (43.5%)	1.00	0.382	2.633	0.995
Education						
High school education	12 (41.4%)	17 (58.6%)	1			
Never attend school	35 (47.9%)	38 (52.1%)	1.305	0.547	3.115	0.549
Primary education	62 (51.2%)	59 (48.8%)	1.489	0.655	3.382	0.342
Secondary education	48 (54.5%)	40 (45.5%)	1.700	0.727	3.977	0.221
Graduated/post-graduated	3 (33.3%)	6 (66.7%)	0.708	0.147	3.407	0.667
Family income (MMK)						
>2,600,000	43 (53.8%)	37 (46.2%)	1			
1,200,001 to 2,600,000	65 (45.8%)	77 (54.2%)	0.726	0.419	1.259	0.254
≤ 1,200,000	52 (53.1%)	46 (46.9%)	0.973	0.538	1.758	0.927

**Statistically significant at p value <0.05*

Other[1]- widowed, divorced and separated

Table 9 Association between sociodemographic factors of cases and controls and malaria infection (Continued)

Sociodemographic factors	Case	Control	Crude OR	95% CI		P-value
	n (%)	n (%)		Lower	Upper	
Family size						
Up to 3 members	83 (51.2%)	79 (48.8%)	1			
More than 3 members	77(48.7%)	81 (51.3%)	0.905	0.584	1.403	0.655
Residential Status						
Local Resident	75 (44.4%)	94 (55.6%)	1			
Non-local resident	85 (56.3%)	66 (43.7%)	1.614	1.037	2.512	**0.034***
Duration of stay for non -local resident (n=151)						
More 3 years	12 (31.6%)	26 (68.4%)	1			
Under 6 months	41 (73.2%)	15 (26.8%)	5.922	2.398	14.628	**<0.001***
Bet; 6 months and 1 year	18 (66.7%)	9 (33.3%)	4.333	1.512	12.416	**0.006***
Bet; 1 year and 3 years	14 (46.7%)	16 (53.3%)	1.896	0.704	5.108	0.206

**Statistically significant at p value <0.05*

4.2.2. Association between migration pattern of cases and controls and malaria infection

Table 10 described the association between migration patterns of migrant workers for internal migration in the Myanmar-Thailand border area. These patterns included interrural migration, intermunicipal migration, and interregional migration.

Interrural migration was statistically associated with malaria infection (Crude OR=1.614 & p value=0.034). Therefore, non-interrural migration had higher risk than interrural migration for 1.6 times while intermunicipal migration was not associated with malaria infection at 5% significance level.

Interregional migration was significantly associated malaria infection with Crude OR= 1.819 at p value=0.018. Therefore, interregional migration increased risk for malaria infection of migrant workers for 1.8 times when compared with interrural and intermunicipal migration groups.

Table 10 Association between internal migration pattern of cases and controls and malaria infection

Migration Pattern	Case	Control	Crude OR	95% CI		P-value
	n (%)	n (%)		Lower	Upper	
Interrural migration						
Interrural	75 (44.4%)	94 (55.6%)	1			
Non-interrural	85 (56.3%)	66 (43.7%)	1.614	1.037	2.512	**0.034***
Intermunicipal migration						
Intermunicipal	31 (50.0%)	31 (50.0%)	1			
Non-intermunicipal	129 (50.0%)	129 (50.0%)	1.000	0.574	1.741	1.000
Interregional migration						
Non-interregional	106 (45.9%)	125 (54.1%)	1			
Interregional	54 (60.7%)	35 (39.3%)	1.819	1.106	2.993	**0.018***

**Statistically significant at p value <0.05*

Table 11 described the association between transnational migration pattern of migrant workers in the Myanmar-Thailand border area including pendular migration, seasonal migration, main season for seasonal migrant worker, type of seasonal job, contract migration and type of contract migration and malaria infection.

For pendular migration, migrant workers who crossed the border regularly was not associated with malaria infection at 5% significance level. Seasonal migration had significantly association with malaria infection (crude OR= 2.999, p value= 0.003). Seasonal migration was a risk factor for malaria infection and it was 2.99 times more likely to be infected with malaria than non-seasonal migration. Among seasonal migration, season and type of seasonal job were not associated with malaria infection.

Contract migration was statistically associated with malaria infection. Non-contract migrant worker was risk factor for malaria infection compared with contract

migrant worker (Crude OR=2.609, p value=0.007). So, non-contract migrant worker was increased malaria risk about 2.6 time than contract migrant worker at 95% confidence interval. Even though, contract migration was associated with malaria infection, type of contract migrant worker was not associated with infection.

Table 11 Association between transnational migration pattern of cases and controls and malaria infection

Migration Pattern (n=320)	Case n (%)	Control n (%)	Crude OR	95% CI Lower	95% CI Upper	P-value
Pendular migration						
Non-pendular	140 (52.4%)	127 (47.6%)	1			
Pendular	20 (37.7%)	33 (62.3%)	0.550	0.300	1.007	0.053
Seasonal migration						
Non-seasonal	131 (46.8%)	149 (53.2%)	1			
Seasonal	29 (72.5%)	11 (27.5%)	2.999	1.441	6.239	**0.003***
Season (n=40)						
Summer season	14 (70.0%)	6 (30.0%)	1			
Rainy season	11 (73.3%)	4 (26.7%)	1.179	0.265	5.237	0.829
Winter season	4 (80.0%)	1 (20.0%)	1.714	0.157	18.726	0.659
Seasonal job (n=40)						
Non-Agriculture	11 (64.7%)	6 (35.3%)	1			
Agriculture	18 (78.3%)	5 (21.7%)	1.964	0.482	7.995	0.346
Contract migration						
Contract	13 (30.2%)	30 (69.8%)	1			
Non-contract	147 (53.1%)	130 (46.9%)	2.609	1.306	5.214	**0.007***
Type of contract migration (n=43)						
Road construction	8 (34.8%)	15 (65.2%)	1			
Others[1]	5 (25.0%)	15 (75.0%)	1.600	0.424	6.031	0.488

**Statistically significant at p value <0.05*

Agriculture- Rubber plantation, oil palm planation, farmer

Non-agriculture- Gold mine worker, Bamboo cutter, fisherman, coal mine worker, Other[1]- building construction and factory worker

4.2.3. Association between knowledge of cases and controls and malaria infection

Table 12 described the association between knowledge on malaria of migrant workers and malaria infection. The knowledge of migrant workers was classified into three levels; good knowledge, moderate knowledge and poor knowledge. Migrant workers who had poor knowledge was 3 times more likely to be infected with malaria than migrant workers who had good knowledge (crude OR=3.012, p value=0.001 at 95% confidence interval) while having moderate knowledge on malaria did not raise the risk of malaria infection compared to the migrant workers who had good knowledge.

Table 12 Association between knowledge of cases and controls and malaria infection

Knowledge level	Case	Control	Crude OR	95% CI		P-value
	n (%)	n (%)		Lower	Upper	
Good Knowledge	22 (37.3%)	37 (62.7%)	1			
Moderate Knowledge	61 (43.3%)	80 (56.7%)	1.282	0.687	2.394	0.435
Poor Knowledge	77 (64.2%)	43 (35.8%)	3.012	1.578	5.747	**0.001***

**Statistically significant at p value <0.05*

4.2.4. Association between protective behavior of cases and controls and malaria infection

Table 13 described the association between protective behavior of cases & control and malaria infection. The levels of protective behavior of migrant workers were classified into three levels; good protective behavior, moderate protective behavior and poor protective behavior. Migrant worker who had moderate protective behavior and poor protective behavior were more likely to be infected with malaria than those who had good protective behavior (crude OR=4.389, p value<0.001 and crude OR=7.125, p value<0.001, respectively) at 5% significance level. Therefore, migrant workers having poor protective behavior and moderate protective behavior increased malaria risk about 7.1 times and 4.3 times than migrant worker who had good knowledge.

Table 13 Association between protective behavior of cases and controls and malaria infection

Protective Behavior	Case	Control	Crude	95% CI		P
	n (%)	n (%)	OR	Lower	Upper	value
Good protective behavior	8 (19.0%)	34 (81.0%)	1			
Moderate protective behavior	95 (50.8%)	92 (49.2%)	4.389	1.929	9.982	**<0.001***
Poor protective behavior	57 (62.6%)	34 (37.4%)	7.125	2.957	17.169	**<0.001***

**Statistically significant at p value <0.05*

4.2.5. Association between treatment seeking behavior of cases and controls and malaria infection

Table 14 described association between treatment seeking behavior of cases and controls and malaria infection which were analyzed by bivariate analysis. The variables involving in treatment seeking behavior of migrant workers were treatment seeking place of migrant worker if they suspect for malaria infection, drug of choice for self-treatment, reason of provider choice, most use health services for migrant worker, duration of travel to health facility, accessibility to health facility and financial difficulty. Treatment seek place of migrant workers, reason of provider choice & most use health services were not associated with malaria infection at 5% significance level.

Duration of travel to health facility was significantly associated with malaria infection at 5% significance level. Migrant workers who traveled to health facility by motor cycle more than 30 minutes was increased risk of malaria infection about 2.275 times than duration of travel less than 30 minutes (crude OR=2.275, p value= 0.001).

Migrant workers who responded that they could not easily access to malaria health services was statistically associated with malaria infection (Crude OR=2.59, p value=0.001). Thus, it increased malaria risk about 2.59 times than migrant worker who got easily access to malaria health services at 95% confidence interval.

Migrant workers who had financial difficulties for seeking of malaria health services was statistically associated with malaria infection (Crude OR=2.051, p value=0.036). These financial difficulties were risk factor for malaria infection and it increased malaria risk about 2.05 times than migrant workers who did not have financial difficulties.

Table 14 Association between treatment seeking behavior of cases and controls and malaria infection

Treatment seeking behaviors	Case n (%)	Control n (%)	Crude OR	95% CI Lower	95% CI Upper	P-value
Treatment seeking place (Multiple answer)						
Go to nearest VMW	131 (52.8%)	117 (47.2%)	1			
Self-treatment	46 (45.1%)	56 (54.9%)	0.738	0.461	1.181	0.206
Quack	0 (0.0%)	3 (100.0%)	0.000	0.000	-	0.999
Myanmar Health Facility	131 (50.0%)	131 (50.0%)	0.813	0.516	1.282	0.373
Thai Health Facility	12 (48.0%)	13 (52.0%)	0.578	0.220	1.519	0.266
Reason of provider choice (Multiple answer)						
Free of charge	89 (46.8%)	101 (53.2%)	1			
Nearest	121 (50.0%)	121 (50.0%)	1.056	0.657	1.699	0.821
Inexpensive cost	23 (50.0%)	23 (50.0%)	1.146	0.599	2.193	0.681
Suggestion of relative	37 (50.7%)	36 (49.3%)	1.157	0.670	1.995	0.601
Getting best services	50 (56.2%)	39 (43.8%)	1.643	0.939	2.874	0.082
Most use health services						
Nearest VMW	65 (52.4%)	59 (47.6%)	1			
Myanmar Health Facility	89 (47.8%)	97 (52.2%)	0.833	0.528	1.313	0.431
Thai health facility	6 (60.0%)	4 (40.0%)	1.362	0.366	5.063	0.645
Duration of travel to health facility						
Less than 30 Minutes	95 (43.6%)	123 (56.4%)	1			
More than 30 minutes	65 (63.7%)	37 (36.3%)	2.275	1.401	3.692	**0.001***
Ability to access malaria health services						
Easy access	115 (45.3%)	139 (54.7%)	1			
Difficult access	45 (68.2%)	21 (31.8%)	2.590	1.459	4.598	**0.001***
Financial difficulties						
No difficulty	132 (47.7%)	145 (52.3%)	1			
Having difficulties	28 (65.1%)	15 (34.9%)	2.051	1.049	4.007	**0.036***

**Statistically significant at p value <0.05 VMW= volunteer malaria worker*

Association between history of malaria infection of respondents and their treatment seeking behavior in past infection and malaria infection

Table 15 described the association between history of malaria infection of respondents and their treatment seeking behavior in past infection with malaria infection. More than half of respondents had history of past malaria infection. Migrant worker with history of past malaria infection was significantly associated with malaria infection (crude OR=1.697, p value=0.019). Therefore, history of past malaria infection was also risk factor for malaria infection and it increased risk of malaria about 1.69 times than migrant worker who did not have history of past malaria infection at 95% confidence interval.

The rapid treatment seeking after onset of malaria symptom was significantly associated with malaria infection (crude OR=1.823, p value=0.026). The respondents who sought for treatment lately after 24 hours were 1.823 times more likely to be infected from malaria than respondent who sought treatment within 24 hours. Moreover, there was association between parasite species (*Plasmodium vivax*) and malaria infection at 5 % significance level (crude OR=2.6, p value =0.018). Therefore, respondent with past history of *Plasmodium vivax* infection was 2.6 times more likely to get malaria infection than those who were infected by *Plasmodium falciparum* in the past.

Drug compliance was also significantly associated with malaria infection. The respondents who did not take full course of antimalarial drug for past malaria infection was more likely 2.7 times to get risk for malaria infection than respondents who took full course of drug (crude OR=2.708, p value=0.034).

For respondent with no history of past malaria infection, there was no association between respondent with experience of taking anti-malaria drug and malaria infection.

Table 15 Association between history of malaria infection of respondents and their treatment seeking behavior in past infection and malaria infection

Treatment seeking behaviors	Case n (%)	Control n (%)	Crude OR	95% CI Lower	95% CI Upper	P-value
History of malaria infection						
Never get infection	67 (43.2%)	88 (56.8%)	1			
Ever get infection	93 (56.4%)	72 (43.6%)	1.697	1.090	2.640	**0.019***
Seeking malaria treatment						
Within 24 hours	29 (38.7%)	46 (61.3%)	1			
After 24 hours	131 (53.5%)	114 (46.5%)	1.823	1.075	3.091	**0.026***
Malaria infected species (n=165)						
Plasmodium falciparum	20 (43.5%)	26 (56.5%)	1			
Plasmodium vivax	40 (66.7%)	20 (33.3%)	2.600	1.177	5.743	**0.018***
Mixed Infection	4 (44.4%)	5 (55.6%)	1.040	0.247	4.382	0.957
Don't know	29 (58.0%)	21 (42.0%)	1.795	0.799	4.033	0.157
Drug compliance (n=165)						
Good	72 (52.6%)	65 (47.4%)	1			
Not good	21 (75.0%)	7 (25.0%)	2.708	1.081	6.788	**0.034***
Experience of taking anti-malaria drug without infection (n=155)						
Never	37 (37.8%)	61 (62.2%)	1			
Ever	30 (52.6%)	27 (47.4%)	1.832	0.946	3.548	0.073

**Statistically significant at p value <0.05*

4.3. Multivariate model of association between significant variables and malaria infection risk

Multiple logistic regression was used to re-examine the variables which were significantly associated with malaria cases and controls at bivariate analysis in order to see clear picture of association. The variables included in the final model are shown in the table 16. The independent variables that were analyzed into multivariate logistic regression were selected from the variables with p value <0.2 in bivariate analysis that tends to associate with malaria infection. The reason for selecting variable with p value<0.20 was providing chance to the variable which were not significance in bivariate analysis to be significance in multivariate model (Hosmer Jr et al., 2013).

There were 16 selected independent variables with p value <0.20 for multiple logistic regression and dependent variable was malaria cases & controls. These independent variables were age, sex, occupation, forest related job, interrural migration, interregional migration, pendular migration, seasonal migration, contract migration, knowledge, protective behavior, duration of travel to health facility, ability to access malaria health services, financial difficulties, history of malaria infection and seeking malaria treatment. After analysis of multiple logistic regression for 16 independent variables, only 7 independent variables predicted the risk of malaria infection at 5% significance level.

Table 16 described about the significant independent variables which predicted malaria risk in multivariate model. Age of respondents was significant predicted risk factor for malaria infection. Age 18 to 24 years group, and age 25 to 54 years increased malaria risk about 6.848 times and 6.071 times than the age group of 55 to 64 years (adjusted OR (AOR)=6.848, p value=0.006 and AOR=6.071, p value=0.004). The main job of respondents which related to forest were also risk factor and it increased malaria risk about 5.287 times than job which not related to forest (AOR=5.287, p value=0.020).

Non-contract migration was still risk factor for malaria infection and it increased malaria risk about 106 time than contract migration (AOR=106.218, p value<0.001) at 95% confidence interval.

Poor knowledge, moderate and poor protective behaviors were still statistically risk factors for malaria infection. Poor knowledge increased 3.982 times, moderate protective behavior rose 5.702 times and poor protective behavior increased 8.858 times to the malaria risk for migrant workers (AOR=3.982, p value=0.005, AOR=5.702, p value=0.001 and AOR=8.858, p value<0.001 respectively) at 5% significance level. Therefore, poor knowledge, moderate and poor protective behavior were important determinant factors for malaria infection.

Difficulty in access to malaria health services was still statistically risk factor for malaria infection and it increased malaria risk about 34.286 times than respondent who got easily access to malaria health services at 95% significance level (AOR=34.286, p value=0.001). Respondents who sought treatment after 24 hours from onset of malaria symptom was also 3 times more likely to be risk for malaria infection than respondents who sought treatment within 24 hours (AOR=3.034, p value=0.005) at 95% confidence interval.

Table 16 Multivariate model of association between significant variables and malaria infection risk

Variables (n=320)	Adjusted OR	95% CI		P- value
		Lower	Upper	
Age				
55 to 64 years	1			
18 to 24 years	6.848	1.730	27.109	**0.006***
25 to 54 years	6.071	1.758	20.971	**0.004***
Sex				
Female	1			
Male	1.175	0.619	2.232	0.621
Occupation				
Non-forested worker	1			
Forested worker	2.483	0.578	10.660	0.221
Others[1]	2.019	0.528	7.716	0.304
Forest related				
Not related	1			
Related	5.287	1.296	21.570	**0.020***
Interrural migration				
Interrural migration	1			
Non-interrural	1.280	0.533	3.073	0.581
Interregional migration				
Non-interregional	1			
Interregional	1.968	0.710	5.456	0.193
Pendular migration				
Non-Pendular	1			
Pendular	0.615	0.214	1.770	0.368

**Statistically significant at p value <0.05*

Others[1]-Fisherman, Factory worker, Teacher, Bishop, building construction worker, Coal mine worker, car driver and betel farmer;

Table 16 Multivariate model of association between significant variables and malaria infection risk (Continued)

Variables (n=320)	Adjusted OR	95% CI		P- value
		Lower	Upper	
Seasonal migration				
Non-seasonal	1			
Seasonal	0.833	0.284	2.444	0.739
Contract migration				
Contract	1			
Non-contract	106.218	9.685	1164.938	**<0.001***
Knowledge				
Good Knowledge	1			
Moderate Knowledge	1.542	0.645	3.690	0.330
Poor Knowledge	3.982	1.516	10.456	**0.005***
Protective Behavior				
Good protective behavior	1			
Moderate protective behavior	5.702	2.061	15.779	**0.001***
Poor protective behavior	8.858	2.822	27.805	**0.000***
Duration of travel to health facility				
Less than 30 Minutes	1			
More than 30 minutes	2.192	0.899	5.342	0.084
Ability to access malaria health services				
Easy access	1			
Difficult access	34.286	4.379	268.480	**0.001***
Financial difficulties				
No financial difficulties	1			
Having financial difficulties	0.948	0.301	2.993	0.928
History of malaria infection				
Never get infection	1			
Ever get infection	1.372	0.679	2.774	0.379
Seeking malaria treatment				
Within 24 hours	1			
After 24 hours	3.034	1.411	6.526	**0.005***

**Statistically significant at p value <0.05*

CHAPTER V

DISSCUSSION, CONCLUSION & RECOMMENDATION

This chapter explain about discussion & conclusion and recommendation for research finding of this study.

5.1. Discussion

This study was unmatched case-control study and it aimed to identify (1) the migration pattern of border migrant people and (2) the factors associated with malaria infection for border migrant people who lived in Dawei, Thayetchaung and Palaw townships of Tanintharyi region which are located in Myanmar-Thailand border area. Moreover, the study pointed out the association between socio-demographic factors, migration patterns, knowledge on malaria, protective behavior, treatment seeking behavior of border migrant people and malaria infection.

The participants of this study were migrant worker with 18 years of age and over. The total participants were 320 with 160 cases and 160 controls. For case and control identification, rapid diagnostic test (RDT) was used. Data were collected by using structure questionnaires with face to face interview during March to May 2018.

5.1.1. Sociodemographic factor of migrant worker

In this study, majority of respondents for cases & controls were male with middle age (25 to 54 years), forested related workers, Kayen ethnicity, nationality of Myanmar, married, with primary education, moderate income and local residents along the border area. However, non-local residents were nearly half of total respondents and most of the cases among non-local residents were under 1 year duration of stay in this border area.

The study described that two third of respondents was middle age group (25 to 54 years) and highest positive cases (66.9%) was also found in this age group. Generally, most of the migrant workers conducted migration in middle age of their life because middle age is their prime working age (Organization for Economic Cooperation and Development, 2018). Young age group (15 to 24 years) of respondents had low malaria cases than middle age group, however, young age group had statistically higher odd ratio than middle age group compared with older age group (55 to 64 years). This factor indicated that young age group had experienced about 4 times of malaria risk and middle age group had occurred about 2.8 times with the same reference of old age group at 5% significance level (p value <0.05) although middle age group had higher participants and higher positives cases than young age group. It means that young age group had higher malaria risk than middle and older age group. This finding was agreed with previous study in which young age had high risk of malaria infection than older age and this study was conducted among migrant workers in Chaing Rai Province, Thailand (Chaveepojnkamjorn et al., 2005).

A number of male and female respondents were not too much different in this study but male was more likely to get malaria infection than female. So, male had higher risk of malaria infection for 2.2 times than female at 95% confidence interval (p value=0.001). According to nature of gender, male had to work at hard to reach and difficult work area than female and then, male had more occupation risk than female. This fact was matched with world health organization report that mentioned male had higher occupation risk than female(World Health Organization, 2007). Moreover, this fact was coincided with other study conducted in Myanmar in which male have higher occupational malaria risk than female (Soe et al., 2017).Therefore, male was more prone to suffer malaria infection than female.

Most occupation of migrant workers in the border area were dealing with forest because Myanmar-Thailand border are still rural area and most of the border area are filled with forest. Then, 42.2% of respondents in this survey were forested workers and the rest of occupation took nearly same proportion (each about 10%). Among malaria cases, more than half of respondent (63.8%) worked as forested workers whereas 20.6% of controls were forested workers. Therefore, forested workers were also risk factor for malaria and it increased about 7.118 times than non-forested worker (reference group)

at 5% significance level (p value<0.001) because they had more chance to expose to *Anopheles* mosquito in the forest. This event was coincided with other study in which forested workers had high malaria infection than others occupation (Chaveepojnkamjorn et al., 2005, Tipmontree et al., 2009). But other occupations were not statistically associated with malaria infection at 95% confidence interval.

The job nature of migrant worker was important factor for malaria infection. About 70% of respondents worked at forest related job and they had more chance to expose *Anopheles* mosquito. Forest related jobs were risk factor for malaria infection and migrant workers did these kinds of jobs increased about 10 times than those worked non-forest related job at 5% significance level (p value<0.001). This event agreed with other study in which forest related worker had high odd ratio than non- forest related workers (Erhart et al., 2005)

Kayen ethnic group was the largest ethnic group in the border area and 60% of respondents in this study was Kayen ethnicity. Moreover, second largest ethnic group was Burma. Ethnicity was not associated with malaria infection in this study and this fact was coincided with other study conducted among migrant population in Thailand-Myanmar border area in which there was no association between ethnicity and malaria infection (Chaveepojnkamjorn et al., 2005). Three quarter of migrant workers were married and more than 80% of migrant workers had no high school education. Most of the migrant workers had moderate income about 1,200,001 to 2,600,000 MMK and median yearly family income of migrant workers was about 1,800,000 MMK. Family size distribution of migrant workers were nearly the same but less than 3 family members had relative high malaria cases than more than 3 family members. Cases and controls distribution of ethnicity, marital status, education level, yearly total income and family size were not significance different. Therefore, these independent variables were not associated with malaria cases and controls at 95% confidence interval. Among these variables, some factors were agreed with previous study conducted in Thailand-Myanmar border area and some were different. In this previous study, family income and race were also not associated with malaria infection but education level was associated with malaria infection (Chaveepojnkamjorn et al., 2005).

Nearly half of the respondents were not local border resident and migrated to border area. Therefore, non-local residents were risk factor and they had about 1.6 times

risk of malaria infection than local resident at 5% significance level because they came from non-malaria area and no immunity to malaria infection whereas local resident had already developed malaria immunity. Among non-local resident, duration of migration was associated with malaria cases and controls. Their migration duration, under 6 months increased about 5.9 times, and between 6 months and 1 years had increased about 4.33 times than at least 3 years migration at 95% confidence interval because migrant workers with more than 3 years duration of migration had assumed that they already developed malaria immunity but under 6 months, and between 6 months and 1 year duration migrant worker had not well-developed malaria immunity. This fact supported with other study done in Myanmar-Thailand border area in which recent migrant worker had high malaria risk than local resident or long duration of migration in endemic area (Sriwichai et al., 2017). Some study reported that immunity developed after heavy, frequent, uninterrupted exposure to *Plasmodium* species (Doolan et al., 2009). Therefore, migrant workers with long duration in the border area had less likely to suffer malaria infection than short duration of migrant workers.

5.1.2. Migration pattern of migrant worker in Myanmar-Thailand border area

In this study, majority of respondents conducted interrural migration and they worked at forest related area. Nearly half of the migrant workers conducted non-interrural migration in which number of intermunicipal & interregional migrant workers were not significantly different. This fact pointed out that most of the local residents were migrating along the border area within Tanintharyi region. Moreover, more than half of the intermunicipal and interregional migrant worker arrived this border area less than 1 year duration. The percentage of pendular migration, seasonal migration and contract migration were lower than interrural migration. All of the malaria cases stayed at Myanmar side between previous 2 weeks and 3 months. This indicated that malaria infection sources were coming from Myanmar side in this survey.

More than half of respondents conducted interrural migration and they migrated in the border area within their township. Most of the interrural migrant workers were local border residents and they had experience of malaria infection because they were

living in endemic area. It supported for developing of malaria immunity among interrural migration. Therefore, non-interrural migrant workers were more likely to occur malaria infection (1.6 times increased) than interrural migration workers (p value=0.034) due to no immunity in non-interrural migrant workers. This phenomena was supported with other study in which they mentioned that people living in endemic area acquired immunity due to frequent exposure (Chiyaka et al., 2007).

Intermunicipal migration was about 20% of total migration and most of the intermunicipal migrant workers came from Pa Lauk townships. There was no association between intermunicipal migration and malaria infection because all of these migrant workers were living in Tanintharyi region and it is also malaria endemic area. Therefore, it can be assumed that these migrant workers had already developed malaria immunity. Interregional migration was about one third of total migration and mostly came from Ayyawaddy and Bago regions. Interregional migration was associated with malaria infection and it increased malaria risk about 1.8 times than non-interregional migration because interregional migrant worker came from another region except Tanintharyi region and they had no immunity to malaria. Development of malaria immunity was depended on duration, species specific and degree of exposure. The phenomena was supported with previous study (Acquired immunity to malaria) in which they mentioned about the consequences of malaria immunity (Doolan et al., 2009). So, they were more likely to suffer malaria infection

Small number of migrant workers (16.6%) conducted pendular migration and they mostly crossed the border at quarterly. But pendular migration was not associated with malaria infection at 95% confidence interval. Moreover, few number of migrant workers conducted seasonal migration and half of the seasonal migrant worker employed at summer season. In this study, seasonal migration was risk factor for malaria infection and seasonal migrant worker had experienced about 2.99 times than non-seasonal migrant worker at 5% significance level because malaria was seasonal disease (Hu et al., 2016) and it peak season in Myanmar are starting in the end of summer to beginning of rainy season and, another peak, in the end of rainy to the beginning of winter season. However, main season of seasonal migrant workers and type of seasonal job were not associated with malaria infection.

Non-contract migrant worker was statistically risk factor for malaria infection and they increased malaria risk about 2.609 times compared with contract migrant workers at 95% confidence interval. The reason of relatively more malaria risk in non-contract migrant worker was that most of the contract migrant workers had their own health services and protective measures provided by their company or contractor compared with non-contract migrant worker who had no health services. Therefore, contract migration was less likely to be infected. Type of contract migration was not associated with malaria infection because there was not too much different for their health services provided by their contractor. Living place of migrant workers between previous 2 weeks and 3 months ago had no association with malaria infection because more than 95% of respondent stayed in Myanmar side between previous 2 weeks and 3 months ago.

5.1.3. Knowledge of migrant worker

Majority of respondents (44.1%) had moderate knowledge about malaria infection and poor knowledge was 37.5% and respondents with good knowledge was less than 20%. Moreover, nearly half of cases had poor knowledge and about 80% of controls had good and moderate knowledge.

There were significant association between poor knowledge and malaria infection but moderate knowledge did not have any association at 95% confidence interval. Poor knowledge increased about 3 times of malaria risk than good knowledge (p value=0.001). This fact agreed with other study in which poor knowledge had high odd ratio than good knowledge and this study was conducted in Myanmar-Thailand border area (Htike, 2015). Respondents with poor knowledge did not know about transmission and symptom of malaria infection and breeding site of *Anopheles* so that they were more likely to suffer from malaria infection. In contrary, respondents with moderate knowledge well knew about transmission and symptom of malaria infection and breeding site of *Anopheles*. Therefore, they would be practiced prevention and early treatment seeking behavior for malaria infection. The main difference between good knowledge and moderate knowledge were drug resistance malaria and larvicide knowledge.

As a result, malaria health program should give more health education about transmission and symptom of malaria infection, breeding site of *Anopheles* and protective measures to migrant worker to protect risk of malaria from migrant workers because they are more vulnerable community for malaria infection and most of them had no malaria immunity.

5.1.4. Protective behavior of migrant work for malaria infection

More than half of respondents had moderate protective behavior (58.4%) and migrant workers with good protective behavior was only 13.2%. Most of the migrant workers had practiced moderate and poor protective behavior because they emphasized on their occupation, most of them were middle age of life which had good health condition and they resisted illness than young and older people.

Moreover, only 5% of total cases had good protective behavior whereas about 80% of controls had good and moderate protective behavior. Therefore, protective behavior to malaria infection was the most important factor among malaria prevention and control. Poor protective behavior and moderate protective behaviors were significant risks factor for malaria infection and both rose malaria risk about 7.1 times and 4.3 times than good protective behavior at 5% significance level (crude OR=7.125 and crude OR=4.389, respectively). This factor indicated that level of protective behavior was inversely proportional to malaria infection. Therefore, local health authorities and non-government organization both international and national organization who conducting malaria project should give health education for using of protective measures to prevent malaria infection. Most of the poor protective behavior came from the questionnaires dealing with wearing of long sleeves, usage of mosquito repellent creams, cleaning of larvae near home and LLIN use in outside and forest.

5.1.5. Treatment seeking behavior of migrant worker for malaria infection

Migrant workers practiced different forms of treatment seeking behavior and unusual health practice because they had less source of information, their priority was

their career, most of them had healthiest time of their life and then, they were migrating from place to place so that they did not familiar with new migrating area and situation. Moreover, they had high risk of malaria infection due to immunity differences.

Majority of respondents sought malaria treatment from Myanmar health facility and volunteer malaria workers. Few numbers of migrant workers cross the border area and sought health services in Thai health facility. Some respondents also practiced self-treatment and they took some medicine by themselves. Among self-treatment, 62.8% of respondents took paracetamol, 22.5% took traditional medicine and 14.7% took anti-malaria drug. Paracetamol and antimalarial drugs are over the counter drug in Myanmar and everyone can easily buy from drug store and taken even they did not know their disease. Nevertheless, there was no association between treatment seeking place including self-treatment and malaria infection because all of health services can give proper malaria treatment.

Migrant workers are vulnerable population of the community and their reason of provider choice was important factor for promoting of health services. If health services were not reasonable with the need of migrant workers, they would be difficult for getting of health services and accident of malaria infection would be high. Majority of respondents chose the provider mainly two reasons; nearest and free of charge. These findings was agreed with other study in which more than 70% of people chose nearest health provider and then, this study was also was conducted in Myanmar (Aung et al., 2016). Although, reason of provider choice was not associated with malaria infection at 95% confidence interval, health authorities should provide more malaria health services for easily available of migrant people with free of charge.

Duration of travel to health facility was one of the important influencing factor that determined malaria incidence in Myanmar because most people neglected their illness if health facility was too far away from their home until their disease severe. So, malaria transmission was also high in these people and they got more severe complication of malaria disease. In this study, 68.1% of respondents stayed at the location of less than 30 minutes duration by motor cycle and the rest were more than 30 minutes duration. Moreover, duration of travel to health facility was associated with malaria infection and it was also risk factor for malaria infection. Duration of travel to health facility by motor cycle more than 30 minutes increased risk about 2.275 times

than shorter duration of travel (less than 30 minutes) at p value 0.001. This finding was supported with many studies in which household located far away from health facility was more likely to delay seeking malaria treatment (Barja et al., 2016, Das et al., 2010, Xu et al., 2012).

Twenty percent of respondents thought that they did not easily access malaria health services although all malaria health services are free of charge and malaria health volunteer present in most of the village. Those migrant workers had suffered malaria infection about 2.59 times than migrant workers with easily access of malaria health services at 95% confidence interval and the reason was that these migrant workers recently arrived the border area and they had less source of health information. Financial difficulties were one of the associated factor for malaria infection. More than 80% of respondents did not have financial difficulties for getting of malaria services because all malaria treatments were free of charge in Tanintharyi Region. But some migrant workers had financial difficulties for seeking of malaria health services because they needed to pay travel cost and other indirect costs even malaria treatment was free of charges. Migrant workers with financial difficulties increased malaria risk about 2 times than migrant workers without financial difficulties because financial difficulties caused delay treatment seeking behavior and then, this caused higher malaria transmission and severe complication.

More than half of the respondents had history of malaria infection in the past because most of respondent were living in malaria endemic area and they were likely to have malaria infection. Moreover, 58% of cases had history of infection and all of these factors indicated that migrant workers with past malaria infection had to be occur next malaria infection again because *Plasmodium vivax* can hide in liver as hypnozoite for a long time (long latency period) without symptom and it can reemerge again when favorable condition occur (White, 2011). This condition is called relapse and it is agreed with this study in which migrant workers with past malaria infection increased malaria risk about 1.69 times than migrant workers with no past malaria history at 5% significance level. And then, among migrant workers with history of malaria infection, only *Plasmodium vivax* was associated with malaria infection whereas other *Plasmodium* infections did not associate. *Plasmodium vivax* increased next malaria infection risk about 2.6 times than *Plasmodium falciparum* at 95% confidence interval

(p value=0.048). This phenomenon was coincided with other study conducted in Nepal in which 17% of malaria infection (*Plasmodium vivax*) was due to relapse which was confirmed by genotypes (Manandhar et al., 2013).

Respondents sought malaria treatment after 24 hours was 76.6% of total respondents and late treatment was risk factor for malaria infection. Moreover, it increased malaria risk about 1.823 times than respondents sought malaria treatment within 24 hours at p value 0.026. This factor was supported with previous study in which more than 50% of malaria patient sought malaria treatment after 24 hours (Xu et al., 2012).

Among respondents with past malaria infection, 17% of respondents did not take full course of antimalarial treatment in past malaria infection and this is bad drug compliance. It was risk factor for malaria infection and it increased about 2.7 times than respondent with good drug compliance at 5% significance level. The reason was that respondents who did not take full course of anti-malaria drug especially primaquine that allowed hypnozoites and gametocytes in the body and they will reemerge again when they have favorable condition (White, 2011).

For respondents with no history of malaria infection, there was no association between experience of taking antimalarial drug and malaria infection. But, taking of anti-malaria drug without malaria infection will lead to development of drug resistant malaria and drug resistant is hot issue in Myanmar-Thailand border area (Wongsrichanalai et al., 2001). Therefore, taking of anti-malaria drug without malaria infection should be avoided.

5.1.6. Multivariate model of association between significant variables and malaria infection risk

Multivariate analysis was used to describe clear association of sociodemographic, pattern of migration, knowledge, protective behavior and treatment seeking behavior of migrant workers and malaria infection in bivariate analysis because some variables were not significance in bivariate analysis at 95% confidence interval but it can be significance in multivariate analysis (multiple logistic regression). So,

variables with p value <0.2 were considered cut off point for final model of association and clear picture of infection risk (Hosmer Jr et al., 2013).

In multivariate analysis, firstly 16 variables were added as independent variables and dependent variable was malaria infection. After analysis, only 7 independent variables were significance at 95% confidence interval. The significance independent variables in multivariate analysis were age, forested related job, contract migration, knowledge on malaria, protective behavior, ability to access malaria health services and seeking malaria treatment.

Age was one of the predicted factor for malaria infection in bivariate and multivariate analysis. Young age (18 to 24 years) group and 25 to 54 years group increased malaria risk about 4 time and 2.8 times in bivariate analysis but its increased about 6.848 time and 6.071 times respectively in multivariate analysis. This factor indicated that young age group had more chance of getting malaria infection than older age because most of the older migrant workers had experience of malaria infection and they already developed malaria immunity but young age migrant workers had no experience and more likely to suffer malaria infection.

Forest related job was significant risk factor with malaria infection in both bivariate and multivariate analysis. This indicated that forest related job had higher malaria risk and it increased about 5.287 times than non-forest related job because *Anopheles* mosquito present in the forest and they transmitted *Plasmodium* species to the people. Non-contract migrant worker had more likely to be infected for malaria infection compared with contract migrant worker and it was significant in both bivariate and multivariate analysis. The reason was that most of contract migrant workers had their own health services provided by their company or contractor whereas non-contract migrant worker didn't have own health services. Therefore, non-contract had more malaria risk than contract migrant worker.

Knowledge and protective behavior were still significant in bivariate and multivariate analysis. These factors were unquestioningly and poor knowledge and protective behavior rose malaria risk. Moderate and poor protective behavior had higher odd ratio in multivariate analysis than bivariate analysis and it indicated protective behavior was very important factor in malaria infection. Moderate and poor protective behavior had 4.3 and 7.1 odd ratio comparing with good protective behavior in bivariate

analysis whereas multivariate analysis, the odd ratio of those were 5.7 and 8.8 times respectively at 5% significance level.

Migrant workers thought that they could not easily access malaria health services was prone to get malaria infection and it increased malaria risk about 34.2 times than migrant workers who thought that they could easily access to malaria health services. Migrant workers sought malaria treatment after 24 hours was risk factor and it increased about 3 times than respondent who sought within 24 hours. Therefore, malaria program should promote more malaria health services and they should give more health education session, furthermore, inform the residents for the location of providing malaria health services they can seek for diagnosis and treatment and the provided service should be free of charge.

5.2. Conclusion

The main purpose of this case-control study was to identify migration pattern and associated factors to malaria infection in Myanmar-Thailand border area especially Dawei, Thayetchaung and Palaw township, Tanintharyi region. The findings will support to the local health authorities and NGO because malaria elimination was going in GMS countries including Myanmar and migrant workers were vulnerable population of community and they will be main distributors of malaria infection in the community on the way malaria elimination.

5.2.1. Sociodemographic factor of migrant worker

Most of the cases in this study were male with middle age, forested worker, Kayen ethnicity, Myanmar nationality, married and they achieved primary education. More than half of the cases was not local border residents and duration of migration in the border area was under 1 years. All of these factors pointing out these migrant workers who were non-local residents with less than 1 year duration of migration had more likely to suffer malaria infection.

Young age male migrant workers with forested occupation, non-local residents and duration of migration less than 1 year duration in border area was statistically associated with malaria infection in this study and all of these factors participating for

more malaria infection. Forest related job was most significant factor that distributed higher malaria positive rates (10 times) than non- forested related job. Forest are the main habitat of *Anopheles* mosquito and then, these migrant workers were carrier for distributing of malaria infection from forest to rural community. Then, the most important point was that local residents was less likely to occur malaria infection than non-local resident because Tanintharyi region are malaria endemic area and they already developed malaria immunity and resist to infection. Moreover, even non-local resident, they arrived border area more than 3 years had less likely to suffer malaria infection than under 1 year duration because it had assumed that they already exposed to malaria infection and developed immunity. Therefore, non-local resident migrant workers with under 1 year duration of migration should be considered as first priority migrant workers for screening of malaria infection and protective intervention.

5.2.2. Pattern of migration

More than half of the respondents conducted interrural migration and they migrated within their township of Tanintharyi region in border area. Interrural migration was relatively protective factor for malaria infection compared with non-interrural migrant workers and these migrant workers had less likely malaria cases than non-interrural migrant workers. Intermunicipal and interregional migration conducted about half of the total respondents. There was no association between intermunicipal migration and malaria infection and same number of malaria cases and controls were happened in intermunicipal migration. But interregional migration was statically associated with malaria infection and it increased malaria risk about 1.8 times than non-interregional migration. The reason was that interregional migrant workers came from another region except Tanintharyi region and they had no malaria immunity.

Although seasonal migrant workers were few percentage of migration in this study but seasonal migration was one of the risk factor for malaria infection. While, contract migration was statistically associated with malaria infection and it had less malaria infection than non-contract migrant workers due to easily available of health services even it was few percentage of total migration.

Among different types of migration, interregional migration and seasonal migration were statistically risk factors for malaria infection but contract migration had relative less malaria infection compared with non-contract migration. Moreover, all of the malaria cases stayed at Myanmar side at previous 2 weeks to 3 months ago, this indicated that sources of malaria infection were coming from Myanmar side. Therefore, malaria program and international non-government organization should emphasize on interregional migration and seasonal migration and gave protective measures and malaria information to them.

5.2.3. Knowledge of migrant worker

Migrant workers had few percentage of good knowledge. But nearly half of cases had poor knowledge and half of controls had moderate knowledge. Poor knowledge was one of the predicted risk factor than good knowledge but having moderate knowledge did not rise malaria infection risk than good knowledge at 95% confidence interval. Most of poor knowledge came from the questionnaires related with breeding site and resting place of malaria mosquito, drug resistant malaria, usage of larvicides and most migrant workers did not know backache and joint weakness as malaria symptom.

5.2.4. Protective behavior of migrant worker for malaria infection

Ninety-five percent of cases practiced poor and moderate protective behavior whereas 80% of controls performed good and moderate protective behavior. This fact indicated that poor and moderate protective behavior was one of the main predictive risk factor for malaria infection and its increased malaria risk remarkably. But good protective behavior provided as predicated protective factor for malaria infection compared with moderate and poor protective behavior. Then, 13% of total respondents in this study had good protective behavior and it pointed out migrant workers needed to practice more good protective behavior and it was one of the reason for increasing malaria infection in the border area. So, good protective behavior was one of the

important factor influencing malaria transmission but most of the migrant workers still needed to have more good protective behavior.

5.2.5. Treatment seeking behavior of migrant worker for malaria infection

Most of respondents sought malaria health services in nearest volunteer and Myanmar health facility with the reasons of nearest and free of charge. Few percentage of migrant workers conducted self-treatment and some crossed the border and received treatment from Thai health facility. Some respondents took antimalarial drug as self-treatment and it may cause more drug resistance problem in the border area. Duration of travel to health facility was inversely proportional to malaria infection because most of migrant workers neglected their disease when duration of travel to health facility was too far away. But most of the respondents in this study were located within 30 minutes far away from health facility.

About 80% of respondents thought that they could easily access malaria health services. This factor was statistically associated with malaria infection and not easy access to health facility increased malaria risk significantly. Financial difficulties for accessing of malaria health services were statistically associated with malaria infection and it increased malaria risk about 2 times than without financial difficulties. Most of the financial difficulties was travel cost because some migrant worker lived in hard to reach area.

Three quarter of migrant worker sought malaria health services after 24 hours of onset of fever. Moreover, more than half of respondents had past malaria history and they were more likely to occur malaria infection again. Among respondents with past malaria history, respondents with *Plasmodium vivax* was statistically associated with malaria infection and it increased malaria risk about 2.6 times than respondents with *Plasmodium falciparum*. One of the reason for this event could be respondent with past malaria infection did not take full course of anti-malaria drug especially primaquine which allowed development of hypnozoite and it could be reemerge again as relapse. Generally, respondent with *Plasmodium vivax* had bad drug compliance because symptom of *Plasmodium vivax* was not severe and duration of primaquine treatment

was too long (14 days). These factors supported that occurrence of relapse cases in some respondent. So, treatment seeking behaviors was one of the important factor for malaria infection risk.

5.2.6. Multivariate model of association between significant variables and malaria infection risk

Multivariate model was calculated to describe clear association with many independent variables & dependent variables which were associated in bivariate analysis with p value <0.2. The 16 independent significant variables were added for multivariate analysis and only 7 independent variables were significant and risk factors for malaria infection at 95% confidence interval. These independent variables were age, forest related job, non-contract migration, knowledge, protective behavior, ability to access malaria health services and seeking malaria treatment. Among these variables, non-contract migration, poor protective behavior and difficult to access malaria health services were strongest predictors and these variables increased malaria risk significantly at 99% confidence interval.

5.3. Recommendation

Based on the finding of this study, the following interventions should be considered for malaria controls and prevention of migrant worker.

Local Health Authorities, INGO and NGO should conduct these recommendations.

1. Regular malaria screening should be targeted non-local residents with duration of migration less than 1 year duration and forest related migrant workers.
2. Promoting of more health services for easily available for migrant workers
3. Malaria health services should be targeted to interregional migrant workers and seasonal migrant workers.
4. Promoting of malaria health education to migrant workers because these migrant workers are vulnerable population and they have less source of information for health services.

5. Non-interrural migrant workers came from another area and most of them did not have bed nets and other protective measures. So, local health authorities should distribute sufficient amount of bed net, mosquito repellent cream and spray to these migrant workers.
6. Forested workers, seasonal migrant workers and non-interrural migrant workers were high risk population for malaria infection so that targeted malaria screening to these people, giving health education frequently about the usage of bed net and how to seek malaria health services and then, health authorities should conduct quickly follow up activities (1,3,7 methods) for malaria positive patients.
7. Frequently updating migrant workers list and providing of necessary protective materials to migrant workers because migrant workers are always moving from place to place and they have difficulties to access malaria information and protective materials.
8. Local health authorities should build migration information network among migrant workers for early reporting and quick intervention process for these migrant workers.
9. During health education to migrant worker, malaria health education program including INGO and local NGO should emphasize on protective behavior for mosquito bite, transmission of malaria infection and more awareness of drug resistant malaria.

Migrant workers should conduct these recommendations

1. Encouraging migrant workers to practice good protective behavior such as bed net usage, bring of LLIN to the forest and outside use, applying mosquito repellent cream, regular screening of malaria test especially when they come back from the forest, removing of larvae source near their house.

2. Encouragement for removing of larvae sources near their house by these ways;
    (i) Cleaning bushes and stagnant water near the house
    (ii) Cleaning dark space in their house
    (iii) Creating of water cask around their house

(iv) Usage of larvicides

3. Encouragement for well usage of LLIN for malaria infected patient for prevention of transmission to another people.

5.4. Limitation

This study was conducted during a short period and there was no enough information for annual data of border area. Therefore, we could not assess malaria seasonal prevalence in migrant population. Recall bias was also limitation of this study due to study design. Moreover, other cofounding factors which affected on the prevalence of malaria infection were household characteristics & its environmental factors, IRS activities and LLIN distribution in community. This was also limitation of this study. Microscopy is gold standard for malaria diagnosis but this study used Rapid Diagnosis Test (most reliable test except microscopy). This was also one of the limitation in this study. Then, the study conducted among migrant people and there were difficulties to catch all migrant people and difficult to assess detail information from migrant population. So, the finding of this study could be limited to cover whole migrant population and therefore, additional research should be considered.

5.5. Further study

1. The future study should expand the survey to all migrant workers and through the whole year to get more valid, annual data and seasonal trend of malaria infection.
2. The future study should expand dealing drug resistance problem in Myanmar-Thailand border area because migrant workers are main distributor of drug resistant parasites to other areas.
3. The future study should be conducted in Thailand side to clear full picture of border migration and malaria infection in Thailand-Myanmar border area.
4. The future study should be conducted qualitative and quantitative study to find out in depth and detail process of malaria infection in migrant workers because life style and their believes are different from local resident.

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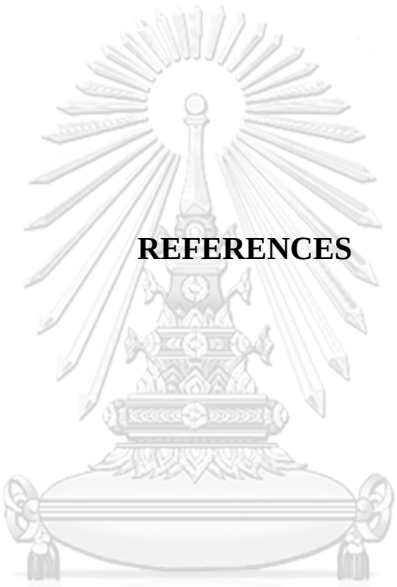

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APPENDIX
APPENDIX A

Questionnaires (English Version)

Survey tool used for data collection

"Migration and Malaria Infection in Myanmar-Thailand border area of Tanintharyi Region, Myanmar: A Case-Control Study"

Structured Survey Questionnaires

A. Sociodemographic information

No	Question	Answer	Code	Instruction
1	Age	( ) years		
2	Sex	Male	1	
		Female	2	
3	Main occupation	Farmer	1	
		Fisherman	2	
		Rubber plantation worker	3	
		Oil Palm planation worker	4	
		Forest worker	5	
		Merchants	6	
		Road construction	7	
		Dependent	8	
		Other	9	
		( )		
4	Ethnicity	Burma	1	
		Mon	2	
		Kayen	3	
		Other	4	

		( )		
5	Nationality	Myanmar	1	
		Thailand	2	
		Other	3	
		( )		
6	Marital status	Single	1	
		Married	2	
		Widowed	3	
		Divorced	4	
		Separated	5	
		Don't answer	99	
7	Education	Never attend school	1	
		Primary education	2	
		Secondary education	3	
		High school education	4	
		Graduated/ Post-graduated education	5	
		Other	6	
		( )		
8	Family average income	( ) MMK		
9	How many house-hold members including you stay in your home?	( ) person		
10	Are you local resident?	Yes	1	Yes, skip Q 11
		No	0	
11	How long have you been here?	Under 6 months	1	
		Bet;6 months and 1 year	2	
		Bet; 1 year and 3 years	3	

		More than 3 years	4	
		Don't remember	99	

B. Pattern of Movement/ Migration

No	Question	Answer	Code	Instruction
12	Are you only live in your village? (no movement)	Yes	1	Yes, go to Q 31
		No	0	
13	Are you a migrant worker or traveler?	Yes	1	No, go to Q 31
		No	0	
14	Do you cross the border and mainly work at another country? (eg; Myanmar worker work at Thailand side or vice vasa)	Yes	1	Yes, go to Q 23
		No	0	
	If you are working/traveling mainly at Myanmar side and not cross the border			
15	Are you living in this township?	Yes	1	Q 15- Yes, skip Q 17 to Q 20 / No, skip Q 16
		No	0	
16	Are you working or travelling along the border area, not crossing the border?	Yes	1	
		No	0	
17	Are you coming from another township within Tanintharyi Region and working at Myanmar border area if this township is not your home town?	Yes	1	Q 17- Yes, skip Q 19 to Q 20 / No, skip Q 18
		No	0	
18	Where are you from? (Township)	( )		
19	Are you coming from another region and working at Myanmar border area if this region is not your home town?	Yes	1	
		No	0	
20	Where are you from? (Region)	( )		

21	How long have you been working here?	Under 6 months	1	
		Between 6 months and 1 year	2	
		Between 1 year and 3 years	3	
		More than 3 years	4	
		Don't remember	99	
22	Does your main job relate to the forest?	Yes	1	
		No	0	
	If you are crossing the border and work at another country or foreigner,			
23	Are you crossing the border daily or regularly?	Yes	1	Q 23 - Yes, skip Q 25 to 29/ No, skip Q 24
		No	0	
24	How frequently do you cross the border?	Daily	1	
		Weekly	2	
		Monthly	3	
		Quarterly	4	
		Yearly	5	
25	Are you the seasonal migrant worker? (Gold mine worker, seasonal rubber plantation)	Yes	1	Q 25 - Yes, skip Q 28 to 29/ No, skip Q 26 to 27
		No	0	
26	Which season do you work most?	summer season	1	
		rainy season	2	
		winter season	3	
		other	4	
		( )		
27	What is your type of job as seasonal migrant worker?	Rubber plantation	1	

		Oil palm plantation	2	
		Farmer	3	
		Gold mine worker	4	
		Other	5	
		( )		
28	Are you a migrant worker contracting with company or owner? (eg. Road construction or foreign company)	Yes	1	
		No	0	
29	What is your type of job as contract migrant worker?	Road construction	1	
		Building construction	2	
		Security	3	
		Factory workers	4	
		Other	5	
		( )		
30	Where are you working between previous 2 weeks or 3 months ago?	Myanmar side	1	
		Thailand side	2	

C. Knowledge of malaria

No	Statement	Yes	No	Don't know
31	**Malaria can be transmitted through**			
	Drinking contaminated water			
	Drinking mosquito eggs			
	Bite of malaria infected female mosquito			
	Eating banana			
	Dirty			
	Food poisoning			
	Close contact with malaria infected patient			
32	**Vector which can transmit malaria to human**			
	Rat			
	Mosquito			
	Fly			
	Cockroach			
33	**Breeding site of malaria mosquito**			
	Pond or lake			
	Stagnant water			
	Canal			
	Old tires			
	Dry area			
	Clean water			
34	**Resting place of malaria mosquito**			
	Bushes			
	Domestic animal shelters			
	Tropical forest			

	Dark corner in the house			
	Open space where sunlight reach			
35	**Vector active time**			
	Day time			
	Night time			
36	**Symptom of malaria**			
	Fever with chill and rigor			
	Headache			
	Sweating			
	Joint weakness			
	Backache			
	Diarrhoea			
37	**Diagnosis of malaria infection**			
	Blood testing			
	Family member/ relative told			
	Fever			
	Self-diagnosis			
38	**Malaria disease can be treated?**			
39	**Appropriate malaria treatment**			
	self-treatment			
	Taking antimalarial drug given by health staff/VMW			
	Purchasing antimalarial drug from shop			
	Taking of drug which given by neighbors			
40	**Reason of drug resistant malaria**			
	Incomplete treatment			
	monotherapy			

	No reason			
	Fake drug			
41	**Way to prevent and control malaria vector**			
	Emptying and removing of stagnant water			
	Trimming brushes around your house			
	cleaning dark space			
	Creating of water cask around your house			
	Using Larvicides			
	Maintaining of your houses (e.g. window screening)			

D. Protective behavior

No	Statement	Always (7 times/ week)	Often (5-6 times/ week)	Sometime (2-4 times/ week)	Once (1 time/ week)	Never (Didn't perform)
42	How often do you sleep under bed net in previous week? (Insecticide treated net/Long lasting insecticide treated net)					
43	How often do you bring Insecticide treated net/Long lasting insecticide treated net/bed net with you when you go to the forest?					
44	How often do you use bed net when you sleep outside?					
45	How often do you use mosquito repellent cream at night time in previous week?					

46	How often do you use mosquito coil in previous week?					
47	How often do you wear long sleeve clothes at night time in previous week?					

No	Statement	Always (4 times/ month)	Often (3 times/ month)	Sometimes (2 times/ month)	Once (1 time/ month)	Never (Didn't perform)
48	How often do you clean source of mosquito larvae near your home?					

E. Treatment seeking behavior

No	Question	Answer	Code	Instruction
49	RDT result at the time of interview	*Plasmodium falciparum*	1	
		Plasmodium vivax	2	
		Mixed Infection	3	
		No malaria infection	4	
50	How do you seek treatment if you suspect malaria infection?	No treatment	1	You can select more than one
		Self-treatment	2	
		Go to Quack	3	
		Go to nearest VMW	4	
		Go to Myanmar health facility	5	

		Go to Thai health facility	6	
		Other	7	
		( )		
51	If you make self-treatment, which drug do you take?	( )		
52	Why did you choose this provider?	Nearest	1	You can select more than one
		Free of charge	2	
		Inexpensive cost	3	
		Suggestion of relative or friend	4	
		Getting best services	5	
		Other	6	
		( )		
53	Which type of health services do you use most?	Quack	1	
		Nearest VMW	2	
		Myanmar health facility	3	
		Thai health facility	4	
54	How do you go to nearest health facility?	By Car	1	
		By Motorcycle	2	
		Walking	3	
		Other	4	
		( )		
55	How long does it take time to reach there?	( ) Min		
56	Do you think that you can access easily malaria health services?	Yes	1	
		No	0	

57	Do you have financial difficulties dealing with malaria health services?	Yes	1	
		No	0	
58	Do you have history of malaria infection?	Yes	1	Q 58- No, go to Q63
		No	0	
	If you had history of malaria infection,			
59	Do you seek treatment within 24 hours after onset of fever?	Yes	1	
		No	0	
60	Which malaria infection did you got?	*Plasmodium falciparum*	1	
		Plasmodium vivax	2	
		Plasmodium ovale	3	
		Plasmodium malariae	4	
		Mixed infection	5	
		Don't know	99	
61	How did they diagnose malaria infection?	RDT	1	
		Microscopy	2	
		Other	3	
		( )		
62	Did you take full course of antimalarial drug?	Yes	1	Finish survey
		No	0	
	If you didn't have history of malaria infection			
63	Did you ever go health services when you suspect malaria infection?	Yes	1	
		No	0	
64	Did you have experience of taking anti-malarial drug?	Yes	1	Finish survey
		No	0	

Questionnaires (Myanmar version)

တနင်္သာရီတိုင်းဒေသကြီး အတွင်းရှိ မြန်မာ-ထိုင်း နယ်စပ် နယ်နိမိတ် မြို့များဖြစ်သော ထားဝယ်၊ သရက်ချောင်း နှင့် ပုလော မြို့နယ် များတွင် ရွှေ့ပြောင်းသွား လာ နေထိုင်သူများနှင့် ငှက်ဖျားရောဂါ ဆက်စပ်မှုများအား သုတေသနပြုခြင်း စစ်တမ်းကောက် မေးခွန်းလွှာ

ကုတ်နံပါတ် (..... | .....) (..... | .....)

နေ့စွဲ ..... | ..... | .....

အပိုင်း (၁) လူမှုရေး ၊ စီးပွားရေးဆိုင်ရာအချက်အလက်များ

စဉ်	မေးခွန်း	အဖြေများ	ကုဒ်	ရည်ညွှန်းချက်
၁	အသက်	( ) နှစ်		
၂	ကျား/မ	ကျား	၁	
		မ	၂	
၃	အဓိက အလုပ်အကိုင်	လယ်သမား	၁	
		တံငါသည်	၂	
		ရာဘာခြံလုပ်သား	၃	
		ဆီအုန်း လုပ်သား	၄	
		သစ်တောနှင့်ဆက်စပ်သောလုပ်သား	၅	
		ကုန်သည်	၆	
		လမ်းပြင်လုပ်သား	၇	
		မှီခို	၈	
		အခြား	၉၉	
		( )		
၄	လူမျိုး	ဗမာ	၁	
		မွန်	၂	
		ကရင်	၃	
		အခြား	၉၉	
		( )		
၅	နိုင်ငံသား	မြန်မာ	၁	
		ထိုင်း	၂	

၆	အိမ်ထောင်ရှိ/မရှိ	အပျို/လူပျို	၁	
		အိမ်ထောင်ရှိ	၂	
		ကွာရှင်း	၃	
		အိမ်ထောင်ကွဲ	၄	
		မုဆိုးဖို/မုဆိုးမ	၅	
		မဖြေပါ။	၉၉	
၇	ပညာအရည်အချင်း	ကျောင်းမနေဖူး	၁	
		အခြေခံပညာအောင်	၂	
		အလယ်တန်းအောင်	၃	
		အထက်တန်းအောင်	၄	
		တက္ကသိုလ်/ဘွဲ့ရ	၅	
၈	မိသားစု ဝင်ငွေ (ခန့်မှန်း)	( ) ကျပ်		
၉	သင်အိမ်တွင် သင်အပါအဝင် မိသားစု ဘယ်နှစ်ယောက်ရှိသလဲ။	( ) ယောက်		
၁၀	ဒီမြို့ ဒီရွာက ဖြေဆိုသူရဲ့ဇာတိလား	ဟုတ်တယ်	၁	ဟုတ်တယ်ဆိုရင် (၁၂) သို့ ကျော်မေးပါ။
		မဟုတ်ပါ	၀	
၁၁	ဒီကို ရောက်တာ ဘယ်လောက်ကြာပြီလဲ	၆ လအောက်	၁	
		၆လ နှင့် ၁ နှစ်ကြား	၂	
		၁နှစ် နှင့် ၃ နှစ်ကြား	၃	
		၃ နှစ် နှင့် အထက်	၄	
		မမှတ်မိပါ	၉၉	

အပိုင်း (၂) ရွှေ့ပြောင်းသွားလာနေထိုင်သူတို့ ပုံစံ

စဉ်	မေးခွန်း	အဖြေ	ကုဒ်	ရည်ညွှန်းချက်
၁၂	သင်ဘယ်ကိုမှ ရွှေ့ပြောင်းသွားလာ ခြင်းမရှိဘဲ ဒီရွာမှာ ဘဲ နေထိုင်တာလား (ဘယ်ကိုမှ သွားလာခြင်းမရှိ)	ဟုတ်တယ်	၁	ဟုတ်တယ်ဆိုရင် (၃၁) သို့ ကျော်မေးပါ။
		မဟုတ်ပါ	၀	
၁၃	သင်ဟာ ရွှေ့ပြောင်းသွားလာနေထိုင်သူ (သို့) အမြဲတမ်း ခရီးသွားလာနေသူလား	ဟုတ်တယ်	၁	မဟုတ်ဘူးဆိုရင် (၃၁) သို့ ကျော်မေးပါ။
		မဟုတ်ပါ	၀	
၁၄	သင်ဟာ နယ်စပ်ကို ဖြတ်ကျော်ပြီး ထိုင်းနိုင်ငံမှာ အဓိက အလုပ်သွားလုပ်တာလား	ဟုတ်တယ်	၁	ဟုတ်တယ်ဆိုရင် (၂၃) သို့ ကျော်မေးပါ။
		မဟုတ်ပါ	၀	

	သင်ဟာ နယ်စပ်ကို ဖြတ်ကျော်ခြင်းမရှိဘဲ မြန်မာ ဘက်မှာ အဓိက အလုပ်လုပ်တာဆိုရင်			
၁၅	သင်ရဲ့ဇာတိက ဒီမြို့နယ် လား	ဟုတ်တယ်	၁	မေးခွန်း (၁၅) က ဟုတ်တယ်ဆိုရင် (၁၇-၂၀) ကိုကျော်သွားပါ။ မဟုတ်ဘူးဆိုရင် (၁၆) ကျော်သွားပါ
		မဟုတ်ပါ	၀	
၁၆	သင်ဟာ နယ်စပ်ကိုဖြတ်ကျော်ခြင်းမရှိဘဲ မြန်မာ နယ်စပ်တစ်လျောက် မှာဘဲ အလုပ်လုပ်နေသော သူလား	ဟုတ်တယ်	၁	
		မဟုတ်ပါ	၀	
၁၇	သင်က ဒီမြို့နယ်က မဟုတ်ဘူးဆိုရင် တနင်္သာရီတိုင်း အတွင်းရှိ တခြားမြို့နယ်မှလား	ဟုတ်တယ်	၁	ဟုတ်တယ်ဆိုရင် (၁၉-၂၀) ကိုကျော်သွားပါ။ မဟုတ်ဘူးဆိုရင် (၁၈) ကျော်သွားပါ
		မဟုတ်ပါ	၀	
၁၈	ဘယ်မြို့နယ်ကလဲ	(	)	
၁၉	သင်က တနင်္သာရီတိုင်း အတွင်းက မဟုတ်ဘူးဆိုရင် အခြားတိုင်း ဒေသကြီး/ပြည်နယ် ကလာပြီး ဒီနေရာ မှာ အလုပ်လာလုပ်တာလား	ဟုတ်တယ်	၁	
		မဟုတ်ပါ	၀	
၂၀	ဘယ်တိုင်းဒေသ ကြီး/ ပြည်နယ်က လာသလဲ။	(	)	
၂၁	ဒီကိုရောက်တာ ဘယ်လောက်ကြာပြီလဲ	၆ လအောက်	၁	
		၆လ နှင့် ၁ နှစ်ကြား	၂	
		၁နှစ်နှင့် ၃ နှစ်ကြား	၃	
		၃ နှစ် နှင့် အထက်	၄	
		မမှတ်မိပါ	၉၉	
၂၂	သင်ရဲ့ အဓိက အလုပ် က တော/တောတောင် ဒေသများနဲ့ ဆက်စပ်လား	ဟုတ်တယ်	၁	
		မဟုတ်ပါ	၀	
	သင်ဟာ နယ်စပ်ကို ဖြတ်ကျော်ပြီး ထိုင်းမှာ အဓိက အလုပ်လုပ်တာ (သို့) သင်ဟာ နိုင်ငံခြားသား ဆိုရင်			
၂၃	သင် က နယ်စပ် ကို နေ့တိုင်း (သို့) ပုံမှန် ဖြတ်သွားဖြတ်လာ လေ့ရှိသလား	ဟုတ်တယ်	၁	ဟုတ်တယ်ဆိုရင် (၂၅-၂၉) ကိုကျော်သွားပါ။ မဟုတ်ဘူးဆိုရင် (၂၄) ကျော်သွားပါ
		မဟုတ်ပါ	၀	
၂၄	သင် က နယ်စပ်ကို ပုံမှန်ဖြတ်ကျော်ဖြစ်တယ်ဆိုရင် ဘယ်နှစ်ကြိမ် ဖြတ်ဖြစ်သလဲ။	နေ့တိုင်း	1	
		အပတ်တိုင်း	2	
		လတိုင်း	3	
		၃ လတစ်ခါ	4	
		နှစ်တိုင်း	5	
၂၅	သင်ဟာ ရာသီအလိုက် ရွှေ့ပြောင်းသွားလာ နေထိုင်သူလား (ဥပမာ- ရာဘာခြံလုပ်သား၊ ရွှေတူးဖော် လုပ်သား)	ဟုတ်တယ်	၁	ဟုတ်တယ်ဆိုရင် (၂၈-၂၉) ကိုကျော်သွားပါ။ မဟုတ်ဘူးဆိုရင် (၂၆-၂၇) ကျော်သွားပါ
		မဟုတ်ပါ	၀	
၂၆	ဘယ်ရာသီ မှာ အဓိက လုပ်တာလဲ	နွေရာသီ	၁	
		မိုးရာသီ	၂	
		ဆောင်းရာသီ	၃	

၂၇	သင်ဟာ ရာသီ အလိုက် ရွှေ့ပြောင်းသွားလာ နေထိုင်သူဆိုရင် သင်အလုပ်အမျိုးအစားက ဘာလဲ	ရာဘာခြံ	၁
		ဆီအုန်းခြံလုပ်သား	၂
		လယ်သမား	၃
		ရွှေတူးဖော်လုပ်သား	၄
		အခြား	၉၉
		( )	
၂၈	သင်ဟာ ကုမ္ပဏီ (သို့) ပိုင်ရှင် နဲ့ စာချုပ် ချုပ်ဆိုပြီး အလုပ်လုပ် တာလား (ဥပမာ- နိုင်ငံခြား စက်ရုံ၊ လမ်းပြင်ဆင်ရေးလုပ်သား)	ဟုတ်တယ်	၁
		မဟုတ်ပါ	၀
၂၉	သင်ဟာ စာချုပ်ချုပ်ဆိုပြီး အလုပ် လုပ်တာဆိုရင် သင့်အလုပ်အမျိုးအစားက ဘာလဲ	လမ်းပြင်ဆင်ရေး လုပ်သား	၁
		ဆောက်လုပ်ရေးလု ပ်သား	၂
		လုံခြုံရေး	၃
		စက်ရုံလုပ်သား	၄
		အခြား	၉၉
		( )	
၃၀	ပြီးခဲ့တဲ့ နှစ်ပတ် ကနေ သုံးလ အတွင်း သင် ဘယ်နိုင်ငံ မှာ ရှိလဲ	မြန်မာ	၁
		ထိုင်း	၂

အပိုင်း (၃) ငှက်ဖျားရောဂါဆိုင်ရာ ဗဟုသုတ

စဉ်	မေးခွန်း	ဟုတ်တယ်	မဟုတ်ပါ	မသိပါ
၃၁	**လူကို ငှက်ဖျားရောဂါ ကူးစက်နိုင်သော အကြောင်းအရင်းမှာ**			
	မသန့်ရှင်းသော ရေသောက်သုံးမိခြင်း			
	ခြင်ဥ ပေါက်ဖွားသောရေကို သောက်သုံးခြင်း			
	ငှက်ဖျားပိုး သယ်ဆောင်သော ခြင်ကိုက်ခံရခြင်း			
	ငှက်ပျောသီး စားသုံးမိခြင်:			
	ညစ်ပတ်လို့			
	အစာ အဆိပ်သင့်လို့			
	ငှက်ဖျားရောဂါရှိသူနှင့် နီးကပ်စွာနေမိခြင်း			
၃၂	**လူကို ငှက်ဖျားရောဂါပိုး ကူးစက်နိုင်သော အကောင်မှာ**			
	ကြွက်			
	ခြင်			

	ယင်ကောင်			
	ပိုးဟပ်			
၃၃	**ငှက်ဖျားခြင်ဟာ ဘယ်နေရာတွေမှာ ပေါက်ဖွားသလဲ ?**			
	ရေကန်			
	ရေသေ (စီးဆင်းမှု မရှိသောရေ)			
	မြောင်:			
	တာယာအဟောင်း			
	ခြောက်သွေ့ပြီး သန့်ရှင်းသောနေရာ			
	ရေကြည် ရေသန့်			
၃၄	**ငှက်ဖျားခြင်ဟာ ဘယ်နေရာတွေမှာ နားခိုလေ့ရှိသလဲ ?**			
	ခြံပုတ်			
	တိရိစ္ဆာန်တင်ကုတ်များ			
	သစ်တော			
	အိမ်၏မှောင်တဲ့နေရာများ			
	နေရောင်ကျသည့် ပွင့်လင်းသည့်နေရာ			
၃၅	**ငှက်ဖျားခြင်ဟာ ဘယ်အချိန်မှာ လူကို ပို၍ ကိုက်သလဲ?**			
	မနက်ပိုင်း			
	ညနေပိုင်း			
၃၆	**ငှက်ဖျားရောဂါ၏ ရောဂါလက္ခဏာများမှာ**			
	ချမ်းတုန်၍ အဖျားတက်ခြင်း			
	ခေါင်းကိုက်ခြင်း			
	ချွေးထွက်ခြင်း			
	အရိုးအဆစ် ကိုက်ခဲခြင်း			
	ခါးနာခြင်း			
	ဝမ်းလျောခြင်း			
၃၇	**ငှက်ဖျားရောဂါ ကို သိရှိနိုင်သော် နည်းလမ်းများမှာ**			
	ငှက်ဖျားသွေးစစ် ကိရိယာဖြင့်စစ်ဆေးခြင်း			
	မိသားစု ဆွေမျိုးပြောလို့ သိရှိခြင်း			
	အဖျားတက်၍			
	မိမိ စိတ်ထင်၍			
၃၈	ငှက်ဖျားရောဂါသည် ကုသလို့ရပါသလား ?			

၃၉	**ထိရောက်သော ၄က်ဖျားရောဂါ ကုသခြင်း နည်းလမ်းမှာ**			
	ဆေးမြီးတိုဖြင့် ကုသခြင်း			
	ကျန်းမာရေးဝန်ထမ်းမှ ပေးသော ၄က်ဖျားဆေးသောက်ခြင်း			
	ဆေးဆိုင်မှ ၄က်ဖျားဆေး ဝယ်သောက်ခြင်း			
	အိမ်နီးချင်းကပေးသော ဆေးများသောက်သုံးခြင်း			
၄၀	**ဆေးယဉ်ပါး ၄က်ဖျားရောဂါ ဖြစ်စေသော အကြောင်းအရာများမှာ**			
	ဆေးကုန်အောင် မသောက်၍			
	အာတီမီစနင်းဆေး တစ်မျိုးတည်းသာ သောက်သုံးခြင်း			
	အကြောင်းအရင်း မရှိပါ			
	ဆေးအတုဖြစ်၍			
၄၁	**၄က်ဖျားခြင် များကို ထိန်းချုပ် ကာကွယ်နိုင်သော နည်းလမ်းများမှာ**			
	ရေဆိုး၊ ရေပုပ်များမရှိအောင် ရှင်းလင်းခြင်း			
	အိမ်ပတ်ဝန်းကျင် မှ ခြုံပုပ်များရှင်းလင်းခြင်း			
	အိမ်တွင် အမှောင်ရှိသော နေရာများရှင်းလင်းခြင်း			
	ရေစည်များကို သေချာစွာ ဖုံးအုပ်ခြင်း			
	ပိုးလောက်လန်းသတ်ဆေး သုံးခြင်း			
	အိမ်ကိုပြုပြင် ထိန်းသိမ်းခြင်း (ခြင်ဇကာတပ်ခြင်း)			

အပိုင်း (၄) ၄က်ဖျားရောဂါ ကာကွယ်ခြင်းဆိုင်ရာ အမူအကျင့်

စဉ်	မေးခွန်း	အမြဲ (တစ်ပတ် လုံး)	မကြာခဏ (၅-၆) ကြိမ်/ တစ်ပတ် အတွင်း	တစ်ခါတစ်ရံ (၂-၄) ကြိမ်/ တစ်ပတ် အတွင်း	တစ်ကြိမ် (တစ်ပတ်အတွင်း တစ်ကြိမ်)	ဘယ် တော့မှ
၄၂	ပြီးခဲ့တဲ့ အပတ်က သင့် တာရှည်ခံ ဆေးစိမ်ခြင်ထောင်နဲ့ အိပ်ဖြစ်ပါသလား၊ ဘယ်နှစ်ကြိမ် အိပ်ဖြစ်ပါသလဲ။					
၄၃	သင် တောထဲသွားတိုင်း တာရှည်ခံ ဆေးစိမ်ခြင်ထောင် အမြဲယူသွားလေ့ရှိသလား					
၄၄	ညဘက် အိမ်အပြင်တွင် အိပ်တိုင်း ခြင်ထောင်ကို အသုံးပြု ဖြစ်ပါသလား။					

၄၅	ပြီးခဲ့တဲ့ အပတ်က သင် ခြင်နိုင်ဆေးကို ညတိုင်း အသုံးပြု ဖြစ်ပါသလား။					
၄၆	ပြီးခဲ့တဲ့ အပတ်က သင် ခြင်ဆေးခွေ ကို အသုံးပြု ဖြစ်ပါသလား။					
၄၇	ပြီးခဲ့တဲ့ အပတ်က သင် ညအိပ်တိုင်း အကျီလက်ရှည် ကို ဝတ်အိပ် ဖြစ်ပါသလား					

စဉ်	မေးခွန်း	အမြဲ (တစ်လ ၄ကြိမ်)	မကြာစကာ (တစ်လ ၃ကြိမ်)	တစ်ခါတစ်ရံ (တစ်လ ၂ကြိမ်)	တစ်ကြိမ် (တစ်လ အတွင်း တစ်ကြိမ်)	ဘယ် တော့မှ
၄၈	ပြီးခဲ့တဲ့ လက သင် အိမ်နားက ခြင်နိုအောင်းနိုင်တဲ့ နေရာတွေကို ရှင်းလင်းဖြစ်သလား					

အပိုင်း (၅) ဒုက်ဖျားရောဂါ ရှာဖွေကုသခြင်း နှင့် စပ်လျဉ်းသော အမူအကျင့်

စဉ်	မေးခွန်း	အဖြေ	ကုဒ်	ရည်ညွှန်းချက်
၄၉	ဒုက်ဖျားသွေးစစ် ကိရိယာ အဖြေ	ပလက်မိုးဒီယမ် း ဖယ်လ်ဆီပရမ်	၁	
		ပလက်မိုးဒီယမ်း ဗိုင်းဗက်	၂	
		ပိုးအရော	၃	
		ဒုက်ဖျားပိုး မရှိပါ	၄	
၅၀	သင် တွင် ဒုက်ဖျားရောဂါ ရှိသည်ဟု သံသယ ရှိပါ က မည်ကဲ့သို့ ကုသမည်နည်း	ကုသမှု မခံယူပါ	၁	တစ်ခုထက်ပို၍ ရွေးချယ်နိုင်ပါသည်။
		မိမိဘာသာ ကုသခြင်း	၂	
		ရမ်းကု	၃	
		နီးစပ်ရာ ကျန်းမာရေး လုပ်သား	၄	
		မြန်မာကျေးလက် ကျန်း မာရေး ဌာန	၅	
		ထိုင်းနိုင်ငံရှိ ဆေးရုံ ဆေးခန်း	၆	

၅၁	မိမိဘာသာကုသခြင်းပြုလုပ် ပါ က မည်သည့်ဆေးကို သင် သောက်ပါသလဲ	( )		
၅၂	ဘာလို့ ဒီ ကုသမှု ကို ခံယူတာလဲ	အနီးဆုံး	၁	တစ်ခုထက်ပို၍ ရွေးချယ်နိုင်ပါသည်။
		အလကားရလို့	၂	
		ဈေးမကြီးလို့	၃	
		ဆွေမျိုးတွေ ညွှန်လို့	၄	
		အကောင်းဆုံး ဝန်ဆောင်မှုပေးလို့	၅	
		အခြား	၉၉	
		( )		
၅၃	မည်သည့် ကျန်းမာရေးဝန်ဆောင်မှုကို သင် အများဆုံး အသုံးပြုလဲ	ရပ်ကု	၁	
		နီးစပ်ရာ ကျန်းမာရေး လုပ်သား	၂	
		မြန်မာကျေးလက် ကျန်းမာရေး ဌာန	၃	
		ထိုင်းနိုင်ငံရှိ ဆေးရုံ ဆေးခန်း	၄	
၅၄	နီးစပ်ရာ ဆေးပေးခန်း ကို ဘယ်လိုသွားလဲ	ကားဖြင့်	၁	
		မော်တော်ဆိုင်ကယ်ဖြင့်	၂	
		လမ်းလျှောက်ခြင်း	၃	
၅၅	ဘယ်လောက်ကြာလဲ	( ) မိနစ်		
၅၆	၄က်ဖျားနှင့် ဆိုင်သော ကျန်းမာရေးစောင့်ရှောက်မှု များကို အလွယ်တကူ ရသည်ဟု သင်ထင်ပါသလား	ဟုတ်တယ်	၁	
		မဟုတ်ပါ	၀	
၅၇	၄က်ဖျားနှင့် ဆိုင်သော ကျန်းမာရေးစောင့်ရှောက်မှု များအတွက် ငွေကြေး အခက်အခဲ ရှိပါသလား	ဟုတ်တယ်	၁	
		မဟုတ်ပါ	၀	
၅၈	အရင်က သင် ၄က်ဖျားရောဂါ ဖြစ်ခဲ့ဖူးပါသလား	ဟုတ်တယ်	၁	မဟုတ်ဘူးဆိုရင် (၆၃) သို့ ကျော်မေးပါ
		မဟုတ်ပါ	၀	
	သင် အရင် က ၄က်ဖျားရောဂါဖြစ် ခဲ့ဖူးလျှင်			
၅၉	သင် ဖျားပြီး ၂၄ နာရီ အတွင်း သွေးစစ် မှုကို ခံယူပါသလား	ဟုတ်တယ်	၁	
		မဟုတ်ပါ	၀	
၆၀	မည်သည့် ၄က်ဖျားရောဂါ ပိုး သင် ရရှိခဲ့သလဲ	ပလက်မိုးဒီယမ် : ဖယ်လ်ဆီပရမ်	၁	

		ပလက်မိုးဒီယမ်း ဗိုင်းဗက်	၂	
		ပလက်မိုးဒီယမ်း အိုမေလီ	၃	
		ပလက်မိုးဒီယမ်း မလေရီယေး	၄	
		ပိုးအရော	၅	
		မသိပါ	၉၉	
၆၁	၄က်ဖျားရောဂါ ကို ဘယ်လို အတည်ပြု စမ်းသပ်စစ်ဆေးလဲ	၄က်ဖျားသွေး အမြန်စစ် ကိရိယာ	၁	
		အဏုကြည့်မှန်ဘီလူး	၂	
		အခြား	၃	
		(	)	
၆၂	၄က်ဖျားဆေးကို ကုန်အောင် သောက်ခဲ့ပါသလား	ဟုတ်တယ်	၁	ပြီးဆုံးပါပြီ
		မဟုတ်ပါ	၀	
	သင် အရင် က ၄က်ဖျားရောဂါ မဖြစ်ဖူးခဲ့ပါ က			
၆၃	သင် တွင် ၄က်ဖျားရောဂါ ရှိသည်ဟု သံသယ ရှိတိုင်း ကျန်းမာရေးဆေးခန်းကို သင်သွားပါသလား	ဟုတ်တယ်	၁	
		မဟုတ်ပါ	၀	
၆၄	သင်ကို ၄က်ဖျားဆေးကို သောက်ခဲ့ဖူးသည့် အတွေ့ အကြုံ ရှိ ပါသလား	ဟုတ်တယ်	၁	ပြီးဆုံးပါပြီ
		မဟုတ်ပါ	၀	

APPENDIX B

Administration and Time schedule

Research Activity	Oct 17	Nov 17	Dec 17	Jan 18	Feb 18	Mar 18	Apr 18	May 18	Jun 18	Jul 18
Literature review	■	■								
Writing Thesis proposal	■	■	■							
Submission of thesis proposal				■						
Proposal Exam				■						
Ethnical approval					■	■				
Pretest Questionnaires						■				
Field preparation and data collection						■	■	■		
Data Analysis								■	■	
Thesis article writing									■	■
Final Thesis Exam										■
Submission of articles for publication										■
Submission of thesis and article										■

Budget plan

No	Topic	Estimated Expenses (Baht)
1	Stationary items	2,000
2	Photocopy	6,000
3	Travelling and lodging to Yangon and field site (border area)	20,000
4	Hiring of research assistant	20,000
5	Printing and binding of research	5,000
6	Compensation for participants	12,000
7	Miscellaneous	5,000
8	Total	70,000

APPENDIX C

AF 02-12

The Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University
Jamjuree 1 Building, 2nd Floor, Phyathai Rd., Patumwan district, Bangkok 10330, Thailand,
Tel/Fax: 0-2218-3202 E-mail: eccu@chula.ac.th

COA No. 079/2018

Certificate of Approval

Study Title No. 050.1/61 : MIGRATION AND MALARIA INFECTION IN MYANMAR-THAILAND BORDER AREA OF TANINTHARYI REGION, MYANMAR: A CASE-CONTROL STUDY

Principal Investigator : MR. SOE LIN THU

Place of Proposed Study/Institution : College of Public Health Sciences, Chulalongkorn University

The Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University, Thailand, has approved constituted in accordance with the International Conference on Harmonization – Good Clinical Practice (ICH-GCP).

Signature: ..... Signature: .....

(Associate Professor Prida Tasanapradit, M.D.) (Assistant Professor Nuntaree Chaichanawongsaroj, Ph.D.)

Chairman Secretary

Date of Approval : 26 March 2018 Approval Expire date : 25 March 2019

The approval documents including

1) Research proposal
2) Patient/Participant Information Sheet and Informed Consent Form
3) Researcher
4) Questionnaire

Protocol No. 050.1/61
Date of Approval 26 MAR 2018
Approval Expire Date 25 MAR 2019

The approved investigator must comply with the following conditions:

1. *The research/project activities must end on the approval expired date of the Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University (RECCU). In case the research/project is unable to complete within that date, the project extension can be applied one month prior to the RECCU approval expired date.*
2. *Strictly conduct the research/project activities as written in the proposal.*
3. *Using only the documents that bearing the RECCU's seal of approval with the subjects/volunteers (including subject information sheet, consent form, invitation letter for project/research participation (if available).*
4. *Report to the RECCU for any serious adverse events within 5 working days*
5. *Report to the RECCU for any change of the research/project activities prior to conduct the activities.*
6. *Final report (AF 03-12) and abstract is required for a one year (or less) research/project and report within 30 days after the completion of the research/project. For thesis, abstract is required and report within 30 days after the completion of the research/project.*
7. *Annual progress report is needed for a two- year (or more) research/project and submit the progress report before the expire date of certificate. After the completion of the research/project processes as No. 6.*

APPENDIX D

Correct percentage of knowledge questionnaires among migrant workers

Knowledge Questionnaires	Correct percentage
Malaria can be transmitted through	
Drinking contaminated water	69%
Drinking mosquito eggs	68%
Bite of malaria infected female mosquito	98%
Eating banana	56%
Dirty	87%
Food poisoning	96%
Close contact with malaria infected patient	51%
Vector which can transmit malaria to human	
Rat	99%
Mosquito	100%
Fly	85%
Cockroach	95%
Breeding site of malaria mosquito	
Pond or lake	84%
Stagnant water	38%
Canal	36%
Old tires	30%
Dry area	88%
Clean water	41%
Resting place of malaria mosquito	
Bushes	53%
Domestic animal shelters	38%

Tropic forest	98%
Dark corner in the house	59%
Open space where sunlight reach	97%
Vector active time	
Day time	81%
Night time	98%
Symptom of malaria	
Fever with chill and rigor	100%
Headache	92%
Sweating	64%
Joint weakness	31%
Backache	18%
Diarrhoea	52%
Diagnosis of malaria infection	
Blood testing	99%
Family/ relative told	94%
Fever	51%
Self believe	72%
Malaria disease can be treated?	99%
Appropriate malaria treatment	
self-treatment	95%
Taking antimalarial drug given by health staff/VMW	99%
Purchasing antimalarial drug from shop	40%
Taking of drug which given by neighbors	74%
Reason of drug resistant malaria	
Incomplete treatment	70%
monotherapy	9%
No reason	28%
Fake drug	22%

Way to prevent and control malaria vector	
Emptying and removing of stagnant water	68%
Trimming brushes around your house	75%
cleaning dark space	79%
Creating of water cask around your house	71%
Using Larvicides	18%
Maintaining of your houses (e.g. window screening)	52%

Mean level of protective behavior questionnaires among migrant worker

Protective behavior questionnaires	**Mean level**
How often do you sleep under bed net in previous week?	2.87
Do you bring ITN/LLIN/bed net when you go to forest?	1.61
Do you use bed net when you sleep outside?	1.6
How often do you use mosquito repellent cream at night time in previous week?	1.43
How often do you use mosquito coil in previous week?	2.88
Do you wear long sleeve clothes at night time in previous week?	1.21
Do you clean source of mosquito larvae near your home? (in previous months)	1.5

VITA

Name: Mr. Soe Lin Thu

Date of Birth: 11. December. 1990

Nationality: Myanmar

Religion: Buddhist

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Email: drsoelinthu@gmail.com

Education: M.B., B.S (Ygn)

Phone No: +95-95640361, +95-796303381

Brief Profile

I am a medical doctor holding M.B., B.S degree and graduated from University of Medicine (II), Yangon, Myanmar. I am a registered doctor with SAMA 38707 from Myanmar Medical Council. I had working about 3 and half years in public health field especially in malaria sectors of Myanmar Medical Association and University Research Co. LLC.

Educational Qualification

-Certificate of basic concepts and application of statistics (SPSS)

-Certificate of Report Writing

-Certificate for Routine Data Quality Assessment

-World Health Organization Mental Health Gap Action Program (mhGAP)

-Certificate of Leadership and Team Building

-Bachelor of Medicine and Bachelor of Surgery (M.B., B.S) (Ygn) Sama 38707, University of Medicine (II), Yangon