DISEASE PATTERNS AMONG BURMESE PEOPLE SEEKING HEALTH SERVICES ALONG TAK BORDER, THAILAND

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**A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE (PUBLIC HEALTH)
PROGRAM IN INFECTIOUS DISEASES AND EPIDEMIOLOGY
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2016**

Thesis
entitled

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was submitted to the Faculty of Graduate Studies, Mahidol University
for the degree of Master of Science (Public Health)
Program in Infectious Diseases and Epidemiology
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ACKNOWLEDGEMENTS

I would like to express my sincere thanks to the following persons, without their encouragement and continuous support, the completion of this thesis would have been impossible.

First of all, I would like to express my deeply sincere gratitude to my major advisor Asst. Prof. Aronrag Cooper Meeyai for the consistent support of my study and self-learning, for her patience, motivation, enthusiasm, and extensive knowledge. She has always encouraged me in the right direction whenever she thought I needed it. I am deeply honored to have her as my master teacher of academic and actual life.

My deeply grateful is extended to my co-advisor, Lecturer Dr. James William Rudge for his encouragement and helpful guidance. The door to his office was always open whenever I ran into a trouble spot or had a question about my research. I would also like to express my deep appreciation to Prof. Richard Coker who was the chair and external examiner of the thesis defense examination, for his constructive comments and valuable suggestions.

I appreciate all lecturers and staff at the Department of Epidemiology, Faculty of Public Health, Mahidol University for their educating and assistance through the study. I would also like to express my gratitude to Dr. Cynthia Maung, a director of Mae Tao Clinic, for her never ending support and give the opportunities, including the staff of Mae Tao Clinic for their kindness help.

Finally, I am really grateful to my family for their encouragement and understanding my own path, and all my friends for their support.

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ABSTRACT

Knowledge of the temporal variation in the frequency of consultations for infectious diseases amongst Burmese clients of Mae Tao Clinic would be of practical value in decisions regarding disease control and surveillance. This study aimed to determine the frequency of disease consultations using descriptive analysis, and investigate the associations of the dynamic patterns of infectious diseases between two Burmese groups using wavelet analysis. The monthly consultation number of MTC's patients for common infectious diseases from January 2008 to December 2012 was extracted as "case incidences" for only single infectious diseases, and as "episode incidences" for both single and multiple infectious diseases.

The case incidence rate and episode incidence rate were both higher amongst Burmese living in Burma than in Burmese migrants living in Thailand for four diseases in the five-year period: hepatitis (RR1.24,95%CI:1.09-1.39); HIV (RR1. 54,95%CI:1.17-1.91); TB (RR2.02,95%CI:1.45-2.60); and malaria (RR2.24, 95%CI: 1.12-3.36). The wavelet results between both Burmese groups found clear and significant synchronicity in consultations for measles (14-month period) and dengue (12-month period). The consultation for pneumonia presented the same dynamic patterns (12-month period) between both Burmese groups with an average one month delay starting with Burmese living in Burma followed by Burmese migrants living in Thailand. Therefore the MTC should cooperate with partner organizations in health along the border to improve control and surveillance of infectious diseases. For further studies, using data collected over longer time-periods combined with mathematical transmission modelling could help explain the temporal coincidence of infectious disease consultations across border areas.

KEY WORDS: INFECTIOUS DISEASE SURVEILLANCE / MIGRANT HEALTH / WAVELET ANALYSIS / BURMESE NATIONALS / MAE TAO CLINIC

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รูปแบบโรคติดเชื้อในชาวพม่าที่แสวงหาบริการสุขภาพตามแนวชายแดนจังหวัดตาก ประเทศไทย
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คณะกรรมการที่ปรึกษาวิทยานิพนธ์: อรุณรักษ์ คูเปอร์ มีใย, Ph.D.(MODERN EPIDEMIOLOGY), JAMES WILLIAM RUDGE, Ph.D.(INFECTIOUS DISEASE EPIDEMIOLOGY)

บทคัดย่อ

ความเข้าใจในการเปลี่ยนแปลงชั่วคราวเชิงความถี่ของการเข้ารับการรักษาด้วยโรคติดเชื้อในชาวพม่าที่เข้ารับบริการที่แม่ตาวคลินิก มีส่วนช่วยในการวางแนวปฏิบัติของแม่ตาวคลินิกในด้าน การเฝ้าระวังและควบคุมโรคต่าง ๆ ได้อย่างเหมาะสม การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อวัดขนาดความถี่ของการเข้ารับการรักษาโรคติดเชื้อที่พบบ่อยด้วยสถิติเชิงพรรณา และสำรวจความสัมพันธ์ของรูปแบบพลวัตรของโรคติดเชื้อในชาวพม่าทั้งสองกลุ่มด้วยวิธี wavelet analysis โดยศึกษาข้อมูลทุติยภูมิของจำนวนการเข้ารักษาโรคติดเชื้อที่แม่ตาวคลินิกรายเดือน ตั้งแต่เดือนมกราคม พ.ศ.2551 ถึงเดือนธันวาคม พ.ศ.2555 สำหรับโรคติดเชื้อครั้งเดียวพิจารณาจำนวนการเกิดโรคเป็นรายคน ส่วนโรค ติดเชื้อมากกว่าหนึ่งครั้งพิจารณาจำนวนครั้งที่เข้ารับบริการ

ผลการศึกษาพบว่า ชาวพม่าที่อาศัยในฝั่งประเทศพม่ามีอัตราการเกิดโรคและอัตราการเข้ารับบริการสูงกว่าอัตราของชาวพม่าที่อาศัยในฝั่งไทยอย่างมีนัยสำคัญทางสถิติอยู่ 4 โรค ในช่วง 5 ปี ดังนี้ ตับอักเสบ (RR1.24,95%CI:1.09-1.39) เอชไอวี (RR1.54,95%CI:1.17-1.91) วัณโรค (RR2.02, 95%CI:1.45-2.60) และ มาลาเรีย (RR2.24,95%CI:1.12-3.36) นอกจากนี้ยังพบว่ารูปแบบพลวัตรการเข้ารับ บริการของโรคหัด (ที่ 14 เดือนต่อรอบ) และไข้เลือดออก (ที่ 12 เดือนต่อรอบ) ระหว่างชาวพม่าทั้งสองกลุ่ม เหมือนกันและเกิดขึ้นพร้อมกัน ส่วนโรคปอดบวมรูปแบบพลวัตรในชาวพม่าทั้งสองกลุ่มเหมือนกัน (ที่ 12 เดือนต่อรอบ) แต่เกิดในชาวพม่าที่อาศัยในฝั่งไทยหลังชาวพม่าในฝั่งพม่าอยู่ประมาณ 1 เดือน ดังนั้นการสร้างเครือข่ายระหว่างแม่ตาวคลินิกกับองค์กรชุมชน เพื่อควบคุมและเฝ้าระวังโรคติดเชื้อ ที่ยังคงเป็นปัญหาในพื้นที่ชายแดน ในการศึกษาต่อไปควรพิจารณาใช้ข้อมูลที่มากขึ้น และใช้สมการ ทางคณิตศาสตร์เพื่อช่วยอธิบายพลวัตรอุบัติการณ์ร่วมของการเข้ารับบริการรักษาโรคติดเชื้อในพื้นที่ชายแดน

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LIST OF ABBREVIATIONS

Abbreviation or symbol	**Term**
%	Percent
MTC	Mae Tao Clinic
AFP	Acute flaccid paralysis
ARI	Acute respiratory infection
TB	Tuberculosis
No.	Number
RR	Rate ratio
95%CI	95% Confident Interval
SQRT	Square root
ed	Edition
et al.	Et alli (Latin), and others

CHAPTER I
INTRODUCTION

1.1 Background and Rationale of the Study

Economic and demographic differentials of countries influence the movement of population elsewhere. In Asia, Thailand is regarded as one of leaders in economy and a center of migration regionally. Maesot, a hub-border city, has become a center of border trade and commerce on the international border between Thailand and Burma country, where many Burmese peoples have been immigrant into Thailand through the Thai-Burmese border before separating to other area of Thailand [1]. In 2010, there was more over four million of migrant workers in Thailand, but some part was only 1.3 million of registered migrant workers (approximately 80% originating from Burma) [2].

The reasons of the migrants leaving Burma to Thailand are to find better economic opportunities, to raise quality of their life and family, and to escape from the political conflict [3-5]. Another reason of Burmese people crossing the national border is the need to seek for the basic health care services in Thailand that should have been available at their homeland [6-9]. However the situation of people's health is related to the national healthcare policy for own population in terms of accessibility, affordability and quality [10-11].

In addition, Burmese government public health system in Burma cannot provide the proper health care for specific areas (i.e. remoted areas, conflicted areas). Therefore the health community-based organizations (CBOs) and ethnics health organizations (EHOs) have working together closely to improve the health system in ethnic areas along eastern Burma (e.g. Karen, Karenni, Shan, and Mon states), which are usually coordinated and supplied from Tak border, Thailand. Those health organizations along eastern border of Burma include Backpack Health Worker Team (BPHWT), Burma Medical Association (BMA), Karen Department of Health and Welfair (KDHW), Karenni Mobile Health Committee (KnMHC), Mon National

Health Committee (MNHC), and Shan Health Committee (SHC) [12-15]. Those organizations' services focused on primary health care programs such as treatment off common diseases, war casualty management, reproductive and child health services, community health education, and water and sanitation programs.

The disparity in the different health care systems for citizen between Thailand and Burma have reflex to the their health status and violence incidence of different diseases, particularly preventable diseases such as malaria, malnutrition, diarrhea, acute respiratory illnesses, tuberculosis, pneumonia, HIV/AIDS, filariasis, and Japanese encephalitis [12, 16-19]. Burma continues to register the greatest number of malaria deaths and the highest malaria case fatality rate of any country in Southeast Asia [12, 16]. While the survey study (Oct 2008 - Jan 2009) of health status of people in eastern Burma's conflict areas found that maternal mortality ratio was totally high (721 per 100,000 live birth), compared ratio for 2008 to 240 per 100,000 live birth in Burma, and 48 per 100,000 live birth in Thailand [12]. The previous studies have focused on the disease burden of difference populations along the Thai-Burmese border, for instance, the prevalence of *Plasmodium falciparum* in 49 villages of eastern Burma during 2003-2006 was higher (10.2%) than among Thai villagers (prevalence less than 2%) and non-Thai (less than 3.5%) in Thailand (20). In addition to the study of tuberculosis burden in 2006-2007 in Tak province found that the TB prevalence rate of Thais was 109 per 100,000 persons, conversely in refugee (prevalence 340) and migrants (prevalence 150), including the multidrug-resistant TB patients diagnosed in this study as 70% Burmese crossing the border for healthcare [21].

While in the five border districts of Tak province (i.e. Maesot, Mae Ramat, Tha Song Yang, Phop Phra, and Umphang), the infectious diseases have trend to increase the emerging epidemic since 2008 such as severe diarrhea, pyrexia of unknown origin, pneumonia, food poisoning, scrub typhus, and sexually transmitted diseases. There are the endemic diseases of both Thais and Burmese migrants on this border including malaria, conjunctivitis, dysentery, chicken pox, dengue, cholera, measles, and tuberculosis [22]. The impact of population movement across the border from a neighbor country to the Thai health system is not only bearing the burden of medical expenses for the local migrants and people crossing the border (approximately

100 million baht per year in the hospitals of the border districts of Tak province) [22], but also concerning the disease transmission in Thai’s public health from those people as a disease carrier [23-24], particularly the reemerging of infectious diseases well controlled in Thailand but still finding the high prevalence in Burma country such as tuberculosis, malaria, filariasis, leprosy and poliomyelitis [6, 25-26].

Thailand has been provided health services, health promotion and prevention programs for both Thai citizen and documented or undocumented migrants. Because the different standard and quality of the healthcare system between two nations and the dynamics of the population movement have supported the spread and transmission of diseases over different areas (i.e. drug-resistant malaria and tuberculosis) [27-29], especially the Burmese people along Tak border as mobile population [13]. Mae Tao Clinic (MTC) is a community-based health organization in Maesot providing free health care services for Burmese peoples in the local area and healthcare seekers crossing from Burma. The services include treatment, prevention, promotion (including maternal and child health, family planning, reproductive health), and immunization program for children (such as tuberculosis, diphtheria, pertussis, tetanus, measles, polio, and hepatitis B). The ratio of care seekers at MTC between living in Thailand side and crossing the border from Burma side is approximately 50%:50% [30-34]. MTC has a significant role in the public health system in Thailand by lightening the burden of medical care for Burmese along the border. In addition to this clinic is capable to help lighten the caseloads of Mae Sot Hospital with providing the medical care for 300 of those people per day [35] when their need for the treatment as well as usually being the first line to identify outbreaks of common diseases in border area [13].

Understanding the health status overview of Burmese people along this border which MTC's health services has fulfilled their needs, the researcher has interest to study the frequency of consultation about infectious disease and the temporal variation in the frequency of diseases consultation amongst Burmese clients of MTC who live along Thai’s border or crossing from Burma’s border. The study finding as an empirical evidence based on research would be of practical value for decision-making of MTC regarding to allocation of human resource, disease control, and surveillance of difference diseases.

1.2 Research Question

Is there an association of dynamic patterns in term of frequency variation of infectious diseases consultation among Burmese clients of MTC along Tak border from 2008 to 2012, when comparing the following two groups: A) Burmese living in Burma (considered as transient migrants), and B) Burmese migrants living in Thailand (considered as permanent migrants)?

1.3 Objectives of the Study

1. To explore the frequency of consultation for common infectious diseases in both groups of Burmese clients of MTC from 2008 to 2012.
2. To explore temporal patterns in the occurrence and frequency of infectious disease consultation in the two groups of Burmese clients of MTC from 2008 to 2012.
3. To investigate the associations of the variation patterns of the infectious disease consultation between both groups of Burmese clients of MTC from 2008 to 2012.

1.4 Hypothesis of the Study

There is no association of dynamic patterns in terms of frequency and time of infectious disease consultation between transient migrants and permanent migrants who received the medical service at MTC during 2008-2012.

1.5 Study Design

Retrospective study

1.6 Study Scope

This study used the monthly visit number of patients who received treatment for common infectious diseases at MTC. The patients were separated into two groups: A) Burmese people in Burma's border (considered as transient migrants) and B) Burmese migrant in Thai's border (considered as permanent migrants). The scope of research is as follows:

1. Firstly, describing the frequency of consultation for common infectious diseases among two groups of Burmese clients accessing health care at Mea Tao Clinic between 2008 and 2012 based on the characteristics of each disease be either the single or multiple infection. These data of specific diseases were described both for each year and in the five-year period, using total case/episode incidence, annual case/episode incidence rate (per 100,000 registered clients/visiting times), and rate ratio (RR) for case/episode incidence comparing between transient migrants and permanent migrants with 95% confidence interval.

According to an uncertain situation along Tak border during the study period (i.e. the closure of immigration checkpoint at the Mae Sot-Myawaddy border, including closing of the Thai-Myanmar friendship bridge from July 2010 to December 4, 2011), the researcher would like to consider the linkage between the annual overview of consultation for common infectious diseases from 2008 2012 and that occurring situation, which might have been related to the accessibility of medical services of Mae Tao Clinic.

2. Use the secondary data of monthly number of case/episode incidence of consultation for common infectious diseases including the yearly number of total visits and total clients collected by Mae Tao Clinic from 2008 to 2012: anthrax*, acute flaccid paralysis (AFP)* (as suspected polio), acute respiratory infection (ARI), chickenpox*, cholera, dengue, diarrhea, dysentery, filariasis*, hepatitis*, herpes simple, herpes zoster, HIV*, malaria, measles*, meningococcal meningitis*, pertussis*, pneumonia, scrub typhus, TB, and suspected typhoid* (* denoted as a single infectious disease considered in term of case incidence and episode incidence; and others as a multiple infectious disease considered in only term of episode incidence).

3. The next step, the researcher would use the descriptive results of common diseases in the five-year period (2008-2012) to select the potential diseases presenting their periodicity for exploring the dynamics pattern of consultation for these diseases between difference groups of Burmese during 2008 to 2012 using wavelet analysis as a trial part of the study.

4. Data collecting in this study operated after getting the approval from the ethics committee of Mahidol University in Thailand and the committee of Mea Tao Clinic.

1.6.1 Variables for each disease used in 2 parts of analysis as follows:

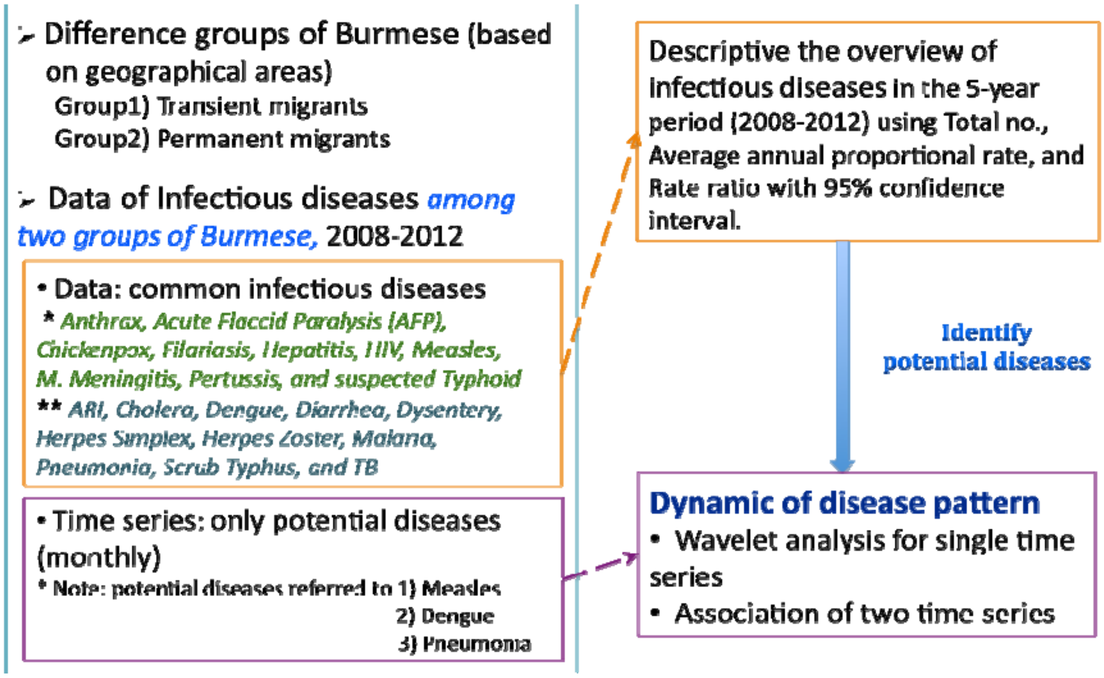
- Descriptive analysis of consultation for single or multiple infectious diseases using independent variables such as date of diagnosis, groups of Burmese people based on their address (transient migrants, and permanent migrants), and the yearly number of total cases/visits; including the monthly number of case/episode incidence (as dependent variable).
- Wavelet analysis for potential infectious diseases using the monthly case/episode incidence (as an independent variable), while dependent variables are the time period of disease emerging in one complete cycle (defined as the scale) and the time position of the highest frequency of disease emerging in one complete cycle (defined as the time position)

1.6.2 Statistical analysis

The frequency of consultation for common infectious diseases among two Burmese clients of MTC explained in two terms as “episode incidence” (number of visits) for both single and multiple infectious diseases and as “case incidence” (persons) for only single infectious diseases. Descriptive approach analyzed the frequency data of consultation for common infections diseases with the STATA statistical software for windows version 12.0 at the significance level of 0.05. Comparing the case incidence rate and the episode incidence rate between two groups of Burmese, Chi-square test (whenever small samples, instance of Fisher’s exact test) used to estimate the annual rate ratio (for each year). While the estimation of average annual rate ratio (in the five years) used F-test.

Wavelet approach analyzed the monthly consultation data of the potential diseases (i.e. measles, dengue, and pneumonia) with WaveletComp: Computational Wavelet Analysis R package version 1.0. (General Public License version 2) [36].

1.7 Data Framework of the Study



1.8 Operational Definitions

- Burmese people seeking health services along Tak border are defined as Burmese clients of Mae Tao Clinic, and were separated two groups in this study as follows:

A) Burmese living in Burma (considered as transient migrants): Burmese people who living or staying in Myawaddy border of eastern Burma while crossing the borderline to access health services at Mae Tao Clinic.

B) Burmese migrants living in Thailand (considered as permanent migrants): Burmese migrants who living or staying in Tak border of western Thailand while accessing the health services at Mae Tao Clinic.

- Address of patient: a place of living or staying of Burmese health seekers permanently or temporally in the moment of their accessing the health services at Mae Tao Clinic, which is their own house or a friend/relative's house in the area of Thailand side or Burma side.

- Diagnosed disease: the infectious disease that the doctor of medical staff of Mae Tao Clinic diagnosed by signs, symptoms, and/or laboratory testing to be a first disease for each consultation of Burmese clients at its medical department (i.e. the in-patient and out-patient departments for adult and child) [37].

- Case incidence (persons): counted as one disease case of a patient presenting to MTC for one or more consultation for the same disease of single infection in the same year.

- Episode incidence (number of visits): the actual number of consultations of a patient visiting to MTC for receiving treatment for the same disease of both single and multiple infections in the same year

- A single infectious disease: an infectious disease which you usually only get infected with once in your life.

- A multiple infectious disease: an infectious disease that you could get infected with several times in your life.

- Co-disease: an infectious disease that Burmese client of MTC infected and diagnosed already before the diagnosed infectious disease (as a first disease) of the current consultation at the medical department of MTC.

1.9 Benefits of the Study

1. Understand the situation of infectious disease consultation among Burmese clients of MTC living along Tak border (connected to eastern Burma).

2. Potential to inform evidence based decisions of MTC with regard to resource allocation in order to control disease (focusing on surveillance and monitoring of diseases).

3. Explain the temporal dynamic of infectious disease consultation between different groups of Burmese clients of MTC as basic information of border disease for the further study.

CHAPTER II
LITERATURE REVIEW

In this study all related literature was reviewed to be the guideline under the following key contents:

2.1 Situation of infectious diseases of Burmese along borders

2.2 Situation of non-infectious diseases of Burmese along borders

2.3 Migration

2.4 Public health system on migrants in Thailand

2.5 Public health system in Burma

2.6 Factors related accessing to health care services

2.7 Literatures related to wavelet analysis

2.1 Situation of Infectious Diseases of Burmese along Borders

2.1.1 The situation of infectious diseases of Burmese migrant along Thai's border

Voravit Suwanvanichkij (2008) [6] discussed the case study of health and diseases in the Shan displaced and fled their homes for Thailand to become economic migrants in the worst working conditions, including in the Thai sex industry. According to the available health data, Shan children have scarcely received the childhood immunizations, especially polio (as a vaccine-preventable illness in Thailand). In northern Thailand, Shan migrants without legal status had high morbidity and mortality of HIV, and tuberculosis, had found the infected cases of lymphatic filariasis in 2004.

A cross-sectional survey on 614 immigrant workers among three occupations in Songkhla province during Jun-Nov 2010 found one-year estimated period prevalence of TB-suspicious symptoms was around 6% (factory workers), 27% (rubber tappers), and 30% (construction workers) [38].

A retrospective survey in Mae Tao Clinic's patients found the prevalence of HIV co-infection in patients with malaria during 2005-2007 was 1.35% (2/148 cases, 1 each for *P. falciparum* and *P. vivax* co-infection) and increased to 2.78% (3/108 cases, 2 and 1 for *P. falciparum* and *P. vivax* co-infection, respectively) during 2010-2012. This finding presented the increasing trend of prevalence of malaria and HIV co-infection in Mae Sot, Tak province [39].

A matched cohort research of Malaria studied 713 post-partum women attending antenatal clinics on the Thai-Myanmar border from November 2007 to September 2009 [40]. The research found that post-partum women experienced significantly less *P.falciparum* episodes than controls (HR0.39; 95%CI 0.21–0.72) but significantly more *P.vivax* (HR1.34; 95%CI1.05-1.72). The reduced risk of *P.falciparum* malaria was accounted for by reduced exposure, whereas a history of *P.vivax* infection during pregnancy was a strong risk factor for *P.vivax* in post-partum women (HR13.98; 95%CI 9.13–21.41). After controlling for effect modification by history of *P.vivax*, post-partum women were not more susceptible to *P.vivax* than controls (HR0.33; 95%CI 0.21– 0.51). This study concluded the post-partum women were less likely to develop falciparum malaria but more likely to develop vivax malaria than controls in the area of low seasonal malaria transmission.

Kyu and et al (2005) [41] studied the knowledge, attitudes about, and practices to prevent, dengue fever among Burmese migrant woman (15-60 years) as a caretaker of their family in Mae Sot District, Tak Province during January 2004. The survey found that the majority of respondents were housewife (70%), a monthly family income of less than Baht 3,000 (80%), and their duration of stay in Mae Sot was more than three years (70%). The main source of information about dengue was family, friends and neighbors. The Burmese migrant women had middle level of knowledge on dengue fever (i.e. knowing about the biting time of dengue mosquitoes, and the biting habit of dengue mosquitoes); conversely misunderstanding about the susceptibility and re-infectious of dengue fever in child, and the habitat of dengue mosquitoes. However no significant association was found between demographic characteristics and attitude of the respondents. Significant association was found between the migrant women's duration of stay in Mae Sot District and knowledge of dengue (p=0.04), which refer to who lived in Maesot more than three years would had the better knowledge on dengue due to more skillful Thai language to get dengue information.

2.1.2 The situation of infectious diseases of Burmese along Burma's border

In 2008-2009, a population-based health survey in eastern Burma (Bago (2 townships), Karen (6 townships), Karenni (4 townships), Shan (6 townships), Mon (2 townships), and Tenasserin (1 township)) was conducted [12]. The survey interviewed the woman in the household with the youngest child covering 5,754 households in low-level conflict zones of eastern Burma between September 2008 and January 2009. The survey's results concluded that the leading causes of death in children under five and all ages were preventable and treatable diseases such as malaria (27.7%; 24.7%), diarrhea (17.9%; 14.4%), and acute respiratory infection (14.9%; 19.5%) respectively.

All eastern regions of Burma are very high burden of malaria. The prevalence of *Plasmodium falciparum* (Pf) among heads of households in the survey was 7.3%. The prevalence levels of malaria separated by ethnic area were 20.4% (Shan), 13.5% (Tenasserin), 8.3% (Karenni), 6.7% (Bago), 4.9% (Karen), and 1.5% (Mon). In all age groups, 6.4% of the surveyed population has suffered from diarrhea in two weeks prior to the survey. Overall the diarrhea prevalence in children under five equals 10.7%. While in townships of Karen the diarrhea prevalence of this age group mostly was lower than 5 percent.

Richards et al (2007) [20] estimated the prevalence of *Plasmodium falciparum* in the target areas (as active conflict zone of eastern Burma) in the malaria program of the ethnic health organizations, including the Karen Department of Health and Welfare (KDHW) and the Backpack Health Worker Team (BPHWT)). The data sources conducted from the cross-sectional screenings of the KDHW malaria program from 2003 to 2006 and the retrospective cluster surveys in the entire BPWHT and KDHW populations in 2004 and 2006. Between 2003 and 2006 a total of 9,796 rapid diagnostic tests were performed among 28,410 villagers participating in 11 universal (n=5,872) and 36 limited (n=3,924) baseline screenings. The prevalence of screenings in malaria program areas were very similar over four years: 8.4% (95% CI= 8.3-8.6) in 2003, 7.1% (95% CI=6.9-7.3) in 2004, 10.5% (95% CI= 9.3-11.8) in 2005, and 9.3%

(95% CI= 8.2-10.6) in 2006. In the cluster survey in 2004, and 2006, prevalence of positive *Plasmodium falciparum* equaled 10.2% with its range 6.3% (95% CI: 3.9-8.8) to 12.4% (95% CI: 9.4-15.4). The prevalence of *P. falciparum* in conflict areas of eastern Burma is higher than rates reported among populations in neighboring Thailand, particularly among children.

2.2 Situation of Non-infectious Diseases of Burmese along Borders

Cardozo et al. (2004) [42] surveyed the psychosocial issues, the prevalence of mental illness related to traumatic experiences, and the identification of its risk factors among Karenni refugees residing in three temporary shelters in Mae Hong Son, Thailand in June 2001. The survey questionnaire included questions about demographic characteristics, and culture-specific symptoms of mental illness. This survey found that Karenni respondents had the quality of life as miserable or very miserable (27%), the status of unemployed or no regular income (94%). When respondents feel unhappy, the ways to make feel better mostly were talking to family or friends (59%) sleeping (19%), and thinking about their homeland (14%). The respondents experienced the common event trauma during the past decade including hiding in the jungle (79%), forced relocation (67%), lost property (66%), and destruction of houses and crops (48%). Karaenni in three camps were diagnosed with the mental illnesses often associated with trauma events, such as depression (41%), anxiety (42%), and PTSD (4.6%). The results of multivariate analysis adjusting for demographic variables showed the association between the previous mental illness and the higher prevalence of anxiety, depression, and PTSD symptoms.

The assessment in cross-border population in eastern Burma found that there was very limited access to the family planning counseling and the educational information about contraception options from both freestanding clinics and the deployment of mobile healthcare workers [43]. In particular, there was misinformation and misunderstanding of emergency contraceptive pills (ECPs) about the use timeframe, regimen, eligibility, and side-effects in cross-border populations and health workers. Cross-border populations in eastern Burma were unable to access the safe and legal abortion and family planning procedures (i.e. intrauterine device (IUD) and hormonal implant insertion, and sterilization procedures) due to distance, lack of funds, security concerns in conflict-affected areas. Moreover, the related organizations have enhanced to training medics, local untrained traditional birth attendants (TBAs), and other health workers about the delivery skill, postpartum hemorrhage, and unsafe abortion to reducing maternal mortality among cross-border populations.

2.3 Migration

Human migration being a phenomenon is impacted from the growth of globalization, including the facilities of international transport and communication, which encourages the spread of disease into other areas or regions. There are the motivates of individual migration such as poverty, conflict, and the chance of wealth and job opportunities. Modern migration of individuals considered complexly as a multiple stage cycle can occur within or across national borders, and be entered in to multiple times and various ways. Considering health effects and a role of migrants, migratory process is separated to five phrases: pre-departure, travel, destination, interception, and return [44].

1. Pre-departure phase is the beginning of the migration process individually. In this phase, the health of individual migrants have been affected by the local diseases and pathogen in the origin country including the pre-existing determinants of health (i.e. demography, socioeconomics, genetics and biology, behavior, and environment) [45]. For example on the forced migrants (e.g. refugees and displaced populations) their health status has normally been compromised by the inadequate nutrition and the lack of health services during the process of forced migration.

2. Travel phase is a period in which individuals travel between their place of origin and a destination or an interception location, individuals can stop for short or long periods at multiple transit places. In this phrase, frequency and ways of population movements between different areas in various prevalence of one disease reflect the chance of disease transmission, the risk of disease infection and burden of infection. When traveling from low to high transmission areas of disease, migrants would play a role as more vulnerable group to infect that disease. On the other hand, a

huge group of people migrating from high to low transmission areas plays a role as a reservoir or active transmitter to introduce the stopped locations [27]. Moreover the health risk of migrants may relate to the kinds of transport and conditions of traveling. For instance the irregular migrants have to face with illegal border crossing, kidnapping, and sexual violence [46].

3. Destination phase is a period of the intended location of individuals either temporary or long-term. Their health status and outcome are influenced by the health determinants in the location include accessing and availability to health care service. While the health risk of migrants will vary on their migrating status including the employment and working conditions at the new setting particular the work-related diseases and mental health [46-47].

4. Interception phase is a period of the situation of temporary detention or interim residence especially for forced migrants or irregular migrants. The recipient countries allow migrants to the temporary settlement at centers or refugee camps, which these situations would make migrants received the impact on their mental and physical health such as a lack of nutrition, a risk of diseases infection [48].

5. Return phase is a period of individuals moving back to the place of origin either temporarily or permanently. In this phase, returning migrants may influence on the introduce of new pathogens or increasing the prevalence of infections among the local population [49]. However the health status of returners for one disease have impacted to the change of the disease prevalence in their origin country or place such as having a low immunity and being susceptible to disease, and carrying an endemic disease from the destination country. In case of labor migrants, there is the practical collaboration between countries of original and destination, including the related organization of migration to support the returning migrants improving their physical, mental and social well-being by professional health systems [46].

The potential impacts of migration process on infectious diseases can considered into three groups 1) migrant health characteristics, 2) health status of host country, and 3) epidemiology [50].

First, the health characteristics of individual migrant are influenced by the process and scope of their migration; the health environments and situations in their original place; and the experiencing environments during their transit phase of migration and their new destination.

Second, the migration process affects the changing of health status in the citizens of host country, which depends on the size of the mobile population and the different degree of disease prevalence between place of origin and destination.

Third, in term of epidemiology, the migration has associated with the introduction of disease into the destination area, particular the migrants originating from area or nation where the infectious persist critically and significantly. The explicit disparity in public health and infectious-control measures of each country has resulted to the impact of migration on the infectious disease epidemiology.

Barnett and Walker (2008) [29] explained the role of migrants related to changing of demographics of infectious diseases in aspects of introducing of infections into naive populations as well as increasing the potential of transmission and changing the pattern of infections in local population. In case of migrants carried or infected the unfamiliar disease, the public health professions in the hosting country are challenged to limit or prevent these diseases by monitoring the spread of diseases and implementing health measures.

2.3.1 Impacts of migration to Thais communities

According to sociology, demography and jurisprudence, cross-border migration of foreign labours from the neighbor countries have affected communities in Thailand as a transit or destination country in 5 dimensions [51].

1. Impact to populations: The number and characteristics of migrants have resulted to the size changes of population structure in destination areas such as age and gender, population dependence rate, birth rate and mortality rate, population density rate in city or industrial areas.

2. Impact to labor and employment rate: In the positive aspects, migrants replaced the labour shortage in the production sectors, especially the low-level work. On the other hand, foreign migrants might depress the local wages, negotiation power, and labor rights of local labors as the employers have alternatives, which might lead to negative changes of working and employment conditions.

3. Impact to the society especially social welfare: Destination countries have to respond to the changes of birth rate, school attendance of dependent or newborn, and increasing use of health services with their own taxes. Such as Thai

public hospitals have to bear the financial burden of medical care expenses for migrants and vulnerable groups unable to pay for their treatments. For example, many thousands of undocumented individuals crossing from Shan state in Burma to Mae Hong Son Province in Thailand have accessed the health care of Thai's public hospitals [6].

4. Impact to health system: In every country it usually creates its health and illness management system for foreign migrants in order to prevent the spread of their diseases, and to protect health of its own citizens. Moreover the destination community had to carry the burden of disease prevention and surveillance including the increasing use of medical service, and immunization program for migrants or newborn children. Conversely, foreign migrants might face with the obstacles of accessing health services in destination countries such as the fear of deportation to simply being unfamiliar with the local health system as well as the linguistic and economic barriers. However the health status of foreign migrants depends on other factors raising the risk of disease infection easily including (i) discrimination due to bias and barrier either intentionally or unintentionally; (ii) migrating to the countries of destination with the different and unfamiliar environment; and (iii) staying in crowded areas without proper hygienic system and essential utilities [3].

5. Impact to national security: That is a main concern of destination countries receiving illegal foreign migrants without verifiable system of controlling their number and residence. The migrating of foreigners in these countries might bring the uncontrollable activities without the power of negotiation (such as employment of illegal labors, illegal medical service provided by illegal clinics, and increasing crimes committed by illegal migrants), so they have been mistreated, taken advantage, and violated their human rights [3].

2.4 Public Health System on Migrants in Thailand

Thai public health systems have been defined for support Thai population in aspects of the public health cares and treatments as well as for foreigner migrants in Thailand. There were the health plans for migrants in both specific and general areas as follow:

2.4.1 The border health development master plan

According to the public health policy of Thailand, the Bureau of Policy and Strategy of the Permanent Secretary Office, the Ministry of Public Health (MOPH) has developed and assigned the Border Health Development Master Plan since 2007. The plan aimed to enhance the quality of life and the health status of populations living along the Thai border including migrants. In the beginning phase, the first plan (2007-2011) focused on improving and providing the disease surveillance system, which cooperated with all stakeholders, and the neighboring countries. The Second plan (2012-2016) has continued to develop the cooperation among the related stakeholders from Thai government, international organizations, and private agencies in the border regions. The plan focuses for improving health service system, promoting access to primary care services, and enhancing the participation of all relevant health stakeholders in order to promote the healthy of all populations in border areas [52].

Apart from the border health development master plan, there were other plan and strategies such as 1) the National Master Plan for HIV/AIDS Prevention, Care and Support for Migrants and Mobile Population, and 2) the Migrant Health Strategy.

1) The National Master Plan for HIV/AIDS Prevention, Care and Support for Migrants and Mobile Population

The Department of Disease Control, the Ministry of Public Health (MOPH) was launched the master plan in the period of 2007-2011 for the prevention care, and support of HIV/AIDS on migrants and mobile population (MMP) to reduce the new cases of HIV infections and to increase their quality of life under the collaboration at local cross-border, bilateral and regional level. The target groups included: 1) external migrants crossing the international border from Myanmar, Lao PDR and Cambodia with or without the authority document to stay in Thailand; 2) displaced people in refugee camps in Thailand; 3) Thai migrant workers working in the neighbour countries; and 4) ethnic minorities [23, 53].

2) The Migrant Health Strategy

The Department of Health Service Support, Ministry of Public Health initiated the Migrant Health Strategy during 2006-2007 with the collaboration of working committee from government, local administrative organization, private sector, NGOs, and local, national and international community based organizations (CBOs) in order to develop the availability and accessibility of migrant health service system in terms of promotion, prevention and control, treatment, and rehabilitation, as well as the health insurance coverage scheme, the migrant health information system and the migrant health management system. The target populations of the strategy were the ethnic minority in Thailand, including migrant workers, their families and dependents from Burma, Lao, Cambodia and other nations who living in Thailand with or without the registration of Ministry of Interior (except the displaced persons in the temporary shelters in Thailand) [23,53].

2.4.2 Types of migrant people in 3 nations (Burmese, Lao, and Cambodia) in Thailand

1. Registered migrants: the irregular migrant workers from Cambodia, Lao PDR and Burma register and to obtain a temporary stay registration (Tor/Ror 38/1) with a 13-digit identification number and a yearly work permit since 1996. For the new registration system between 2006 and 2013, the migrant workers register to allow to temporary live and work in Thailand and have to complete the Nationality Verification (NV) process.

2. Regular migrants passed nationality verification: the registered migrants with valid work permits in Thailand are able to acquire a legalized status by the process of nationality verification approved by their country of origin (the NV process started for Laotian and Cambodian in 2004, and Burmese in 2009). After the nationality verification completely the individual migrant gain a temporary passport or certificate of identity form their authorities, and then the Thai government gave them non-immigrant L-A visa and a work permit to work and remain in Thailand for two years [54-57].

3. Regular migrants entering through MOU: there are the memorandum of understanding (MOU) between the Thai Government and the Government of neighbor countries (Lao PRD in Oct 2002; Cambodia in May 2003; Burma in Jun 2003) to reduce migrants' vulnerability to exploitation. The migrant worker from these countries were recruited and imported directly with their passport

and non-immigrant L-A visa to be domestic migrant workers in Thailand with non-immigrant L-A visa and a work permit for two years [53, 55].

4. Undocumented/non-registered migrants: the irregular migrant workers from Cambodia, Lao PDR and Burma work without the valid work permit due to the non-registration of flexible approach continually or the non-passed NV process.

2.4.3 Health insurance for migrants in Thailand

Health insurance for migrant people in 3 nations in Thailand has been initially managed by Bureau of Health Service System Development, Department of Health Service Support during 2008-2008 to extend the coverage of their health care accessibility. Until 2009 this mission was transferred to Bureau of Health Administration, Office of the Permanent Secretary for Public as the supervision of hospitals under MOPH. However migrant worker (Burmese, Lao, Cambodia) in Thailand can entitle to health welfare or insurance scheme, which depends on their type and status of the migrant-worker registration [58].

In the present, there are two health insurance systems of medical care and public health for migrant worker and their children and dependents in Thailand.

1. The Social Security Scheme (SSS) managed by the Office of Social Security, the Ministry of Labor and Social Welfare for the regular migrants passed nationality verification completely and the regular migrants entering through MOU. Therefore migrant workers who already have a passport and a work permit could register and access the health coverage from the Social Security Fund for migrant workers.

According to the regulation the rate of contributions to the SSS (percentage of wages of the insured person) from the insured person 4% (decreasing from 5% since 2013); their employer 5%; and the Thai Government 2.75%. The health coverage of SSS consist of the free of charge to diagnosis and treatment of sickness and work-related injuries at registered hospital, including in cases of invalidity, maternity, child allowance, old-age, event of death, and unemployment [59]. However the benefit of this scheme exclude the health prevention and control [58].

2. The Compulsory Migrant Health Insurance scheme (CMHIS) managed by the Ministry of Public Health. The migrant workers passing nationality verification or entering through MOU work in the fishery, agriculture/livestock, household work sectors, and other employment sectors uninsured in the SSS. The migrant workers passing nationality verification or entering through MOU are waiting for the right of medical care in the SSS. These included 1) Undocumented/non-registered migrants, and 2) Children under 7 years, dependents and family of migrant worker.

MOPH is a key stakeholder of medical care and public health for the migrants in Thailand including the physical examination for the registered migrants as well as check-ups for children migrants under 7 years [24, 53]. According to an announcement of MOPH on 26th-27th June 2014, there are the fee of physical exams and health insurance of CMHIS in the registration process as following [60]:

1. Migrant workers and their dependents with an official document for a temporary stay in Thailand: the fee for each person includes the health check-up 500 baht and the health card 1,600 baht/year or 900 baht/6 months or 500 baht/3 months.

2. Children migrants under 7 years: the fee of yearly health card 447 baht.

3. Migrants and their dependents: the fee for each person includes the health check-up 600 baht and the yearly health card 2,200 baht.

The migrant people enrolled to CMHIS are eligible to access the benefit of the health coverage at the hospital in which they received the health screening as following [61]:

1. Treatment of illness and dental care consists of physical examination, diagnosis, and treatment; child delivery; neonate medical; rehabilitation and approved alternative medicine; and the antiretroviral therapy (ARV) drug.

2. The cases of accident and emergency conditions can access the hospitals within the registered province, excepted for migrants in the fishing industry accessing at designated hospitals in 22 coastal provinces.

3. Medical referral to appropriate hospitals within or outside of the registered province.

4. Health services of promotion and prevention cover the basic vaccination programs for children 1-15 years; perinatal care; antiretroviral therapy in pregnant women for prevention of mother-to-child transmission of HIV; contraception for male and female, including tubal ligation; home visit and home health care; health education and consultation; as well as the disease prevention and control.

2.4.4 Health programs on migrants in Thailand

The endeavor of MOPH collaborated with international organization, NGOs, and other stakeholders in order to improve access to needed health care services and prevention for border population. According to their collaborations, there have been three health programs on migrants [56].

1) The Border Health Program (BHP)

The WHO Thailand operated the Border Health Program during 2001-2007 with supports from UK government to improve the health situation of the local population as Thai and non-Thai in ten provinces along Thailand-Burma border, especially the vulnerable group, and the cross border/mobile group. The main activities undertaken by the BHP focused on [56]:

(1) Improve the coordination on border health for the disease control between the Thai public health organizations, NGOs in ten-border provinces and Myanmar public health officials.

(2) Develop and assign the standardized system of health information collecting the epidemiological and related data for target population in the border area.

(3) Implement the primary health care services for migrants in the border areas.

2) Programs with supports from the GFATM

Global Fund to fight HIV/AIDS, tuberculosis and malaria (GFATM) have supported many interventions and initiatives under programs of health organizations to against these three diseases in Thailand since 2004 for the high-risk population and the vulnerable groups including migrants. The interventions for these migrants were separated by disease as follows [23, 53]:

(1) The prevention and treatment programs of HIV/AIDS among the border migrants and HIV infected mothers under NAPHA

extension program; as well as the migrant workers and families in PHAMIT project. This program was composed of: (a) increasing condom use and RH practices among migrant workers; (b) enhancing the health system favorable for migrant workers; (c) supporting psychosocial environment and community strengthening for migrant workers; and (d) promoting a political environment that supports rights to health and treatment of migrant workers.

(2) The intervention program of tuberculosis for foreigner migrants in Thailand were separated by their objectives and target groups as follows: (i) The TB interventions preventing and caring on border migrants consist of the advocacy on the direct observed treatments (DOTs) in hospitals, and promoting the TB patient screening and drug-resistance surveillance; (ii) The reducing of TB infection on migrant workers operated by World Vision Foundation of Thailand (WVFT); and (iii) The control of the TB infection among non-Thai populations treated by Raks Thai Foundation.

(3) The reduction of malaria infection on migrant and conflicted-affected population. The key interventions were the distribution the mosquito nets and visiting migrant’s village with assistance from Migrant Health Volunteer (MHV) and Community Health Worker (CHV).

3) Migrant Health Program: Healthy Migrants, Healthy Thailand

The Migrant Health Program (MHP) as the initial program of addressing in the migrant health issues in Thailand since 2003 under the collaboration between the Ministry of Public Health (MOPH), the International Organization for Migration (IOM), the World Health Organization (WHO), and the local health authorities and relevant facilities for the better health and well-being of both regular and irregular migrants, and their families in the migrant-rich communities and villages along the Thai-Myanmar border including Tak (6 districts) and Chiangrai (7 districts), Ranong (Muang district), Samut Sakorn (Muang municipality), Phang-nga (4 districts) with close coordination from the local health authorities and relevant facilities [56].

However the objective of MHP was to provide assistance and supports to minimize the inequalities of health knowledge and health access among migrants and their Thai host communities living within the same communities through the provision of a comprehensive, participatory, sustainable and cost-effective migrant health.

2.4.5 Non-profit health organizations in Tak border

The non-government organizations have played a key role in supporting health care programs for refugee and migrant populations along the Thailand-Burma border such as The migrants the Program for Appropriate Technology in Health (PATH), International Rescue Committee (IRC), Medicin Sans Frontier (MSF), and Global Health Access Program (GHAP), Migrant Assistance Programme Foundation (MAP Foundation). The other organizations involve in providing health services in their clinics for specific disease (i.e. TB, HIV, and malaria) such as World Vision Foundation of Thailand (WVFT), Raks Thai Foundation (RFT), and Shoklo Malaria Research Unit (SMRU) [43].

Moreover along Tak border there is a community-based organization for healthcare formed and directed by Dr. Cynthia Maung in Maesot district, Tak province, Thailand since Feb 1989. Mae Tao Clinic has provided and advocated for the equitable and essential health system, education and protection for refugees, migrant workers, and vulnerable people living in the Thailand-Burma border area and eastern Burma through comprehensive programs of health treatment, prevention, and promotion.

Over twenty-five years later, Mae Tao Clinic has developed and provided the quality healthcare services through 9 departments as follows:

1. The acupuncture department cures the patients (30-50 persons per day) with problematic symptoms, especially chronic conditions such as back pain and paralysis related to strokes, and where western medicine is having limited effects.

2. The Child Inpatient Department established in 2005 to serve the health needs of children as a sever case such as treatment of illness and diseases, malnutrition, weakened immune systems.

3. The Child Outpatient Department provides the healthcare for children with both acute and chronic conditions, the nutritional status assessments and supplementary feeding programs for malnutrition, vitamin-A deficiency and

worming prevention as well as de-worming treatment, and an immunization programe (Hepatitis B, BCG, OPV, DPT, MMR for 6 days a week) including the added education on health issues for their parents.

4. The Dental Clinic opened in 2001 serves the oral treatment (20-30 persons per day), the health education on dental and oral hygiene.

5. The eye care department began in 1995 to exam and treat the basic eye diseases and refracting and dispensing donated eyeglasses. Until now, this department has the eye surgeries for 400-500 cases a year, who come from nearby factories and refugee camps, as well as from inside Burma such as cataracts or glaucoma, the victims of landmines, or suffer from eye infections.

6. The Adult Inpatient Department founded in 1999 treats a variety of diseases and conditions with a special isolation ward for the contagious illnesses such as Tuberculosis. While In case of unable to treatment at Mae Tao Clinic, the patient as a severe case has to refer to Mae Sot Hospital (MSH) under its referral program.

7. The Adult Our Outpatient Department manages all acute and chronic medical problems, ranging from minor conditions to malaria, tuberculosis, HIV, malnutrition, pneumonia, acute diarrhea diseases and chronic conditions such as diabetes, epilepsy, thyroid disease and cancer with the established protocols of treatment of each disease.

8. Surgery and trauma department serves the patient affected the dangerous nature of the border situation in their homeland, particularly the serious injuries including gun shot wounds, landmine injuries and severe burns, as well as work-related injuries and chronic conditions such as hemorrhoids and prostate problems.

9. The Reproductive Health department provides the delivery (3-15 births per day), the comprehensive reproductive health care including family planning, neonatal and post-abortion care, as well as prevention of mother to child transmission of HIV, malaria, sexually transmitted infections and anemia.

10. Prosthetics, Landmines and Rehabilitation department provides the over 200 new and replacement limbs every year, including the prosthetic workshop for the health worker of partner organizations.

Moreover, Mae Tao Clinic has committed to supporting the work of the Thai government’s Border Health Development Master Plan, which promotes the provision of health services to all Burmese groups along the Thai border including who crossing from Burma. This collaboration made the chance of the work permit for staffs of the clinic and expanding access to HIV treatment particularly for Burmese pregnant women (62). Moreover there is a cross-border collaboration of health services for border populations between Mae Tao Clinic, Myawaddy Hospital and Mae Sot Hospital such as the referral system [63].

In addition to be continued to provide the accessible quality health care among displaced Burmese, migrants and vulnerable peoples along Tak border. The Mae Tao Clinic has collaborated with the ethnic health service providers in the eastern Burma into a social services network for refugees, migrant workers, and other displaced Burmese in order to provide basic health services, to educate the training course of health care in basic and advance skills to the ethnic health worker and volunteers who are able to serve and deliver the healthcare needs for their own communities, as well as enhance communities to manage their own health system [33, 64].

Burmese migrants (not only as the undocumented status, but also the regular status for living and/or working in Thailand) who living near MTC more likely to access the health services at MTC than Thai public hospitals. The main reasons were the free services, no communication problem of language, and no risk to arrest [65-66].

2.5 Public Health System in Burma

The National Health Committee, chaired by the Secretary of the State Peace and Development Council (known as the military regimes of Burma), is a high-level interministerial and health policy-making. The National Health Plan (NHP) developed by the National Health Committee has assigned to focus on reproductive health, child health, adolescent health, HIV/AIDS, TB and malaria, and sanitation and hygiene with the improvement of health system by increasing the average levels and reducing the inequalities as followed the exception of their population [68-69].

The Burmese Ministry of Health has been responsible for the preventive, promotive, curative and rehabilitative health services at all levels through the hospitals and clinics at state, division, and township levels. The Health Department at the state or regional level plays a role to planning, coordination, training and technical support, close supervision, monitoring and evaluation of health services. The primary health care services are provided by the health center with the participation of voluntary health workers. Furthermore the health seekers have to access the special care at to station hospitals, township hospitals, district hospitals, or specialist hospitals.

The health system in Burma provides services for the majority population in Township or urban areas. High proportion of Burmese people have to pay out of their pocket for health treatment [67]. Most of Burmese vulnerable groups in the remote areas, particularly in eastern Burma have accessed or received the basic health services delivered by the medical teams of their ethnic communities.

2.5.1 Public Health System in eastern Burma

Burma is one of the world's most ethnically diverse countries with many non-Burman ethnic groups. The major non-Burman ethnic groups are the Arakanese, Chin, Kachin, Shan, Karenni, Karen, and Mon, all of that have their own states and people in which they are the dominant ethnic group [68-69]. All these states have ethnic insurgent activities of varying intensities against the Burma military (a.k.a. Tatmadaw). The Burma military had employed a "Four Cuts" counterinsurgency strategy which attempted to deny the ethnic insurgents access to food, funding, information, and recruits [17]. Also the policies of the military regime had led to the impoverishment of and human rights abuses toward the ethnic peoples causing the hundreds of thousands of them to seek safety by the resettlement in the neighbor countries (such as Thailand, China, India, and Bangladesh); or to be an as internally displaced persons (IDPs) living in the jungle inside Burma [70].

Under the successive military regime, the public health was one casualty of decades of military rule with the long-term disinvestment of basic, essential social services. Without accessing to a public social service system or official international humanitarian assistance, many people in Burma, in particular the eastern, were forced to rely on health, education and community development programs set up and run by their members of the ethnic communities themselves [12]. The health community-based organizations (CBOs) and ethnics health organizations (EHOs) operated their health care system for their own communities and IDPs in the eastern states to provide the health services of curative, preventative, and promotive for impoverished communities through various public health programs, that have covered the control and prevention of infectious diseases, the development of the water and sanitation system, as well as improving their reproductive health, and the nutrition status through education, micronutrient supplementation, and de-worming. These health organizations have worked together closely and collaborated with international NGOs, which has followed the standardized medical treatment protocols in the *Burma Border Guidelines 2007 (updated Eng version)*, as an aid in confirming for medics and health worker, that was developed through the collaboration with international NGOs and international technical support [12].

Six main health organizations based on their ethnic and community along the eastern areas of Burma have played a significant role of health service providers for IDPS and other communities in the remote and conflict-affected regions of eastern Burma (covering target population of almost 500,000 people) [15].

1. Back Pack Health Worker Team (BPHWT): The BPHWT was established by doctors and health workers from Karen, Karenni, and Mon States in 1998 for providing and delivery the quality and affordable services of primary health care in the conflict and rural areas of Burma including medical care, community health education and prevention, as well as the maternal and child healthcare services to IDPs and other vulnerable groups in target communities with those unavailable health services. The BPHWT has already had 100 active mobile teams of health workers with advance skills comprised of health workers (3-5 persons) with the trained traditional birth attendants (5-10 persons) in each team. They have to travel on foot and carry medical supplies and educational materials to provide the essential primary health care under the collaboration with the village health workers or volunteers in participating communities. The BPHWT teams currently target the displaced and vulnerable communities in the states of Karen, Karenni, Mon, Arakan, Kachin and Shan, as well as the some portions of Pegu, Sagaing and Tenasserim Divisions. Furthermore the BPHWT mobile teams have to worked with their stationary health workers (having the basic skill of health) at twenty-four Public Health Centers in the stability and security areas within Shan, Karenni, Karen, and Mon States and Tenasserim Division in order to delivery the health services for a target population of over 225,000 IDPs and other vulnerable people [8, 71].

2. Burma Medical Association (BMA): The BMA was established in Karen State, Burma since June 1991 to strengthened the primary health care services and human rights among displaced people through the collaboration with ethnic organizations, CBOs and nongovernmental organizations [72].

The BMS has been facilitate the ethnic partner organizations providing the health care services, reproductive and child health services, as well as medical care and community health promotion education for 38 clinics in 519 villages (over 170,000 villagers). The BMA has continually provided medicines and supplies, including the basic needs to develop a health care infrastructure, sanitation and safe drink water, and the reliable water and electricity systems. Another role of BMA is the medical and first aid training such as community health education, HIV prevention education for community health workers and mobile medical teams.

3. Karen Department of Health and Welfare (KDHW): The KDHW established by the Karen National Union in 1999 to provide the health care resources as well as delivery the primary health care; the disease-specific health care (e.g. dental care, eye care, herbal medicine, trauma management, vitamin A, dewarming); the community education. The KDHW also supports the development of the skill of community health workers by offering the healthcare training and workshops, quality management, and ongoing skills improvement. The KDHW health workers operate at the mobile health clinic and the fixed health clinics for the conflict-affected populations of all ethnic groups in Karen state (such as Karen, Mon, Burman, Karenni) covering the target population of 96,005 [73].

4. Karenni Mobile Health Committee (KMHC): The KMHC was founded in 1983 to delivery the primary health care services via mobile teams in Kayah state, Karenni state (6 townships), covering their target populations of 50,000 approximately [15].

5. Mon National Health Committee (MNHC): The MNHC has served the primary health care since 1992 to IDP and their communities along the eastern border of Burma, and deeper inside of Mon state and some areas of Karen

States and Tenassarim Division. The health services of MNHC have been operated in nine clinics and two village health facilities for approximately 10,000-target population [15].

6. **Shan State Development Foundation (SSDF):** The SSDF has formed in 2012 by merging three organizations: the Shan Health Committee (1997), Shan Relief and Development Committee (1999), and the Shan Education Committee (2008) in order to enhance the basic needs and improve the livelihood of people in Shan state. In term of health, SSDF has aimed to improve the quality and accessibility of health services, including the reproductive and child health services, the health education, and the referral serious case to Thai general hospital in Mae Hong Son province [15].

2.6 Factors Related Accessing to Health Care Services

2.6.1 Factors related to accessing to health care services in Thailand

Voravit Suwanvanichkij (2008) [6] discussed the case study of health and diseases in the Shan displaced by the Burmese military regime as part of its counter-insurgency policy and then fled their homes for Thailand to become economic migrants in the worst working conditions, including in the Thai sex industry. However the registration for their legal status is filled with the many restriction and complicated measures including misunderstanding, language barriers, discrimination, and registration costs. Hence Shan migrants in Thailand mostly are undocumented or illegal status that is a key barrier to accessing health care in Thailand.

A research of Canavati and et al (2011) [74] represented the barriers to successful implementation of immunization campaign launched by the border clinics of the Shoklo Malaria Research Unit (SMRU) (WangPha, Mawker Thai, and MaeKon Ken district) for the school-age and migrant children residing in four districts of Tak between 14 May and 10 July, 2009. Its result was the distance to immunization services, fear of arrest, not remembering immunization appointments, and the disruption of parental work. For migrant parents from Burma their barrier was just identified fear of arrest.

2.6.2 Factors related to accessing health care services in eastern Burma

The population-based survey of Mullany et al (2008) [65] studied to estimate the coverage of maternal health services, provided by the community-based organizations (CBOs) operating from Thailand, among ever-married women of reproductive age (15-45 y) in the 12 vulnerable and accessible communities in the Karen (n=8), Karenni (n=1), Mon (n=1), and Shan (n=2) regions of eastern Burma (as the pilot-target areas of the Mobile Obstetric Maternal Health Workers (MOM) Project) between September 2006 and January 2007. The survey in Karen stage (next to Tak province) found almost forty percent had experienced the death of one or more of their live-born children; the almost lowest coverage of basic antenatal care services, and the extremely low coverage (1.9%) of the skilled attendance at birth. Moreover Karen women received one-quarter percent of the postnatal care at home (25.59%), and the postpartum vitamin A (4.3%). Almost three-quarters of Karen women's needs are unmet for contraceptive. However the overall coverage of basic maternal health interventions was insufficient in these selected populations and really lower than the national estimates for Burma, among the lowest in the region.

2.7 Literatures Related to Wavelet Analysis

In term of infectious diseases, the applications of wavelet analysis were used to explore the nature of underlying epidemiology process.

2.7.1 Related literatures of using wavelet analysis

Khoa Thai et al (2010) [75] applied wavelet analysis to dengue data in Binh Thuan Province, Southern Vietnam from January 1994 to June 2009. The data included (i) the number of the monthly notified dengue cases in nine districts in Binh Thuan Province, (ii) historical monthly climatic data (i.e. mean temperature, humidity and rainfall), and (iii) the ENSO indices. Wavelet analysis was performed on time series of notified dengue cases by using the Morlet wavelet function. This study found that the dynamic of dengue in Binh Thuan Province had a continuous annual mode of oscillation and a multi-annual cycle of around 2-3-years only from 1996 to 2001.

Synchrony pattern in time and between districts was detected for both the annual and 2–3-year cycle. In the analysis of phase differences in the spatio-temporal patterns suggest that the seasonal wave of infection was either synchronous among all districts or moving away from Phan Thiet district. The 2-3-year periodic wave was moving towards, rather than away from Phan Thiet district. Finally, there is a strong non-stationary association between ENSO indices and climate variables with dengue incidence in the 2-3-year periodic band.

Michael Johansson et al (2009) [76] applied wavelet analysis to investigate the relationship between ENSO, local weather, and dengue incidence in Puerto Rico, Mexico, and Thailand. The data included (i) the number of monthly clinically suspected cases of dengue fever (DF) and dengue hemorrhagic fever (DHF) in Puerto Rico from July 1986 through December 2006, (ii) monthly counts of reported DF and DHF in the years 1985–2006, (iii) the number of monthly DHF cases for the years 1983–1996 in Thailand, (iv) weather data for the years 1901 through 2000 (i.e. total monthly precipitation and minimum, maximum, and mean average monthly temperatures), and (v) the average of ENSO index value for the years 1971–2000 the ENSO. Each dengue time series was log-transformed and normalized prior to analysis to reduce skewing, remove the mean, and standardize the amplitude. As a result, change over time, the focus of this analysis, is more directly analyzed. The finding of this research was that for Thailand, ENSO was associated with both temperature and precipitation. Although precipitation was associated with dengue incidence, the association was nonstationary and likely spurious. In Mexico, no association between any of the variables was observed on the multiyear scale.

Guillaume Constantin de Magny et al (2007) [77] explored the relationship between cholera and climate on both global and local scales (i.e., Indian Oscillation Index (IOI) and rainfall) from 1975 to 2002 for five coastal adjoining West African countries (Côte d'Ivoire, Ghana, Togo, Benin and Nigeria). The researchers performed wavelet approach to analyze the 3 set of time series data: the monthly cholera morbidity reports (1975-2002), rainfall data (1975-1996), and the Indian Oscillation Index (IOI) from 1975 to 2002. This study found that there were the periodicities for all incidences and IOI time series during 1975–2002 even if transient. The periodicity of IOI was a common 2–5-year periodicity in all countries except for Côte d'Ivoire, and a shift from 4- to 3-year periodicity between 1989 and 1994. Cholera time series correlate with IOI and rainfall during the early 1990's significantly in the 2- to 4-year periodic band, except for Côte d'Ivoire.

Bernard Cazelles et al (2005) [78] studied the role of climate variability in shaping the interannual pattern of dengue epidemics in Thailand from 1983 to 1997 by using wavelet approach to analyze the incidence time series of monthly DHF cases comparing between Bangkok and the rest of Thailand. Including the data of climatic indexes that describe El Niño oscillations: the Nino 3 index and the Southern Oscillation Index. This study found that a strong association between monthly dengue incidence in Thailand and the dynamics of El Niño for the 2–3-y periodic mode. This association is nonstationary, seen only from 1986 to 1992, and appears to have a major influence on the synchrony of dengue epidemics in Thailand.

A comparative study of Helene Broutin and et al (2005) [79] is to obtain an overall view of pertussis dynamics and the impact of vaccination in both the prevaccination period and the postvaccination period in 12 countries. The researchers found a clear 3- to 4-year cycle in all countries, but this periodicity was transient. In the effect of vaccination on pertussis dynamics, some spatial synchrony between countries was detected.

Coudeville and Garnettin (2012) [80] used the mathematical model of transmission dynamics of the four dengue serotypes in southern Vietnam to explore the potential impact of two vaccination strategies at a population level. In this study, they also applied wavelet analysis to quantify the significant existence of multi-year periodic mode of the observed annual incidence of dengue (i.e. hemorrhagic fever and dengue shock syndrome).

2.7.2 Strength and weakness of using wavelet analysis

The wavelet method has used to analysis the temporal dynamics of disease occurrence (with non-consistent over time) into the time-frequency dimensions. The key advantage of wavelet analysis is to quantify the main and significant periodic component of single time series over time location of data set, including the detection of the hidden periodic component. Moreover, this method can identify the shift/

changing of its time evolution, that maybe effect the impact of health intervention during the time (such as vaccination program) [79].

The complex or temporal linear relationships between the disease occurrence and the observed factors (such as climate or environment factors) are revealed by Wavelet analysis [75-76, 78]. This approach also detects the temporal influences of related factors to the variation of disease occurrence in the difference periodic component over time location. Furthermore, Wavelet analysis, applied in the spatial-temporal pattern of disease occurrence, is ability to describe the direction of disease movement between difference populations or areas [77].

Although wavelet method is used to initially explore the complexity of both the epidemiological data of diseases occurrence and the observed factors (such as climate or environment factors). There is no information about the causal relationship between the cyclicity of disease occurrence and biological or epidemiological mechanisms [81].

CHAPTER III
MATERIALS AND METHODS

3.1 Study Design

This research was a longitudinal study with the retrospective data in order to explore the frequency and temporal variation of infectious disease consultation among different groups of Burmese clients of Mae Tao Clinic (MTC): A) Burmese living in Burma (considered as transient migrants) and B) Burmese migrants living in Thailand (considered as permanent migrants) from 2008 to 2012.

3.2 Population and Sample

This research used the secondary data of monthly visit number of patients who received the medical services at MTC for common infectious diseases from 2008 to 2012 such as anthrax*, acute flaccid paralysis (AFP)* (as suspected polio), acute respiratory infection (ARI), chickenpox*, cholera, dengue, diarrhea, dysentery, filariasis*, hepatitis*, herpes simplex, herpes zoster, HIV*, malaria, measles*, meningococcal meningitis*, pertussis*, pneumonia, scrub typhus, TB, and suspected typhoid* (* denoted as a single infectious disease considered in term of case incidence and episode incidence; and others as a multiple infectious disease considered in only term of episode incidence). For hepatitis in this study, the Burmese clients of MTC could get infected hepatitis only once time for each type, even though there are three types of hepatitis a person has. Therefore hepatitis was considered as a single infectious disease without identified its types according to the medical record of MTC database.

3.2.1 The number of monthly case incidence/episode incidence of each disease in two groups of Burmese clients (as mention above) collected from the database of the medical outpatient and inpatient department for adult and child belonging to MTC, Maesot district, Tak province, which is a non-profit organization and providing the free health care services for Burmese migrants in Thailand (e.g. refugees, migrant workers and their dependents) and Burmese people crossing the Thai-Burmese border for accessing the health services of Mae Tao Clinic [32]. Information of patients in this study recorded in the Mae Tao Clinic's database has two parts. First, the personal data includes patient ID, patient name, and address of patient (township, district, or state), age, gender, date of birth. Second, the medical data includes visited date of diagnosis, diagnosed disease, medical department (adult IPD, adult OPD, child IPD or child OPD), and patient of visit (new or old).

However address of Burmese patient recorded in the Mae Tao Clinic's database did not identify the position of address on either Thailand side or Burma side. So the researcher would request the head of registration department of Mae Tao Clinic to validate the address of patient being on either Thailand side or Burma side.

3.2.2 According to the explanation of an expert of Mae Tao clinic as presented in this thesis proposal on May 8, 2015, Mae Tao clinic serves the health care services for a target population of approximately 150,000 on the Thai-Burmese border, of which approximately half are care seekers crossing the Maesot border from Burma. Therefore the ratio of care seekers at Mae Tao Clinic between Burmese crossing the border from Burma (as transient migrants) and Burmese migrants living in Thailand (as permanent migrants) is about 50%:50% [30-34]. Also the number of total visits or total clients in each group of Burmese clients is approximately half of annual total visits or total clients respectively (in Table 3.1).

Table 3.1 Annual number of total visits and total clients of Mae Tao clinic, 2008-2012

Mae Tao Clinic	**2008**	**2009**	**2010**	**2011**	**2012**
Total Visits	140,937	153,703	148,374	150,904	148,561
Total Clients	68,165	75,210	71,997	71,799	72,998

Source: Annual report of Mae Tao Clinic

3.2.3 The data gathering the number of case/episode incidence from Mae Tao Clinic's database

Step 1 Collecting the time series of monthly visit number of patients received treatment of MTC for common infectious diseases between 2008 to 2012 as the original records of common infectious diseases. These data were gathered from the all-patient records of MTC's database (only the in-patient and out-patient departments for adult and child) authorized from the director of MTC for this research. The original records were separated into twenty-one infectious diseases such as anthrax, acute flaccid paralysis (suspected polio), acute respiratory infection (ARI), chickenpox, cholera, dengue, diarrhea, dysentery, filariasis, hepatitis, herpes simplx, herpes zoster, HIV, malaria, measles, meningococcal meningitis, pertussis, pneumonia, scrub typhus, TB, and suspected typhoid.

Step 2 Deleting the duplicate records of each disease based-on the characteristics of infectious disease to get the monthly visit number of each disease. In case of the single infection diseases, the duplicate records in the same year were deleted by only patient ID. For the multiple infection diseases, the duplicate records were deletes by patient ID, visited date of diagnosis, age, and gender. There is the recommendation of the committees of Community Ethics Advisory Board (CAB), Mae Tao Clinic as follows:

1. Some information records for each patient in the database is not checked, or/and updated at the registration department every times of visiting and accessing the medical service at Mae Tao Clinic, especially address of patient.

2. According to the security concern of own patient about sharing their real name and/or address, the patient maybe inform the address of the friend/relative instantly, particular the undocumented migrants.

Step 3 Selecting the patient records of the common infectious disease as the first disease of diagnosis at that time of consultation, which was excluded the records as co-disease.

Step 4 Deleting the patient records that the address of patient was unavailable or recorded as "other".

Step 5 Identify the address of patient of each record either in Thailand or Burma, which is classified by the head of registration department of MTC.

Table 3.2 The number of case/episode incidence in twenty-one diseases used in the study through the steps of gathering from the original database of Mae Tao Clinic, 2008-2012

Diseases	Step 1 Original records	Step 2 Duplicated records	Step 3 Records of co-disease	Step 4 Address of records (n/a)	Step 5 Cases used in the study
Single infection*					
Anthrax	9	0	0	0	9
Acute Flaccid Paralysis (suspected polio)	24	2	4	0	18
Chickenpox	225	30	21	0	174
Filariasis	3	0	0	0	3
Hepatitis	900	115	197	0	588
HIV	843	353	129	0	361
Measles	647	77	65	2	503
Meningococcal Meningitis	44	6	7	0	31
Pertussis	130	11	46	0	73
Typhoid (suspected) [b]	36	0	0	0	36
Multiple infection					
ARI	6,173	1,376	352	0	5,186
Cholera	252	32	53	0	167
Dengue	1,899	120	244	5	1,530
Diarrhea	9,491	552	1,315	9	9,491
Dysentery	1,581	84	154	7	1,336
Herpes Simplex	77	0	9	0	68
Herpes Zoster	67	1	2	0	64

Table 3.2 The number of case/episode incidence in twenty-one diseases used in the study through the steps of gathering from the original database of Mae Tao Clinic, 2008-2012 (cont.)

Diseases	Step 1 Original records	Step 2 Duplicated records	Step 3 Records of co-disease	Step 4 Address of records (n/a)	Step 5 Cases used in the study
Malaria	21,278	0	0	1	21,267
Pneumonia	7,191	752	786	3	7,191
Scrub Typhus	460	129	28	0	303
TB	881	0	0	0	881

3.3 Data Analysis

All statistical analyses in the descriptive part (part1 of study method) were performed using STATA statistical software for windows version 12.0 (serial number 40120514582) describe the frequency of consultation for common infectious diseases among two groups of Burmese people seeking health care at MTC from 2008 to 2012. Descriptive statistics, chi-square test, and the F-test were used to analyze the case data of twenty-one infectious diseases at the significance level of $p<0.05$.

1) Frequency and the case/episode incidence rate (per 100,000 registered clients or visiting times) were used for the analysis of all diseases in each group of Burmese.

2) Chi-square test (or, whenever small samples, instance of Fisher's exact test) was used for the estimation of annual rate ratio (for each year) for case/episode incidence between two groups of Burmese.

3) F-test was used for the estimation of average annual rate ratio (in the five years) for case/episode incidence between two groups of Burmese.

Furthermore preparing a time series data of the potential disease consultation before wavelet analysis, the test of normal distribution and the transformation form used "gladder" command in STATA statistical software version 12.0 for windows.

In the part2 of study method, another statistical analysis will be performed by the wavelet method for exploring the dynamic patterns of consultation for the potential disease presenting their periodicity between two groups of Burmese clients of MTC from 2008 to 2012 with WaveletComp: Computational Wavelet Analysis in R package version 1.0 [36].

The simple bootstrapping, as a resampling scheme, is a classical method involving repeated sampling (with replacement) from an empirical distribution function. This scheme is associated with a null hypothesis defined by: the observed values of the wavelet quantities are identical to those that can be generated by a white noise process [82-85]. Then we can compare the wavelet quantities of the raw series with their distribution under the null hypothesis, extracting the 95th percentiles of this distribution. Therefore in wavelet analysis all significance levels of periodic components compared with those generated the bootstrapped replications [81-82].

3.4 Methods

The methods of this study are separated into two parts:

Part 1 Describe the frequency of consultation for common infectious diseases amongst two groups of Burmese clients of MTC along Tak border both for each year and in the five-year period (2008-2012). We would determine the single infection diseases in terms of case incidence and episode incidence. On the other hand, the multiple infection diseases were defined in term of episode incidence. Therefore to calculate the overview of a common disease, we using the statistic values as following:

1.1 Total case/episode incidence of one disease in one Burmese group between 2008-2012 were obtained from the a source as explaining above:

For each year,

Annual case incidence = sum of monthly case incidence from Jan. to Dec.

Annual episode incidence = sum of monthly episode incidence from Jan. to Dec.

For the 5-year period,

Total case incidence = sum of annual case incidence from 2008 to 2012

Total episode incidence = sum of annual episode incidence from 2008 to 2012

1.2 The number of total visits and total clients of each Burmese group (as mentioned above) were used as a denominator for the annual case/episode incidence rate calculation in those Burmese groups in this study.

1.3 The case/episode incidence rate (per 100,000 registered clients/visits) of one disease in each group of Burmese calculated as:

For each year,

$$Annual\ case\ incidence\ rate\ (per\ 100{,}000) = \frac{yearly\ number\ of\ case\ incidence}{number\ of\ total\ cases} \times 100{,}000$$

$$Annual\ episode\ incidence\ rate\ (per\ 100{,}000) = \frac{yearly\ number\ of\ episode\ incidence}{number\ of\ total\ visits} \times 100{,}000$$

For the 5-year period,

$$Average\ annual case\ incidence\ rate\ (per\ 100{,}000) = \frac{summation\ of\ annual\ case\ incidence\ rate\ during\ 2008-2012}{5} \times 100{,}000$$

$$Average\ annual\ episode\ incidence\ rate\ (per\ 100{,}000) = \frac{summation\ of\ annual\ episode\ incidence\ rate\ during\ 2008-2012}{5} \times 100{,}000$$

1.4 Rate ratio (RR) for case incidence and episode incidence comparing between transient migrants and permanent migrants with 95% confidence interval under a following null hypothesis: *the rate ratio of a disease in the 5-year or for each year is no different from one*.

Furthermore the accessibility of medical services of Mae Tao Clinic might have related to the some situation along Tak border overlap the study time (i.e. the closure of the Thai-Myanmar friendship bridge by Burmese authorities from 18 July 2010 to 4 December 2011 because of the armed conflict and the sporadic fighting in Karen state and other ethnic areas on the eastern border of Burma [86-87], the researcher also would like to consider the linkage between the annual overview of twenty-one infectious diseases from 2008 to 2012 and the occurring situation during that time.

According to the unreliability of address of patient mentioned by the expert of MTC on May 8, 2015 the researcher would like to investigate the temporal variation of disease consultation pattern using wavelet analysis following the second and third objective of the study (in part 2 of study method). Then the researcher give a new definition of "the address of patient" for this study being a place of living or staying of Burmese health seekers permanently or temporally in the moment of their accessing the health services at MTC, which is their own house or a friend/relative's house in area of either Thailand or Burma.

Therefore the wavelet analysis was applied to the monthly episode incidence of consultation for those potential diseases under the assumption that "the address of patient was recorded in the MTC's database is the correct residence of patient for the moment of each time of a patient's accessing the health service of MTC". Under this assumption, the Burmese clients of MTC were separated into 2 groups as mentioned in the operational definitions of chapter 1.

The potential diseases were identified by the descriptive results of the five-year overview of twenty-one diseases in part1 of study method under the conditions of each infectious disease. In this study, there are 2 theoretical and 2 specific criteria for selecting the potential diseases in wavelet analysis, respectively: 1) Length of data set was sufficient for wavelet method (more than 100 time points) [88]; 2) Included only diseases which displayed periodicity; 3) The result of the disease data from MTC have to represent in the target population of the study (i.e. Burmese people accessing health services of MTC); and 4) Selecting the disease presenting its seasonal pattern (according to the 2nd objective of the study, we would like to view the disease pattern of infectious disease consultation). For each criterion, a disease was given the score as 1 or 0 that have or have not that criterion respectively. Then a disease had to get a score of 1 for *all* of these criteria in order to be eligible for inclusion in the wavelet analysis.

Part 2 The dynamic of disease pattern of consultation for the potential diseases (selected from the criteria mentioned above) between transient migrants and permanent migrants along Tak border during 2008 to 2012 was investigated using wavelet analysis.

Wavelet analysis involves analyzing sequential sets of observed data measured over equal-spaced time periods (such as day, week, month, or year), defined as a data set of time series. This set of time series with time domain is decomposed into time and frequency domain using the wavelet function (Figure 3.1).

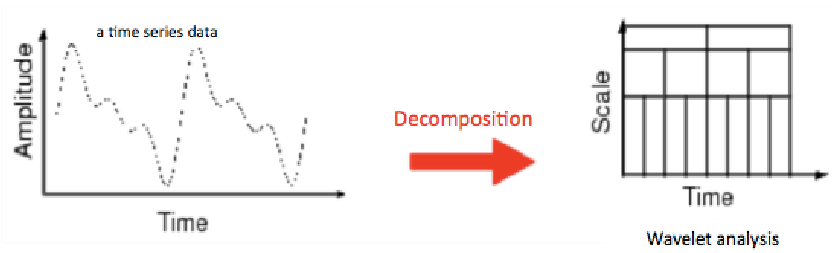


Figure 3.1 Decomposition of time domain (i.e. year, month, week, or day) of a time series. In wavelet analysis, time domain *(t)* viewed in aspect of time of duration of disease emerging in one cycle known as scale or period *(a)*; and frequency domain *(f)* viewed in aspect of time point of highest peak in one cycle known as time position *(τ)*.

Source: http://jfcgomez.webs.ull.es/WAVELET%20METHODS%20FOR%20TIME%20SERIES%20ANALYSIS.pdf

Examples of a set of time series data in epidemiology include a weekly series of number of road accidents, monthly number of new disease events, daily minimum temperature, and so on. A time series of epidemiological data usually has the characteristics of its mean constant or variance constant changing over time as non-stationary, which may be related to the changing of the disease epidemic affected from a event (such as vaccination, intervention program), or the variability of factors associated with disease transmission (e.g. temperature, climate) [81]. Therefore we can observe the different scale of time series changed over time, which view in both time domain and frequency domain with wavelet method [89-90].

Because of the recommendation of the expert of MTC about the unreliability of patient address recorded in the database, the part 2 of this study is to initially study the dynamic patterns of potential disease consultation between two groups of Burmese from 2008 to 2012 using the wavelet approach under the assumption as mention above.

According to the theory of wavelet analysis, all time series of potential diseases were transformed and normalized (having normal distribution) in order to make mean constant or variance constant be uniform or not vary over time (homogenize the variance of time series) prior to analyses before comparison time series of each Burmese group by wavelet approach [91]. When using the Ladder-of-powers histograms test of “gladder” command in STATA program, which displays nine histograms of transforms of one time series according to the ladder of powers (such as cubic, square, identity, square root, log, inverse of square root, inverse of identity, inverse of square, and inverse of cubic). The results of Ladder-of-powers histograms test showed that the mathematics form of transformation of time series was appropriate for that time series of monthly episode incidence of a disease from January 2008 to December 2012 before analyzing in wavelet method.

In this study, wavelet analysis is used to explore the disease pattern of monthly episode incidence (transformed in term of mathematics) of the potential diseases between two Burmese groups who accessing the health services of MTC from 2008 to 2012 into 3 aspects: (i) Transformation for analyzing single time series to explore the temporal dynamics of a potential disease in each Burmese group; (ii) Coherence for two time series to investigate the association of dynamic patterns of a potential disease between two groups of Burmese; and (iii) Phase difference of disease pattern between two time series (i.e. transient migrants, and permanent migrants) to consider the dynamic of disease consultation patterns between both groups of Burmese having the same pattern of disease emerging within the same time or a time delay [81].

In part 2 of this study, the wavelet analysis used applied with a data set of time series of monthly episode incidence (transformed in term of mathematics) of one potential disease between two groups of Burmese clients accessing health services of MTC from 2008 to 2012. Where $x(t)$ denotes a time series of monthly episode incidence of transient migrants; and $y(t)$ denotes a time series of monthly episode incidence of permanent migrants.

Transformation

In the theory of wavelet analysis, a time series data in term of time (day, week, month, or year) is decomposed into 2 terms of scale and time position and presented as a signal or wave plotting in a two-dimensional graph.

Transformation is a decomposition of time location *(t)* of a time series based on a function with period *(a)* and time position *(τ)*, known as "wavelet function", to get wave or signal feature (Figure 3.2 (a)) [78, 81]. However the wavelet function in a normal form must have zero mean and be localized in both time and frequency space defined as:[(1)]

$$\Psi_{a,\tau}(t) = \frac{1}{\sqrt{a}}\Psi\left(\frac{t-\tau}{a}\right)$$

Where $\Psi\left(\frac{t-\tau}{a}\right)$ is a set of wavelet; *t* is time location parameter; time position *(τ)*; and wavelet period *(a)*.

According to the previous studies of epidemiology, the Morlet wavelet was chosen to be a basic wavelet function applied in this study for the signal decomposition of time series [81, 89-90]. As the Morlet wavelet is a continuous wavelet being very well localized in period (*a*), and then a high frequency resolution of the Morlet wavelet is expected in frequencies (*f*) [88]. The Morlet wavelet, a complex sine wave localized by a Gaussian distribution, defined as (81)

$$\Psi(t) = \pi^{-1/4}\exp^{(-2\omega_0 t)}\ \exp^{(-t^2/2)},$$

where *t* is time location parameter; ω_0 is the central angular frequency of the wavelet (ω_0=6, here to satisfy admission criteria) [76]. The term $\pi^{1/4}$ is a normalization factor to ensure unit variance.

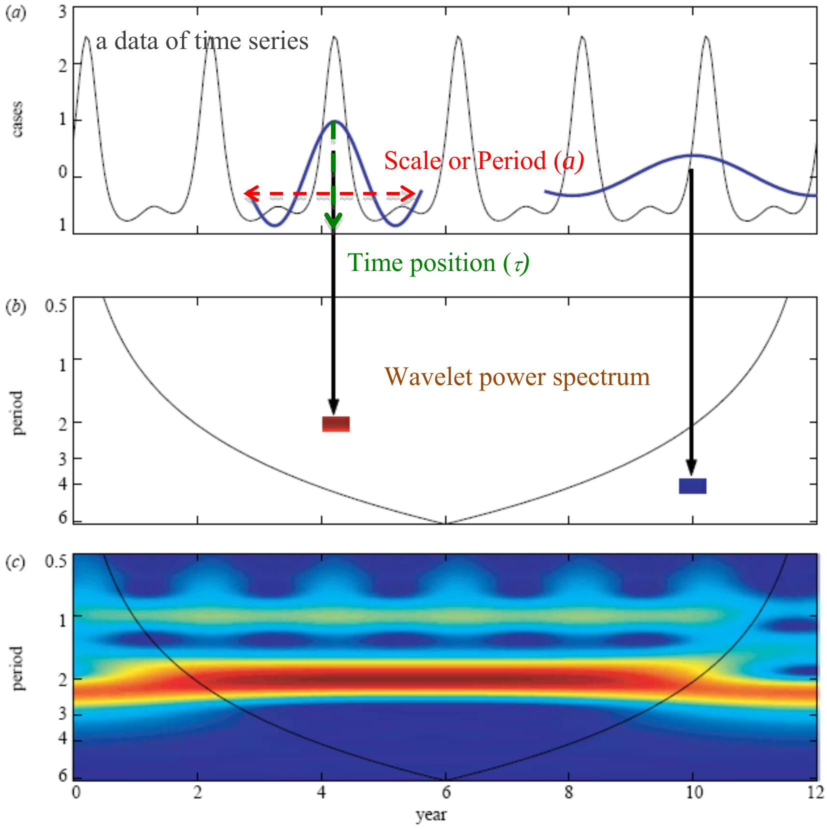


Figure 3.2 Example of Wavelet power spectrum of an epidemiological time-series. (a) A time-series of the infectious generated by the classical SEIR model (Aron & Schwartz 1984). On this time-series Morlet wavelets with a scale (period) a=2-year and a=4-year are superimposed at time position τ_1= 4.2 and τ_2=10, respectively. (b) Wavelet power spectrum $(S_x(a,\tau_i))$ are plotted as function of time and period in a two-dimensional graph. As an example, the graph shows the value of $S_x(a,\tau_i)$ for a=2-year at τ_1= 4.2 year and for a=4-year at τ_2=10 year. At $\tau_1$for a=2-years, the matching between the time-series and the wavelet is high, this gives a high positive value of the wavelet transform and a high value for the wavelet power spectrum $(S_x(a,\tau))$at this time position for this periodic component. This high value of $(S_x(a,\tau_1)$ is shown in dark red in the two-dimensional time-period plot (b). Similarly, when the matching is weak as at $\tau_2$for a=4-years, the low value for the wavelet power spectrum is shown in dark blue (b). (c) The complete two-dimensional plot is obtained simply by computing wavelet

transforms and wavelet power spectrum for a given range of a and τ values. The colours code for power values from dark blue, low values, to dark red, high values. The SEIR model used is given by: $dS/dt=\mu-\beta(t)SI-\mu S$; $dE/dt=\beta(t)SI-(\mu+\alpha)E$; $dI/dt=\alpha E-(\mu+\gamma)I$; $dR/dt=(\gamma I-\mu)R$; with $S+E+I+R=1$, μ the birth and death rates, $1/\alpha$ the duration of the latency period, $1/\gamma$ the effective infectious period and β the contact rate with $\beta(t)=\beta_0(1+\beta_1 cos\ 2\pi t)$ (Aron & Schwartz 1984). The parameter values used are: α=35.84, μ=0.02, γ=100, β_0=1800, β_1=0.10.

Source: Cazelles B, Chavez M, Magny GC, Guegan JF, Hales S. Time-dependent spectral analysis of epidemiological time-series with wavelets. Journal of the Royal Society, 2007; 4(15): 625-36.

For the Morlet wavelet, there is the relation between frequencies and wavelet scales given by $\frac{1}{f} = \left(\frac{4\pi a}{\omega_0 + \sqrt{2+\omega_0^2}}\right)$. When $\omega_0 \approx 2\pi$, period *(a)* is inversely proportional to the central frequency of the wavelet, i.e. $f \approx \frac{1}{a} \approx a^{-1}$ (88). This greatly simplifies the interpretation of the wavelet analysis and one can replace scale or period *(a)* by the period $\frac{1}{f}$ (or wavelength) on all equations [81, 88].

Then a decomposed signal of each series is represented as a spectrum at particular periodic band *(a)* and time position *(τ)*, that is known as "wavelet power spectrum" $S_x(a^{-1},\tau)$ with difference color plotted in the two-dimensional graph between time position *(τ)* and period *(a)* (in Figure 2(b)).

However the color coding of each spectrum depends on the value of wavelet power spectrum by calculating the magnitude of "wavelet coefficient" $W_x(a,\tau)$ at each periodic band *(a)*, and over time position *(τ_i)* defined [76, 78, 81]:

$$S_x(a^{-1},\tau) = |W_x(a,\tau_i)|^2,$$

where $W_x(a,\tau)$ as a function with normal distribution, which the factor $1/\sqrt{a}$ normalizes the wavelets so that they have unit varience and comparable for all period *(a)*.

$$W_x(a,\tau) = \frac{1}{\sqrt{a}}\int_{-\infty}^{\infty} x(t)\Psi^*\left(\frac{t-\tau}{a}\right)dt = \int_{-\infty}^{\infty} x(t)\Psi_{a,\tau}^*\left(\frac{t-\tau}{a}\right)dt \ .$$

Also the difference level of power value of a spectrum is presented from dark blue (as low spectrum) to dark red (for high spectrum) in Figure 2(c).

Therefore wavelet power spectrum of single time series illustrate the main periodic component of a time series and its time evolution, which is represented as dark red region in the two-dimensional plot in Figure 2(c) [81].

In the transformation process for single time series, we will get spectrum banding to a complete two-dimensional plot, including the dotted lines (the white line in WaveletComp) show statistically significant area (threshold of α = 5% confidence interval), and the cone of influence (black curve or the area of non-shading in WaveletComp) indicates the region not influenced by edge of time series (as the edge effect) in Figure 2(c). Hence dark red regions inside the cone of influence will represent significant periodicity mode of single time series, which is an average time period for disease emerging for one complete cycle at particular time location under the null hypothesis: *the variability of the observed time-series is no different to that expected from a purely random process* [81-82).

In addition the wavelet power of each series comprises with two parts of power. First, the power of variance contained in all wavelet coefficients of the same frequency *(f)* defined as "the average variance" $S_x(a^{-1})$. Second, the power of the variance obtained by averaging the frequency components at each time location *(τ)* known as "the mean variance" $\bar{s}_x(\tau)$ [81, 88].

$$S_x(a^{-1}) = \frac{\sigma_x^2}{T}\int_0^T |W_x(a^{-1},\tau)|^2 d\tau$$

$$\bar{s}_x(\tau) = \frac{\sigma_x^2 \pi^{1/4} \tau^{1/2}}{C_g}\int_0^\infty a^{1/2}|W_x(a^{-1},\tau)|^2 da^{-1} \ .$$

According to the theory of wavelet analysis, wavelet transformation will be used to analyze single time series of episode incidence of a potential disease of one Burmese group recorded every month (in term of time location (monthly)), in order to estimate the average number of months in one complete cycle of disease emerging in that Burmese group called as scale (a). Including estimating that average months of one complete cycle having the highest peak of disease occurring called as time position (τ). Then the number of scale and time position of each series in one complete cycle is represented as a spectrum with difference color depended on the power value of each spectrum. In this study, we will quantify a significant periodic band for single set of time series, which is the average time period for disease emerging for one complete cycle in particular time location of time series data.

Coherence

Coherence is a measurement of the dependencies in terms of frequency *(f)* and time position (τ) between single-to-single time series [75]. Coherence in wavelet analysis can investigate the association of disease consultation patterns between transient migrants and permanent migrants in this study.

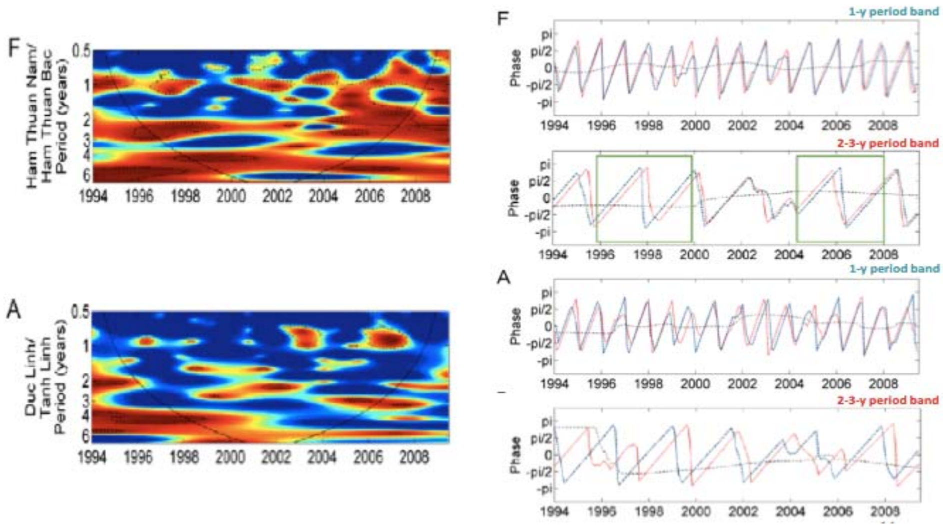


Figure 3.3 Example of Wavelet coherence and phase analyses of dengue time series between neighboring districts in Binh Thuan province. The left panel represents the wavelet coherence. Blue, low coherence; red, high coherence. The dotted lines show α=5% significance level. The cone of influence (black curve) indicates the region not influenced by edge effects. The right panels represent the phase analyses between two districts (in blue and red), based on wavelets for1-year periodic band, and 2-3-year

periodic.band. Green boxes in the 2–3-year periodic band represents the period of time where coherency is significant, when interpretation of analysis was possible. Red lines: first district; blue lines: second district; dashed black lines: phase difference between the two oscillating components.

Source: Thai KTD, Cazelles B, Nguyen NV, Vo LT, Boni MF, et al. Dengue Dynamics in Binh Thuan Province, Southern Vietnam: Periodicity, Synchronicity and Climate Variability. PLoS Negl Trop Dis. 2010; 4(7): e747.

At the beginning we have to transform two sets of time series simultaneously, then we get wavelet cross-spectrum with time domain and frequency domain (as period). The wavelet cross-spectrum normalized by spectrum each signal is plotted as "wavelet coherence" $R_{x,y}(a^{-1},\tau)$ in Figure 3(left) computed at a periodic band *(a)* and over time position *(*τ_i*)*:

$$R_{x,y}(a^{-1},\tau) = \frac{\langle W_{x,y}(a^{-1},\tau)\rangle^2}{|\langle W_x(a^{-1},\tau)\rangle|^2 |\langle W_y(a^{-1},\tau)\rangle|^2}$$

where $\langle\rangle$ denotes a smoothing operator in both time and scale. $W_x(a^{-1},\tau)$ is the wavelet transform of disease time series *x(t)*, $W_y(a^{-1},\tau)$ is the wavelet transform of disease time series y(t), $W_{x,y}(a^{-1},\tau) = W_x(a^{-1},\tau)W_y{}^*(a^{-1},\tau)$ is the cross-wavelet transform between *x(t)* and *y(t).*

Therefore the wavelet coherence represents the magnitude of a linear correlation between two-wavelets spectrums at particular time location *(t)* in a given periodic band, and is bounded by $0 \ll R_{x,y}(a,\tau) \ll 1$ with difference color from dark blue (from low coherence) to dark red (for high coherence) [78, 81, 88].

In the two-dimensional graph of wavelet coherence for two time series, high coherence coded as dark red region means the perfect linear relationship between two signals at particular time location and a given periodic band, including the dotted lines (the white line in WaveletComp) show statistically significant area (threshold of

α = 5% confidence interval), and the cone of influence (black curve or the area of non-shading in WaveletComp) indicates the region not influenced by the edge effect in Figure 3.3 (left) [81, 88]. Hence dark red regions inside the cone of influence will represent high coherence between two signals at a significant periodicity mode and particular time location under the null hypothesis: *the variability of the association between two time series is no different to that expected from a purely random process* [81, 82].

Therefore the dark red region in the wavelet coherence graph as high coherence (Figure 3.3 (left)) would show the association of disease consultation patterns between two groups of Burmese at a particular and significant periodic band. Then to quantify whether the oscillations of two time series based on a significant periodic band be rising and falling together simultaneously, which is to having the synchrony between two time series. Therefore in case of having synchrony of the disease consultation patterns between two groups of Burmese at a given periodic band, there is the disease emerging between transient migrants and permanent migrants in the same time within a duration of time location (month) of data (presented as a green box in Figure 3(right)).

Phase difference

Wavelet coherence in Figure 3.3 (left) illustrates the degree of linear relation between two non-stationary time series in the time-frequency domain. In the previous topic, we can examine what time location (month) having the high coherence that is significantly the high association between these two signals based on a significant periodic band represented as a graph in Figure 3.3 (right). Also in case of the similar pattern of disease consultation between two groups of Burmese with a time delay, we can consider the phase difference of oscillations between two signals $\phi_{x,y}(a^{-1},\tau)$ computed based on that significant periodic band as [76, 78]:

$$\phi_{x,y}(a^{-1},\tau) = tan^{-1}\frac{\Im\left(W_{x,y}(a^{-1},\tau)\right)}{\Re\left(W_{x,y}(a^{-1},\tau)\right)} ,$$

where $W_{x,y}(a^{-1},\tau) = W_x(a^{-1},\tau)W_y^*(a^{-1},\tau)$ is the cross-wavelet transform between *x(t)* and *y(t)*.

Moreover the phase difference can be converted from an angle in the interval ($-\pi$, π) to a period of time in order to measure the time lag of significant coherence.

However the dynamic patterns of potential disease consultation between two groups of Burmese in this study was interpreted only in the interval of angle $(-\pi,\pi)$ of phase difference of these oscillations based on a significant periodic band in order to estimate the time delay of disease consultation in a duration of time location (month), that equals to an angle of in-phase difference $\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$ (as the black line in Figure 3(right)) multiplied with a selected number of significant periodic band and divided by 2π.

3.5 Ethical Consideration

This research have been reviewed and approved by:

1. The Ethical Review Committee for Human Research, Faculty of Public Health, Mahidol University (MUPH 2558-076) on March 9, 2015 (Appendix B).

2. The Community Ethics Advisory Board (BAC), Mae Tao Clinic, Tak province on June 24, 2015 (Appendix C).

CHAPTER IV
RESULTS

The purpose of this study was to explore the frequency and dynamic patterns of consultation for infectious diseases among Burmese clients of MTC from 2008 to 2012. The secondary data of monthly case incidence/episode incidence of both single and multiple infectious diseases from the MTC's database was separated by the geographical areas of patient address into two groups of Burmese patients as follow: A) Burmese living in Burma (considered as transient migrants), and B) Burmese migrants living in Thailand (considered as permanent migrants). Results of this study are presented into 2 parts as follow:

Part 1: Descriptive analysis based on the characteristics of each disease (as either single infection or multiple infection)

1.1 The five-year overview of twenty-one infectious diseases from 2008 to 2012.

1.2 The annual overview of twenty-one infectious diseases from 2008 to 2012.

1.3 Exploring the linkage between the monthly consultation of twenty-one infectious diseases from 2008 to 2012 and an uncertain situation in Tak border (i.e. the closure of the Thai-Myanmar friendship bridge by Burmese authorities from 18 July 2010 to 4 December 2011).

1.4 Selecting the potential diseases for wavelet analysis (in Part 2) with the theoretical and specific criteria of each infectious disease.

Part 2: Comparative analysis for each potential disease in wavelet method

2.1 To explore the temporal dynamics of consultation for a disease in each Burmese clients of MTC using wavelet transformation.

2.2 To investigate the association of dynamic patterns of consultation for a disease between two groups of Burmese clients of MTC using coherence.

2.3 To consider the difference of dynamic patterns of consultation for a disease between two groups of Burmese clients of MTC using phase difference.

Part 1: Descriptive analysis based on the characteristics of each disease

1.1 The five-year overview of twenty-one infectious diseases from 2008 to 2012

We described the overview of twenty-one infectious diseases into 2 groups as the 10 diseases of single infection explained in terms of case incidence and episode incidence and the others of multiple infections explained in term of episode incidence (Table 4.1-4.7).

For the single infectious diseases in the 5-year period (2008-2012), both the average case incidence rate and the average episode incidence rate were significantly higher for two diseases in transient migrants than in permanent migrants, with a RR of 1.2 or higher: HIV (RR ≈ 1.54, 95%CI: 1.17-1.91); and hepatitis (RR ≈ 1.24, 95%CI: 1.09-1.39). (Table 4.1, part single infection)

On the other hand, during the same period the average case incidence rate and the average episode incidence rate for chicken pox and measles in transient migrants were significantly lower, at about a half the risk observed in permanent migrants (RR ≈ 0.55, 95%CI: 0.33-0.78; and RR ≈ 0.61, 95%CI: 0.40- 0.83 respectively). (Table 4.1, part single infection)

When considering the disease group of the multiple infections estimated in terms of episode incidence of consultation at MTC for the 5-year period (2008-2012), we estimated the episode incidence rate of consultation of transient migrants crossing from Burma to access MTC's treatment was, significantly, over twice as high than the visiting of permanent migrants for malaria (RR ≈ 2.24, 95%CI: 1.12-3.36); and TB (RR ≈ 2.02, 95%CI: 1.45-2.60). (Table 4.1, part multiple infections)

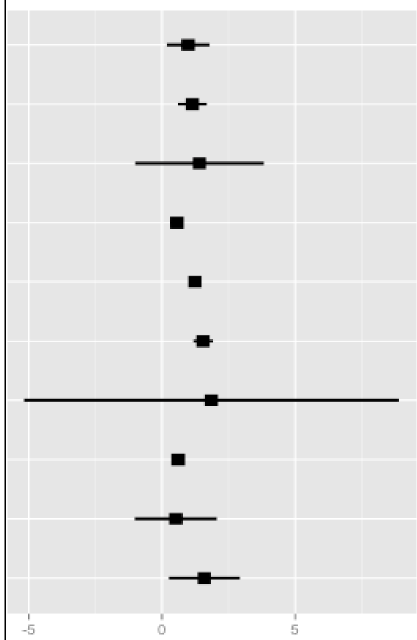
Whereas the episode incidence rate of consultation in transient migrants crossing from Burma was significantly lower, with a RR of around 0.3-0.6 compared with the visiting of permanent migrants for the following diseases: dysentery (RR ≈

0.64, 95%CI: 0.51-0.76); diarrhea (RR ≈ 0.61, 95%CI: 0.49-0.73), cholera (RR ≈ 0.58, 95%CI: 0.50-0.66); scrub typhus (RR ≈ 0.47, 95%CI: 0.24-0.69); dengue (RR ≈ 0.43, 95%CI: 0.31-0.56); and herpes zoster (RR ≈ 0.34, 95%CI: 0.03-0.64). (Table 4.1, part multiple infections).

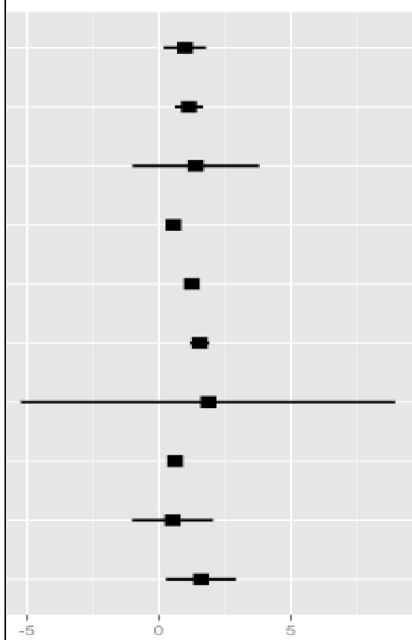
Table 4.1 Rate ratio (RR) for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2008-2012

Diseases	RR for case incidence: BM : TH[#] RR	95%CI	p-value	RR for episode incidence: BM : TH[#] RR	95%CI	p-value
Single infection[*]						
typhoid (suspected)	0.98	0.18 – 1.79	0.9571	0.98	0.18 – 1.79	0.9614
pertussis	1.14	0.60 – 1.68	0.5073	1.14	0.60 – 1.68	0.5053
meningococcal meningitis	1.40	-1.01 – 3.82	0.6658	1.40	-1.01 – 3.80	0.6692
measles	0.56	0.33 – 0.78	0.0050[a]	0.55	0.33 – 0.78	0.0051[a]
hepatitis	1.24	1.09 – 1.39	0.0120[a]	1.24	1.09 – 1.39	0.0123[a]
HIV	1.54	1.17 – 1.91	0.0156[a]	1.54	1.17 - 1.91	0.0151[a]
filariasis	1.85	-5.19 – 8.90	0.7536	1.87	-5.23 – 8.96	0.7516
chickenpox	0.61	0.40 – 0.83	0.0074[a]	0.61	0.40 - 0.83	0.0072[a]
anthrax	0.52	-1.03 – 2.06	0.4361	0.52	-1.02 – 2.06	0.4337
acute flaccid paralysis (AFP)	1.59	0.26 – 2.93	0.2846	1.59	0.26 - 2.92	0.2858

RR for case incidence



RR for episode incidence



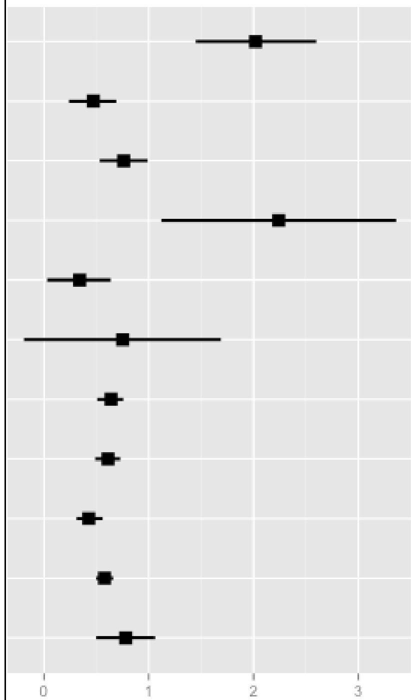
[#] Ratio of disease incidence in transient migrants (BM) divided by disease incidence of permanent migrants (TH)

* denoted infectious diseases with single infection; and others as multiple or recurrence infections

[a] p-value < 0.05 was considered statistically significant

Table 4.1 Rate ratio for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2008-2012 (cont.)

Diseases	RR for case incidence	BM : TH[#]			RR for episode incidence	BM : TH[#]		
		RR	95%CI	p-value		RR	95%CI	p-value
Multiple infection								
TB						2.02	1.45 – 2.60	0.0076[a]
scrub typhus						0.47	0.24 – 0.69	0.0028[a]
pneumonia						0.76	0.53 – 0.99	0.0423
malaria						2.24	1.12 – 3.36	0.0372[a]
herpes zoster						0.34	0.03 – 0.64	0.0038[a]
herpes simplex						0.75	-0.19 – 1.69	0.5023
dysentery						0.64	0.51 – 0.76	0.0014[a]
diarrhea						0.61	0.49 – 0.73	0.0008[a]
dengue						0.43	0.31 – 0.56	0.0002[a]
cholera						0.58	0.50 – 0.66	0.0001[a]
acute respiratory infection (ARI)						0.78	0.50 – 1.06	0.0935



[#] Ratio of disease incidence in transient migrants (BM) divided by disease incidence of permanent migrants (TH)

* denoted infectious diseases with single infection; and others as multiple infections

[a] p-value < 0.05 was considered statistically significant

In the 5-year period of the study (2008-2012) the total case incidence of the diseases of single infection among two groups of Burmese clients of MTC (transient migrants, permanent migrants) were over hundred for the following diseases: hepatitis (325; 263 cases respectively), measles (179; 322 cases), HIV (219; 142 cases), chickenpox (66; 108 cases). Furthermore, the rare diseases in each group of Burmese clients, with less than 40 cases in the whole five years, included infections such as pertussis, typhoid, meningococcal meningitis, AFP, particularly anthrax, and filariasis. (Table 4.2, part single infection, left)

With regard to the diseases of multiple infections in the same period of time (2008-2012), the majority of episode incidence of consultation at MTC among each Burmese group was to access its medical service for the following diseases: malaria (14663; 6604 times respectively), diarrhea (2871; 4744 times), ARI (2542; 3274 times), pneumonia (2436; 3214 times), dengue (461; 1069 times), dysentery (520; 816 times), and TB (589; 294 times). There were only 4 diseases were lower 200 episode of consultation at MTC in each group of Burmese client for receiving the treatment of pertussis, scrub typhus, cholera, herpes simplex, and herpes zoster. (Table 4.2, part multiple infections, right)

Comparing the average case incidence rate (per 100,000 clients in one year) of the single infectious diseases among MTC's clients (transient migrants, permanent migrants) accessing the health services in the 5-year period (2008-2012), the average case incidence rates per year in each Burmese group during 2008-2012 were clearly high for hepatitis, HIV, measles and chickenpox than the rates of the other diseases such as pertussis, typhoid, meningococcal meningitis, AFP, anthrax, and filariasis. However from 2008 to 2012 the average annual episode incidence rates in transient migrants were greater than the rate in permanent migrants for hepatitis (180.97; 146.05 respectively), HIV (122.45; 79.46), pertussis (21.04; 18.43), menningococcal meningitis (10.04; 7.15), AFP (6.22; 3.90), and filariasis (1.09; 0.59). In comparing with permanent migrants, the average annual case incidence rates were elevated for measles (97.34; 175.28), and chickenpox (36.47; 59.34), and anthrax (1.73; 3.33). (Table 4.2, part single infection, left)

While in terms of the average episode incidence rate of the multiple infectious diseases (per 100,000 visiting times in one year) among two Burmese groups (transient migrants, and permanent migrants) in the 5-year period (2008-2012), the average episode incidence rates of visiting times per year for single infectious diseases in each Burmese group were almost a half of the average case incidence rates per year of the same group. However the difference level of the average episode incidence rates of consultation between both Burmese groups in each year of the period (2008-2012) was the same pattern of the average annual case incidence rates between those groups. (Table 4.2, part single infection, right)

For the disease of multiple infections, we computed the episode incidence rate of consultation for the 5-year period (2008-2012) between two Burmese groups. The average episode incidence rates of consultation per year in both Burmese groups were clearly high for malaria, diarrhea, ARI, pneumonia, dengue, dysentery, and TB than others of multiple infections (such as scrub typhus, cholera, herpes zoster, and herpes simple). However during 2008-2012 the average annual episode incidence rates of consultation in transient migrants were greater than the rate in permanent migrants for malaria (3963.23; 1770.85 respectively) and TB (157.55; 77.84). In comparing with permanent migrants, the average annual episode incidence rates of consultation were elevated for diarrhea (774.09; 1275.89), ARI (686.92; 880.34), pneumonia (655.86; 863.61), dengue (123.92; 287.37), dysentery (140.39; 220.16), scrub typhus (26.09; 55.80), cholera (16.45; 28.55), herpes zoster (4.36; 13.00), and herpes simplex (7.80; 10.39). (Table 4.2, part multiple infections, right).

Table 4.2 Total number, average annual rate, and rate ratio for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2008-2012

Diseases	Case incidence rate per 10^5 clients (no. of case incidence)		BM : TH[#]			Episode incidence rate per 10^5 visits (no. of episode incidence)		BM : TH[#]		
	Burmese_BM	Burmese_TH	RR	95%CI	p-value	Burmese_BM	Burmese_TH	RR	95%CI	p-value
***Single infection*[*]**										
anthrax	1.73 (3)	3.33 (6)	0.52	-1.03 - 2.06	0.4361	0.84 (3)	1.62 (6)	0.52	-1.02 - 2.06	0.4337
acute flaccid paralysis (AFP)	6.22 (11)	3.90 (7)	1.59	0.26 - 2.93	0.2846	3.01 (11)	1.90 (7)	1.59	0.26 - 2.92	0.2858
chickenpox	36.47 (66)	59.34 (108)	0.61	0.40 - 0.83	0.0074[a]	17.75 (66)	28.88 (108)	0.61	0.40 - 0.83	0.0072[a]
filariasis	1.09 (2)	0.59 (1)	1.85	-5.19 - 8.90	0.7536	0.53 (2)	0.28 (1)	1.87	-5.23 - 8.96	0.7516
hepatitis	180.97 (325)	146.05 (263)	1.24	1.09 - 1.39	0.0120[a]	87.60 (325)	70.72 (263)	1.24	1.09 - 1.39	0.0123[a]
HIV	122.45 (219)	79.46 (142)	1.54	1.17 - 1.91	0.0156[a]	59.34 (219)	38.45 (142)	1.54	1.17 - 1.91	0.0151[a]
measles	97.34 (179)	175.28 (322)	0.56	0.33 - 0.78	0.0050[a]	47.51 (179)	85.61 (322)	0.55	0.33 - 0.78	0.0051[a]
meningococcal meningitis	10.04 (18)	7.15 (13)	1.40	-1.01 - 3.82	0.6658	4.88 (18)	3.49 (13)	1.40	-1.01 - 3.80	0.6692
pertussis	21.04 (39)	18.43 (34)	1.14	0.60 - 1.68	0.5073	10.25 (39)	8.97 (34)	1.14	0.60 - 1.68	0.5053
typhoid (suspected)	10.23 (18)	10.40 (18)	0.98	0.18 - 1.79	0.9571	4.96 (18)	5.04 (18)	0.98	0.18 - 1.79	0.9614
Multiple infection										
acute respiratory infection (ARI)						686.92 (2,542)	880.34 (3,274)	0.78	0.50 - 1.06	0.0935
cholera						16.45 (61)	28.55 (106)	0.58	0.50 - 0.66	0.0001[a]
dengue						123.92 (461)	287.37 (1069)	0.43	0.31 - 0.56	0.0002[a]
diarrhea						774.09 (2,871)	1275.89 (4,744)	0.61	0.49 - 0.73	0.0008[a]
dysentery						140.39 (520)	220.16 (816)	0.64	0.51 - 0.76	0.0014[a]
herpes simplex						7.80 (29)	10.39 (39)	0.75	-0.19 - 1.69	0.5023
herpes zoster						4.36 (16)	13.00 (48)	0.34	0.03 - 0.64	0.0038[a]

Table 4.2 Total number, average annual rate, and rate ratio for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2008-2012 (cont.)

Diseases	Case incidence rate per 10^5 clients (no. of case incidence)		BM : TH[#]			Episode incidence rate per 10^5 visits (no. of episode incidence)		BM : TH[#]		
	Burmese_BM	Burmese_TH	RR	95%CI	p-value	Burmese_BM	Burmese_TH	RR	95%CI	p-value
malaria						3963.23 (14,663)	1770.85 (6,604)	2.24	1.12 - 3.36	0.0372[a]
pneumonia						655.86 (2,436)	863.61 (3,214)	0.76	0.53 - 0.99	0.0423
scrub typhus						26.09 (96)	55.80 (207)	0.47	0.24 - 0.69	0.0028[a]
TB						157.55 (589)	77.84 (292)	2.02	1.45 - 2.60	0.0076[a]

[#] Ratio of disease incidence in transient migrants (BM) divided by disease incidence of permanent migrants (TH)

* denoted infectious diseases with single infection; and others as multiple infections

[a] p-value < 0.05 was considered statistically significant

1.2 The annual overview of twenty-one infectious diseases from 2008 to 2012

When comparing the descriptive overview of each infectious disease (as either single or multiple infections) in year-to-year among both Burmese groups from 2008 to 2012, we described the temporal trend of annual case incidence rate for the single infectious diseases as well as the annual episode incidence rate of consultation to receive the MTC's treatment for the diseases of the multiple infections from 2008 to 2012 as follows: (Table 4.3-4.7)

- Chickenpox: the case incidence rate of chickenpox for each year was higher in permanent migrants than in either of transient migrants (except their similar rates in 2008) under the same direction of their trend. Moreover the greatest difference in case incidence rates between the groups was observed in 2009.

- Hepatitis: the case incidence rate of hepatitis for each year was higher in transient migrants than either of permanent migrants with the same direction of their trend, except the opposite direction and closely magnitude of the morbidity rate in 2009. Moreover there was high level (peaks) of their rates in 2010 and 2011.

- HIV: the case incidence rate of HIV for each year was higher in transient migrants than either of permanent migrants, but theirs rates were close in the last two year of period. However the case incidence rates of HIV among transient migrants consistently decreased since 2008. While the rates of permanent migrants were trend to lower, except the negligible increase of their rates in 2009-2011.

- Measles: the case incidence rate of measles for each year was higher in permanent migrants than either of transient migrants with the same direction of their trend. Moreover the visibly difference in case incidence rates between the groups was observed in 2009 and 2010.

- ARI: the episode incidence rate of consultation for treatment of ARI in each year was higher in permanent migrants than either of transient migrants with the decreasing direction consistently, particular the similar rates of both groups in 2008 and 2012. However these rates of consultation in transient migrants was lower ostensibly from 2009 to 2010.

- Dengue: the episode incidence rate of consultation for treatment of dengue in each year was higher in permanent migrants than transient migrants with the same direction. There was the highest peak of the episode incidence rate among both Burmese groups in 2010, when there were clear differences in rates of consultation between two groups (around 3 times).

- Diarrhea: the episode incidence rate of consultation of diarrhea in each year was higher in permanent migrants than transient migrants. However the episode incidence rate of consultation in transient migrants decreased in each year, while rates among permanent migrants were slightly increasing and fluctuating within a narrow range.

- Dysentery: the episode incidence rate of consultation of dysentery in each year was higher in permanent migrants than transient migrants, with an overall decreasing trend, except the increasing rates of permanent migrants in 2010.

- Malaria: the episode incidence rate of consultation for treatment of malaria for each year was higher in transient migrants than in permanent migrants, with rates decreasing since 2009. The rates of consultation from 2008 to 2009 in permanent migrants increased twice, while the rates of transient migrants were similar during the same period.

- Pneumonia: the episode incidence rate of consultation of pneumonia in each year was higher in permanent migrants than in transient migrants, with an upward trend, particularly in 2010-2012.

- TB: the episode incidence rate of consultation of TB in each year was higher in transient migrants than in permanent migrants, with a peak incidence in 2009. For the last three years of study, rates remained relatively stable among transient migrants, while the rates of permanent migrants were fluctuating in a narrow range.

Table 4.3 Annual number, annual rate, and rate ratio for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2008

Diseases	Case incidence rate per 10^5 clients (no. of case incidence)		BM : TH[#]			Episode incidence rate per 10^5 visits (no. of episode incidence)		BM : TH[#]		
	Burmese_BM	Burmese_TH	RR	95%CI	p-value	Burmese_BM	Burmese_TH	RR	95%CI	p-value
Single infection[*]										
anthrax	5.87 (2)	0.00 (0)				2.84 (2)	0.00 (0)			
acute flaccid paralysis (AFP)	14.67 (5)	5.87 (2)	2.50	0.49 -12.88	0.4531	7.10 (5)	2.84 (2)	2.50	0.49 - 12.89	0.4531
chickenpox	41.08 (14)	38.14 (13)	1.08	0.51 - 2.29	1.0000	19.87 (14)	18.45 (13)	1.08	0.51 - 2.29	1.0000
filariasis	0.00 (0)	2.93 (1)				0.00 (0)	1.42 (1)			
hepatitis	176.04 (60)	123.23 (42)	1.43	0.96 - 2.12	0.0916	85.14 (60)	59.60 (42)	1.43	0.96 - 2.12	0.0917
HIV	199.51 (68)	120.29 (41)	1.66	1.13 - 2.44	0.0123[a]	96.50 (68)	58.18 (41)	1.66	1.13 - 2.44	0.0124[a]
measles	17.60 (6)	38.14 (13)	0.46	0.18 - 1.21	0.1670	8.51 (6)	18.45 (13)	0.46	0.18 - 1.21	0.1670
meningococcal meningitis	14.67 (5)	0.00 (0)				7.10 (5)	0.00 (0)			
pertussis	2.93 (1)	2.93 (1)	1.00	0.06 - 15.99	1.0000	1.42 (1)	1.42 (1)	1.00	0.06 - 15.99	1.0000
typhoid (suspected)	32.27 (11)	44.01 (15)	0.73	0.34 - 1.60	0.5571	15.61 (11)	21.29 (15)	0.73	0.34 - 1.60	0.5572
Multiple infection										
acute respiratory infection (ARI)						1052.95 (742)	966.38 (681)	1.09	0.98 - 1.21	0.1099
cholera						11.35 (8)	15.61 (11)	0.73	0.29 - 1.81	0.6476
dengue						70.95 (50)	123.46 (87)	0.57	0.41 - 0.81	0.0020[a]
diarrhea						885.50 (624)	1172.15 (826)	0.76	0.68 - 0.84	0.0000
dysentery						183.06 (129)	249.76 (176)	0.73	0.58 - 0.92	0.0083
herpes simplex						5.68 (4)	5.68 (4)	1.00	0.25 - 4.00	1.0000
herpes zoster						8.51 (6)	14.19 (10)	0.60	0.22 - 1.65	0.4545

Table 4.3 Annual number, annual rate, and rate ratio for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2008 (cont.)

Diseases	Case incidence rate per 10^5 clients (no. of case incidence)		BM : TH[#]			Episode incidence rate per 10^5 visits (no. of episode incidence)		BM : TH[#]		
	Burmese_BM	Burmese_TH	RR	95%CI	p-value	Burmese_BM	Burmese_TH	RR	95%CI	p-value
malaria						6598.65 (4,650)	1715.65 (1,209)	3.85	3.61 - 4.09	0.0000[a]
pneumonia						607.36 (428)	549.18 (387)	1.11	0.96 - 1.27	0.1599
scrub typhus						42.57 (30)	61.02 (43)	0.70	0.44 - 1.11	0.1596
TB						133.39 (94)	46.83 (33)	2.85	1.92 - 4.23	0.0000[a]

[#] Ratio of disease incidence in transient migrants (BM) divided by disease incidence of permanent migrants (TH)

* denoted infectious diseases with single infection; and others as multiple infections

[a] p-value < 0.05 was considered statistically significant

Table 4.4 Annual number, annual rate, and rate ratio for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2009

Diseases	Case incidence rate per 10^5 clients (no. of case incidence)		BM : TH[#]			Episode incidence rate per 10^5 visits (no. of episode incidence)		BM : TH[#]		
	Burmese_BM	Burmese_TH	RR	95%CI	p-value	Burmese_BM	Burmese_TH	RR	95%CI	p-value
Single infection[*]										
anthrax	0.00 (0)	0.00 (0)				0.00 (0)	0.00 (0)			
acute flaccid paralysis (AFP)	5.32 (2)	5.32 (2)	1.00	0.14 - 7.10	1.0000	2.60 (2)	2.60 (2)	1.00	0.14 - 7.10	1.0000
chickenpox	61.16 (23)	101.05 (38)	0.61	0.36 - 1.02	0.0721	29.93 (23)	49.45 (38)	0.61	0.36 - 1.02	0.0721
filariasis	2.66 (1)	0.00 (0)				1.30 (1)	0.00 (0)			
hepatitis	138.28 (52)	132.96 (50)	1.04	0.71 - 1.53	0.9211	67.66 (52)	65.06 (50)	1.04	0.71 - 1.53	0.9212
HIV	140.94 (53)	74.46 (28)	1.89	1.20 - 2.99	0.0072	68.96 (53)	36.43 (28)	1.89	1.20 - 2.99	0.0073[a]
measles	226.03 (85)	366.97 (138)	0.62	0.47 - 0.81	0.0005[a]	110.60 (85)	179.57 (138)	0.62	0.47 - 0.81	0.0005[a]
meningococcal meningitis	7.98 (3)	0.00 (0)				3.90 (3)	0.00 (0)			
pertussis	74.46 (28)	55.84 (21)	1.33	0.76 - 2.35	0.3914	36.43 (28)	27.33 (21)	1.33	0.76 - 2.35	0.3915
typhoid (suspected)	13.30 (5)	7.98 (3)	1.67	0.40 - 6.97	0.7265	6.51 (5)	3.90 (3)	1.67	0.40 - 6.97	0.7266
Multiple infection										
acute respiratory infection (ARI)						1000.62 (769)	1262.17 (970)	0.79	0.72 - 0.87	0.0000[a]
cholera						6.51 (5)	9.12 (7)	0.71	0.23 - 2.25	0.7744
dengue						115.81 (89)	209.49 (161)	0.55	0.43 - 0.72	0.0000[a]
diarrhea						869.23 (668)	1371.47 (1054)	0.63	0.58 - 0.70	0.0000[a]
dysentery						165.25 (127)	223.81 (172)	0.74	0.59 - 0.93	0.0107[a]
herpes simplex						781 (6)	20.92 (16)	0.38	0.15 - 0.96	0.0525[a]
herpes zoster						2.60 (2)	0 (0)			

Table 4.4 Annual number, annual rate, and rate ratio for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2009 (cont.)

Diseases	Case incidence rate per 10^5 clients (no. of case incidence)		BM : TH#			Episode incidence rate per 10^5 visits (no. of episode incidence)		BM : TH#		
	Burmese_BM	Burmese_TH	RR	95%CI	p-value	Burmese_BM	Burmese_TH	RR	95%CI	p-value
malaria						6688.18 (5,140)	3033.10 (2,331)	2.21	2.10 - 2.31	0.0000[a]
pneumonia						637.59 (490)	641.49 (439)	0.99	0.88 - 1.13	0.9490
scrub typhus						16.92 (13)	57.25 (44)	0.30	0.16 - 0.55	0.0000[a]
TB						297.98 (229)	144.43 (111)	2.06	1.64 - 2.59	0.0000[a]

Ratio of disease incidence in transient migrants (BM) divided by disease incidence of permanent migrants (TH)

* denoted infectious diseases with single infection; and others as multiple infections

[a] p-value < 0.05 was considered statistically significant

Table 4.5 Annual number, annual rate, and rate ratio for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2010

Diseases	Case incidence rate per 10^5 clients (no. of case incidence)		BM : TH[#]			Episode incidence rate per 10^5 visits (no. of episode incidence)		BM : TH[#]		
	Burmese_BM	Burmese_TH	RR	95%CI	p-value	Burmese_BM	Burmese_TH	RR	95%CI	p-value
Single infection [*]										
anthrax	2.78 (1)	16.67 (6)	0.17	0.02 - 1.38	0.1250	1.35 (1)	8.09 (6)	0.17	0.02 - 1.38	0.1250
acute flaccid paralysis (AFP)	8.33 (3)	8.33 (3)	1.00	0.20 - 4.95	1.0000	4.04 (3)	4.04 (3)	1.00	0.20 - 4.95	1.0000
chickenpox	27.78 (10)	58.33 (21)	0.48	0.22 - 1.01	0.0707	13.48 (10)	28.31 (21)	0.48	0.22 - 1.01	0.0707
filariasis	2.78 (1)	0.00 (0)				1.35 (1)	0.00 (0)			
hepatitis	236.12 (85)	186.12 (67)	1.27	0.92 - 1.75	0.1673	114.58 (85)	90.31 (67)	1.27	0.92 - 1.75	0.1675
HIV	199.51 (44)	120.29 (29)	1.52	0.95 - 2.42	0.1005	59.31 (44)	39.09 (29)	1.52	0.95 - 2.42	0.1006
measles	122.23 (44)	80.56 (58)	0.76	0.51 - 1.12	0.1975	59.31 (44)	78.18 (58)	0.76	0.51 - 1.12	0.1976
meningococcal meningitis	5.56 (2)	2.78 (1)	2.00	0.18 - 22.06	1.0000	2.70 (2)	1.35 (1)	2.00	0.18 - 22.06	1.0000
pertussis	16.67 (6)	25.00 (9)	0.67	0.24 - 1.87	0.6072	8.09 (6)	12.13 (9)	0.67	0.24 - 1.87	0.6072
typhoid (suspected)	5.56 (2)	0.00 (0)				2.70 (2)	0.00 (0)			
Multiple infection										
acute respiratory infection (ARI)						525.70 (390)	924.69 (686)	0.57	0.50 - 0.64	0.0000[a]
cholera						1137.74 (28)	66.05 (49)	0.57	0.36 - 0.91	0.0220[a]
dengue						233.19 (173)	653.75 (485)	0.36	0.30 - 0.42	0.0000[a]
diarrhea						780.46 (579)	1252.24 (929)	0.62	0.56 - 0.69	0.0000[a]
dysentery						136.14 (101)	243.98 (181)	0.56	0.44 - 0.71	0.0000[a]
herpes simplex						0.00 (0)	4.04 (3)			
herpes zoster						0.00 (0)	0.00 (0)			

Table 4.5 Annual number, annual rate, and rate ratio for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2010 (cont.)

Diseases	Case incidence rate per 10^5 clients (no. of case incidence)		BM : TH[#]			Episode incidence rate per 10^5 visits (no. of episode incidence)		BM : TH[#]		
	Burmese_BM	**Burmese_TH**	**RR**	**95%CI**	**p-value**	**Burmese_BM**	**Burmese_TH**	**RR**	**95%CI**	**p-value**
malaria						3330.77 (2,471)	2025.96 (1,503)	1.64	1.54 - 1.75	0.0000[a]
pneumonia						626.79 (465)	994.78 (738)	0.63	0.56 - 0.71	0.0000[a]
scrub typhus						28.31 (21)	49.87 (37)	0.57	0.33 - 0.97	0.0479[a]
TB						121.32 (90)	55.27 (41)	2.20	1.52 - 3.18	0.0000[a]

[#] Ratio of disease incidence in transient migrants (BM) divided by disease incidence of permanent migrants (TH)

* denoted infectious diseases with single infection; and others as multiple infections

[a] p-value < 0.05 was considered statistically significant

Table 4.6 Annual number, annual rate, and rate ratio for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2011

Diseases	Case incidence rate per 10^5 clients (no. of case incidence)		BM : TH[#]			Episode incidence rate per 10^5 visits (no. of episode incidence)		BM : TH[#]		
	Burmese_BM	Burmese_TH	RR	95%CI	p-value	Burmese_BM	Burmese_TH	RR	95%CI	p-value
Single infection[*]										
anthrax	0.00 (0)	0.00 (0)				0.00 (0)	0.00 (0)			
acute flaccid paralysis (AFP)	2.79 (1)	0.00 (0)				1.33 (1)	0.00 (0)			
chickenpox	16.71 (6)	33.43 (12)	0.50	0.19 - 1.33	0.2378	7.95 (6)	15.90 (12)	0.50	0.19 - 1.33	0.2379
filariasis	0.00 (0)	0.00 (0)				0.00 (0)	0.00 (0)			
hepatitis	225.63 (81)	183.84 (66)	1.23	0.89 - 1.70	0.2476	107.35 (81)	87.47 (66)	1.23	0.89 - 1.70	0.2479
HIV	100.28 (36)	89.14 (32)	1.13	0.70 - 1.81	0.7162	47.71 (36)	42.41 (32)	1.13	0.70 - 1.81	0.7162
measles	16.71 (6)	36.21 (13)	0.46	0.18 - 1.21	0.1670	7.95 (6)	17.23 (13)	0.46	0.18 - 1.21	0.1670
meningococcal meningitis	5.57 (2)	5.57 (2)	1.00	0.14 - 7.10	1.0000	2.65 (2)	2.65 (2)	1.00	0.14 - 7.10	1.0000
pertussis	11.14 (4)	8.36 (3)	1.33	0.30 - 5.96	1.0000	5.30 (4)	3.98 (3)	1.33	0.30 - 5.96	1.0000
typhoid (suspected)	0.00 (0)	0.00 (0)				0.00 (0)	0.00 (0)			
Multiple infection										
acute respiratory infection (ARI)						481.10 (363)	823.04 (621)	0.58	0.51 - 0.67	0.0000[a]
cholera						17.23 (13)	31.81 (24)	0.54	0.28 - 1.06	0.0988
dengue						60.97 (46)	139.16 (105)	0.44	0.31 - 0.62	0.0000[a]
diarrhea						695.81 (525)	1354.50 (1022)	0.51	0.46 - 0.57	0.0000[a]
dysentery						123.26 (93)	198.80 (150)	0.62	0.48 - 0.80	0.0003[a]
herpes simplex						2.65 (2)	7.95 (6)	0.33	0.07 - 1.65	0.2890
herpes zoster						3.98 (3)	21.21 (16)	0.19	0.05 - 0.64	0.0044[a]

Table 4.6 Annual number, annual rate, and rate ratio for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2011 (cont.)

Diseases	Case incidence rate per 10^5 clients (no. of case incidence)		BM : TH[#]			Episode incidence rate per 10^5 visits (no. of episode incidence)		BM : TH[#]		
	Burmese_BM	**Burmese_TH**	**RR**	**95%CI**	**p-value**	**Burmese_BM**	**Burmese_TH**	**RR**	**95%CI**	**p-value**
malaria						2226.58 (1,680)	1392.94 (1,051)	1.60	1.48 - 1.73	0.0000[a]
pneumonia						636.17 (480)	1016.54 (767)	0.63	0.56 - 0.70	0.0000[a]
scrub typhus						26.51 (20)	55.66 (42)	0.48	0.28 - 0.81	0.0071[a]
TB						117.96 (89)	87.47 (66)	1.35	0.98 - 1.85	0.0767[a]

[#] Ratio of disease incidence in transient migrants (BM) divided by disease incidence of permanent migrants (TH)

* denoted infectious diseases with single infection; and others as multiple infections

[a] p-value < 0.05 was considered statistically significant

Table 4.7 Annual number, annual rate, and rate ratio for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2012

Diseases	Case incidence rate per 10^5 clients (no. of case incidence)		BM : TH[#]			Episode incidence rate per 10^5 visits (no. of episode incidence)		BM : TH[#]		
	Burmese_BM	Burmese_TH	RR	95%CI	p-value	Burmese_BM	Burmese_TH	RR	95%CI	p-value
Single infection[*]										
anthrax	0.00 (0)	0.00 (0)				0.00 (0)	0.00 (0)			
acute flaccid paralysis (AFP)	0.00 (0)	0.00 (0)				0.00 (0)	0.00 (0)			
chickenpox	35.62 (13)	65.76 (24)	0.54	0.28 - 1.06	0.0988	17.50 (13)	32.31 (24)	0.54	0.28 - 1.06	0.0988
filariasis	0.00 (0)	0.00 (0)				0.00 (0)	0.00 (0)			
hepatitis	128.77 (47)	104.11 (38)	1.24	0.81 - 1.90	0.3854	63.27 (47)	51.16 (38)	1.24	0.81 - 1.90	0.3855
HIV	49.32 (18)	32.88 (12)	1.50	0.72 - 3.11	0.3615	24.23 (18)	16.15 (12)	1.50	0.72 - 3.11	0.3615
measles	104.11 (38)	273.98 (100)	0.38	0.26 - 0.55	0.0000[a]	51.16 (38)	134.62 (100)	0.38	0.26 - 0.55	0.0000[a]
meningococcal meningitis	16.44 (6)	27.40 (10)	0.60	0.22 - 1.65	0.4544	8.08 (6)	13.46 (10)	0.60	0.22 - 1.65	0.4545
pertussis	0.00 (0)	0.00 (0)				0.00 (0)	0.00 (0)			
typhoid (suspected)	0.00 (0)	0.00 (0)				0.00 (0)	0.00 (0)			
Multiple infection										
acute respiratory infection (ARI)						374.25 (278)	425.41 (316)	0.88	0.75 - 1.03	0.1281
cholera						9.42 (7)	20.19 (15)	0.47	0.19 - 1.14	0.1338
dengue						138.66 (103)	310.98 (231)	0.45	0.35 - 0.56	0.0000[a]
diarrhea						639.46 (475)	1229.12 (913)	0.52	0.47 - 0.58	0.0000[a]
dysentery						94.24 (70)	184.43 (137)	0.51	0.38 - 0.68	0.0000[a]
herpes simplex						22.89 (17)	13.46 (10)	1.70	0.78 - 3.71	0.2477
herpes zoster						6.73 (5)	29.62 (22)	0.23	0.09 - 0.60	0.0015[a]

Table 4.7 Annual number, annual rate, and rate ratio for case/episode incidence of 21 infectious diseases between two groups of Burmese clients of MTC, 2012 (cont.)

Diseases	Case incidence rate per 10^5 clients (no. of case incidence)		BM : TH#			Episode incidence rate per 10^5 visits (no. of episode incidence)		BM : TH#		
	Burmese_BM	Burmese_TH	RR	95%CI	p-value	Burmese_BM	Burmese_TH	RR	95%CI	p-value
malaria						971.98 (722)	686.58 (510)	1.42	1.26 - 1.58	0.0000[a]
pneumonia						771.40 (573)	1116.03 (829)	0.69	0.62 - 0.77	0.0000[a]
scrub typhus						16.15 (12)	55.20 (41)	0.29	0.15 - 0.56	0.0001[a]
TB						117.12 (87)	55.20 (41)	2.12	1.46 - 3.08	0.0001[a]

[a] Ratio of disease incidence in transient migrants (BM) divided by disease incidence of permanent migrants (TH)

* denoted infectious diseases with single infection; and others as multiple infections

[a] p-value < 0.05 was considered statistically significant

1.3 Exploring the linkage between the monthly (case or episode) incidence of twenty-one infectious diseases from 2008 to 2012 and an uncertain situation in Tak border

The closure of the Thai-Myanmar friendship bridge by Burmese authorities from 18 July 2010 to 4 December 2011 was unusual situation, which is likely to have affected the number of transient migrants crossing the Tak border in order to access the health services of Mae Tao Clinic. The following results consider the potential linkage between the border closure and reported disease incidence data. This was considered at 3 levels (Figure 4.1 and 4.2).

Level 1: The formal closure of the Thai-Myanmar friendship bridge may have led to decreases in the case incidence or episode incidence in transient migrants during the closure period (31^{th} - 47^{th} month of the study), which was observed for the following disease: chickenpox (approximately 9 months), HIV (approximately 12 months), ARI (all period of the situation), TB (approximately 8 months) as well as dengue, malaria, and pneumonia (approximately 2-5 months).

Level 2: In contrast, no difference in the case incidence or episode incidence in transient migrants when comparing periods with or without the border closure was observed for the following diseases: measles, meningitis meningococcal, diarrhea, dysentery, herpes zoster. Therefore, data for these diseases would suggest that the disease incidence or the accessibility of health services among transient migrants was not impacted by the formal closure of the Thai-Myanmar friendship bridge during 31^{th} - 47^{th} month of the study.

Level 3: For the other infectious diseases, it was unclear if the border closure had an impact or not.

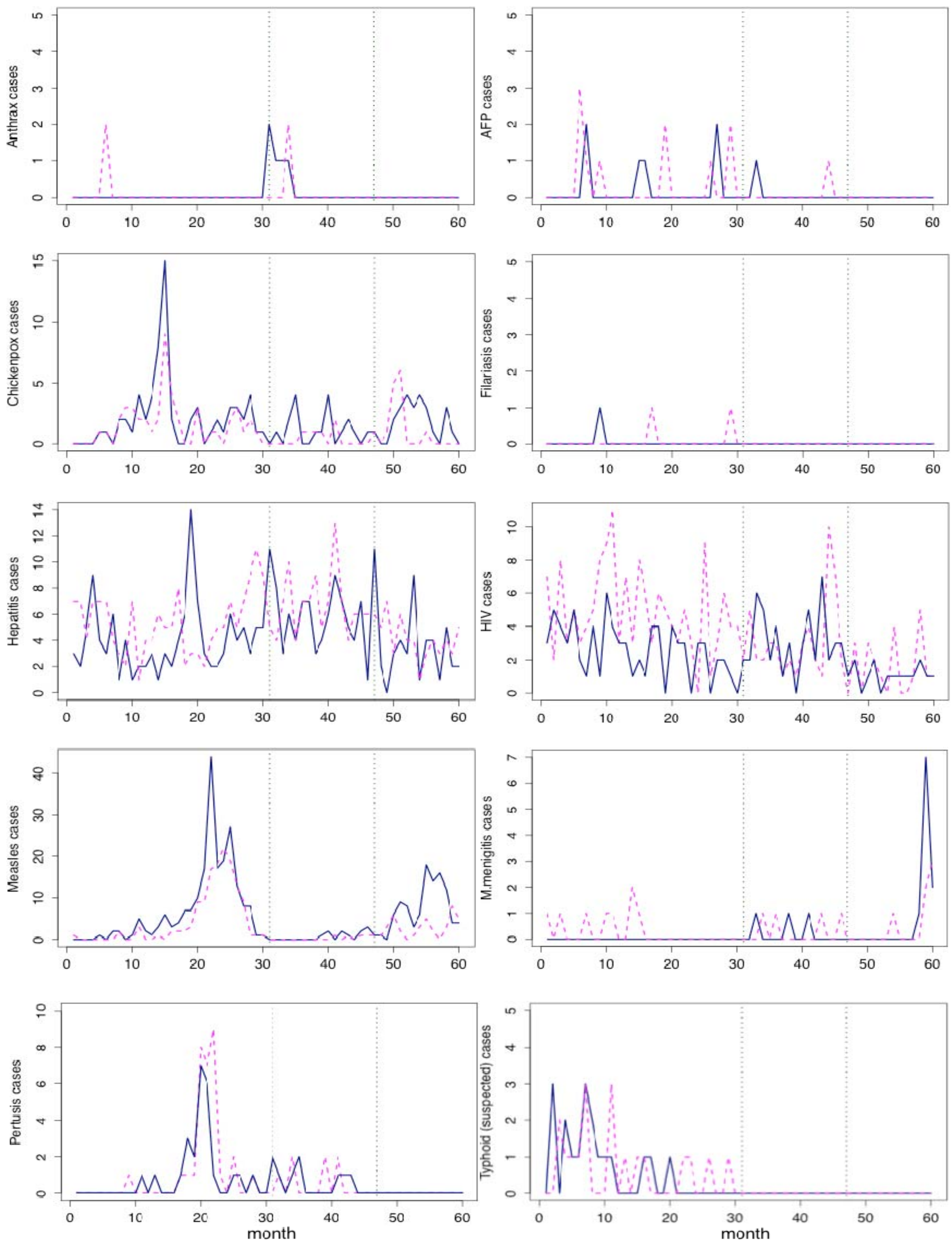


Figure 4.1 Total case incidence of diseases of single infection between two groups of Burmese (transient migrants (magenta dashed line); and permanent migrants (dark-blue line)) along Tak border from 2008 to 2012 with the closure of the Thai-Myanmar friendship bridge from 18 July 2010 to 4 December 2011 (green dotted line).

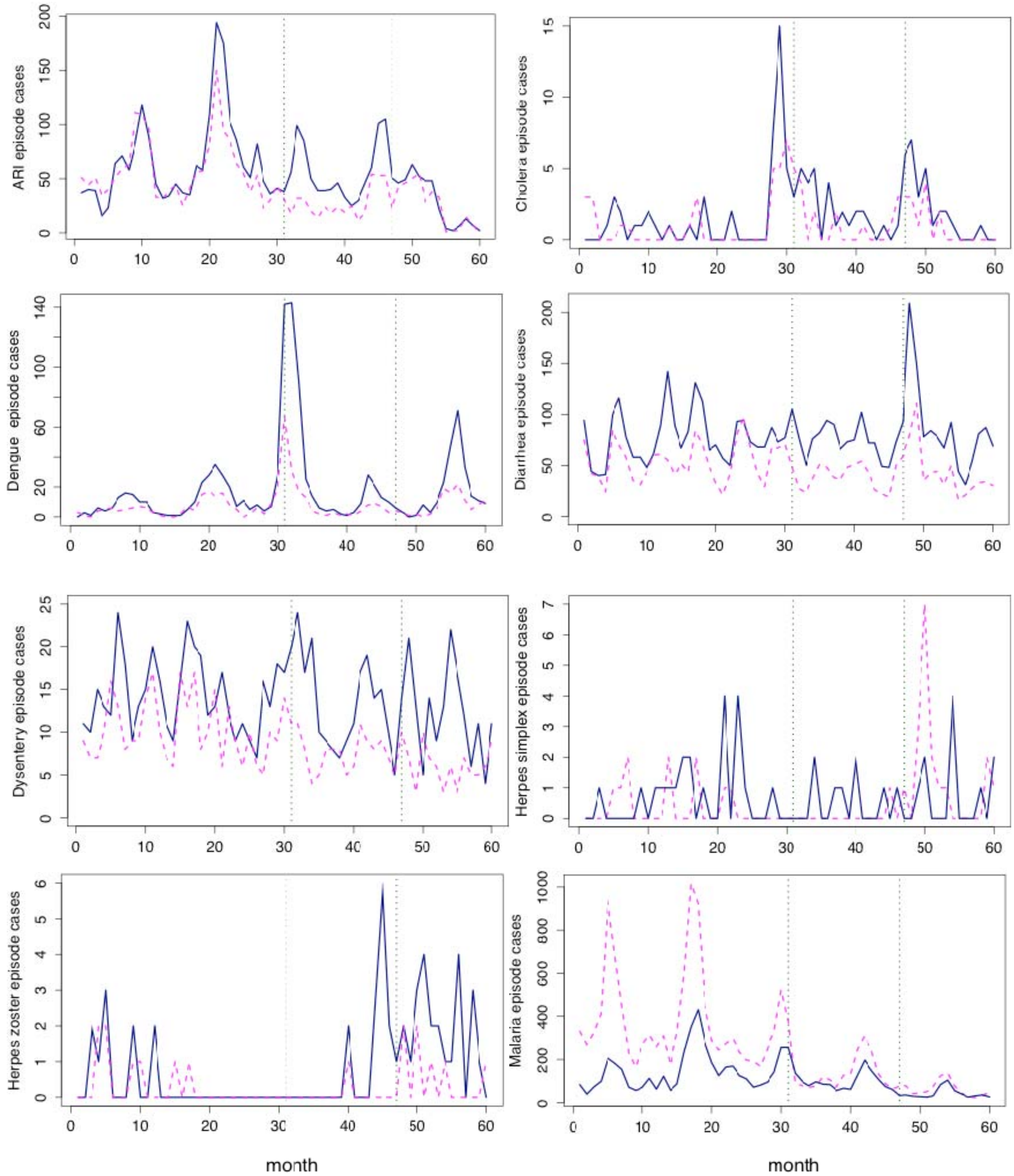


Figure 4.2 Episode incidence of consultation for treatment of multiple infection diseases at Mae Tao Clinic between two groups of Burmese (transient migrants (magenta dashed line); and permanent migrants (dark-blue line)) along Tak border from 2008 to 2012 with the closure of the Thai-Myanmar friendship bridge from 18 July 2010 to 4 December 2011 (green dotted line).

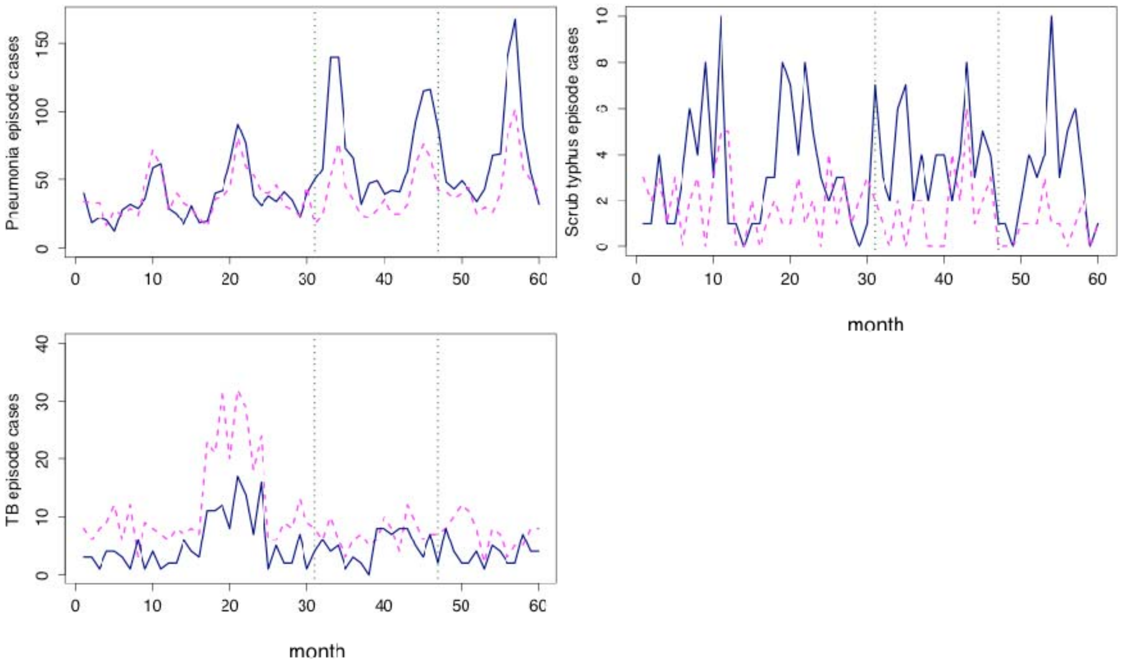


Figure 4.2 Episode incidence of consultation of multiple infection diseases at Mae Tao Clinic between two groups of Burmese (transient migrants (magenta dashed line); and permanent migrants (dark-blue line)) along Tak border from 2008 to 2012 with the closure of the Thai-Myanmar friendship bridge from 18 July 2010 to 4 December 2011 (green dotted line). (cont.)

1.4 Selecting the potential diseases for wavelet analysis in the next part

In the comparative analysis in part 2, we focused on quantifying the periodicity mode of time series of a potential disease as well as investigating the association of case/episode incidence time series between two groups of Burmese using the wavelet approach. Therefore we identified the potential diseases under the criteria of each infectious disease as follows (in Table 4.8).

a) Theory of wavelet method applied should be applied to more than 100 time points for a data set [81]. Also the data set of infectious disease in this study is monthly in the 5-year period, that might have been their number case of a disease enough to analyze following the objective and the hypothesis of the study. Diseases meeting this first criterion were: hepatitis, measles, ARI, dengue, diarrhea, dysentery, malaria, pneumonia, and TB.

b) Included only diseases which displayed periodicity. Therefore, hepatitis was then excluded, as periodicity of this disease was not observed [92].

c) Another special clinic for malaria or TB was present along the Thai-Burmese border belonging to Shoklo Malaria Research Unit (SMRU) and World Vision Foundation of Thailand (WVFT). As this is likely to reduce the representativeness of data from MTC on these diseases in the target population (i.e. Burmese people accessing health services at MTC). Malaria and TB were also excluded.

d) Selecting the disease presenting its seasonal pattern by considering the disease pattern of monthly case incidence (or episode incidence). The monthly pattern of ARI, diarrhea, and dysentery in Figure 2 could not present their seasonal pattern. ARI, diarrhea, and dysentery were also excluded from the wavelet analysis.

Therefore in the next part of the study, we would analyze the monthly data of time series of measles (in case incidence), dengue and pneumonia (in episode incidence).

Table 4.8 The 4 criteria of selecting the potential diseases for wavelet analysis

Included diseases	**a) Length of data set for wavelet method**	**b) Detect the periodicity of disease emergence**	**c) Represent the target population of the study**	**d) Present its epidemic pattern**	**Total score**
hepatitis	1	0			1
measles	1	1	1	1	**4**
ARI	1	1	1	0	3
dengue	1	1	1	1	**4**
diarrhea	1	1	1	0	3
dysentery	1	1	1	0	3
malaria	1	1	0		2
pneumonia	1	1	1	1	**4**
TB	1	1	0		2

Note: - giving one score for each criterion.
- if a disease got zero score in a criterion, then stop to consider in the next criteria.
- the potential disease has 4 scores (passed all criteria).

Part 2: Comparative analysis for each potential disease in wavelet method

The comparative approach in this study was applied to analyze a monthly set of time series data (January 2008 - December 2012) between two groups of Burmese clients of Mae Tao Clinic on the eligible diseases (measles, dengue and pneumonia) identified from the result of the descriptive approach (as described above), to detect and quantify the disease dynamics and to investigate the association of these patterns between difference groups of Burmese clients who accessing the health services of Mae Tao Clinic.

We focused on the monthly case incidence of measles (Figure 4.3) and the monthly episode incidence of consultation for dengue (Figure 4.4) and pneumonia (Figure 4.5) between two groups of Burmese clients of MTC (transient migrants, and permanent migrants) from January 2008 to December 2012.

2.1 Exploring the dynamic pattern of consultation for potential diseases in each Burmese clients of Mae Tao Clinic using wavelet transformation.

The epidemic periods of measles of both Burmese groups were displayed during September 2009-February 2010 and during 2012 (Figure 4.3, part a). For both Burmese groups the annual peaks of dengue were observed around July-September (Figure 4.4, part a) and for pneumonia around September-November (Figure 4.5, part a).

All monthly time-series data (square-root-transformed) were represented in part b of Figure 4.3-4.5, and results from the wavelet spectrum and average spectral analyses (part c-d) are illustrated in the left and right panels, respectively.

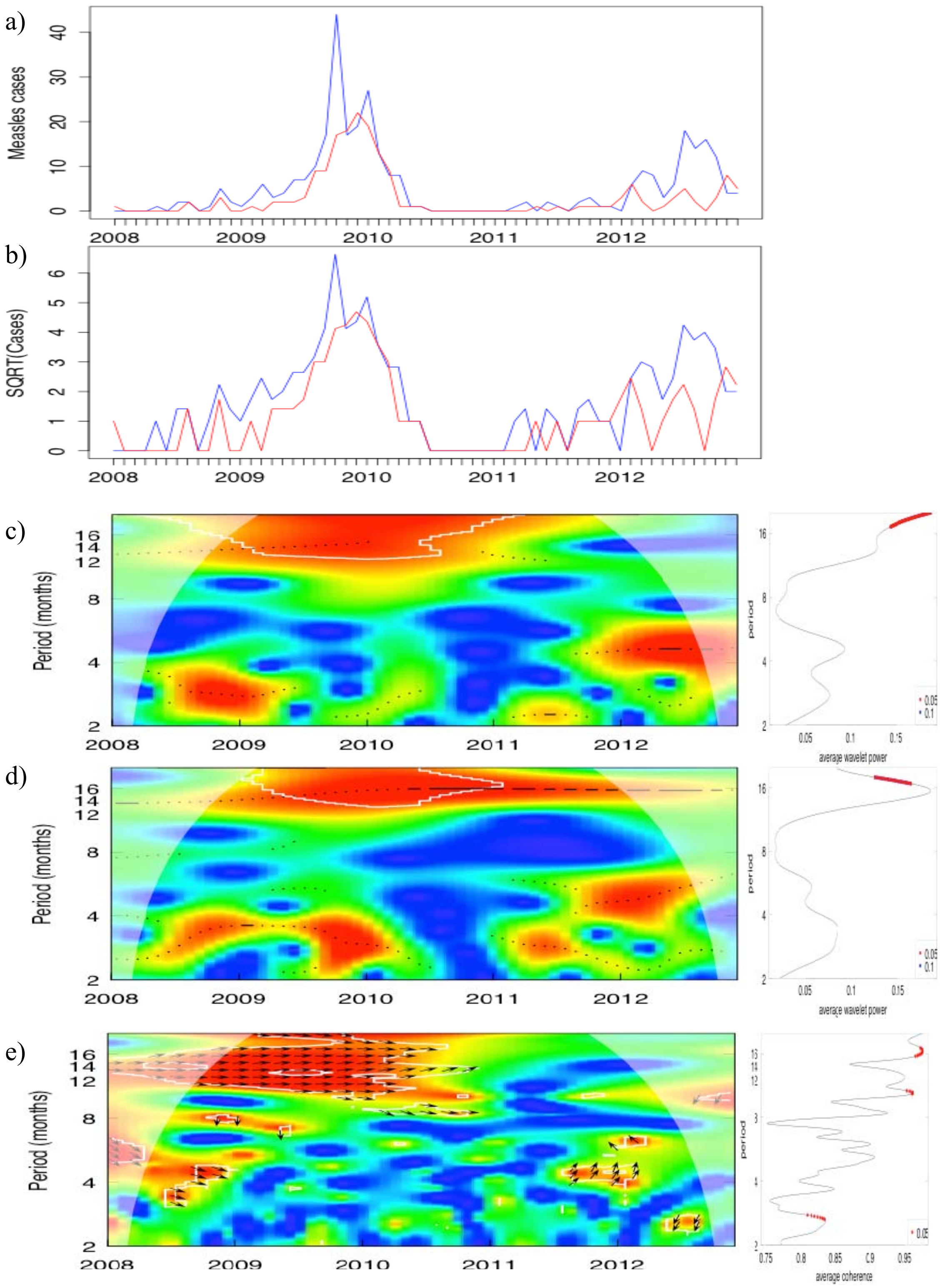


Figure 4.3 Wavelet analyses of measles (as single infection disease) time series among two groups of Burmese (transient migrants side as “red line” and permanent migrants side as “blue line”). Panel a: the time series of monthly cases. Panel b: the time series of monthly cases transformed and

normalized by square root (SQRT). Panel c-b (left): the wavelet power spectrum of disease cases (transformed and normalized) in each group of Burmese respectively; colors code for increasing spectrum intensity, from blue to red; the white line show statistically significant area (threshold of 5% confidence interval); the black curve or the area of non-shading delimits the cone of influence (region not influenced by edge effects. Panel c-b (right): to the average power spectrum (solid line) with its threshold value of 5% as “red dotted line”. Panel e (left): Wavelet coherence between two groups of Burmese. The colors are coded a dark blue, low coherence and dark red, high coherence. Panel e (right): the average power of coherence between both Burmese groups (solid line) with its threshold value of 5% as “red dotted line”.

a)

b)

c)

d)

e)

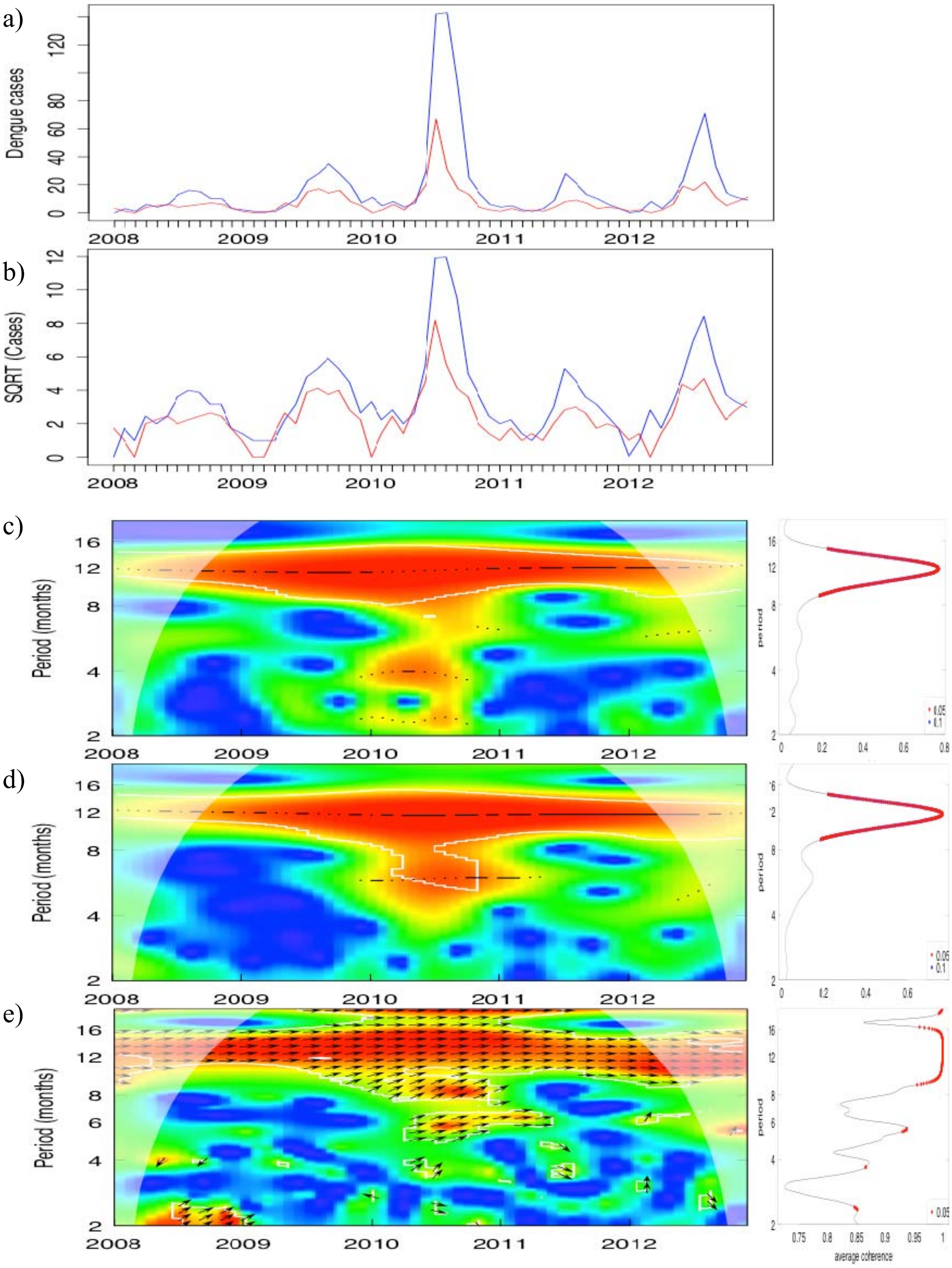


Figure 4.4 Wavelet analyses of dengue (as single infection disease) time series of visiting at MTC among two groups of Burmese (transient migrants side as "red line" and permanent migrants side as "blue line"). Panel a: the time series of monthly cases. Panel b: the time series of monthly cases transformed

and normalized by square root (SQRT). Panel c-b (left): the wavelet power spectrum of disease cases (transformed and normalized) in each group of Burmese respectively; colors code for increasing spectrum intensity, from blue to red; the white line show statistically significant area (threshold of 5% confidence interval); the black curve or the area of non-shading delimits the cone of influence (region not influenced by edge effects. Panel c-b (right): to the average power spectrum (solid line) with its threshold value of 5% as “red dotted line”. Panel e (left): Wavelet coherence between two groups of Burmese. The colors are coded a dark blue, low coherence and dark red, high coherence. Panel e (right): the average power of coherence between both Burmese groups (solid line) with its threshold value of 5% as “red dotted line”.

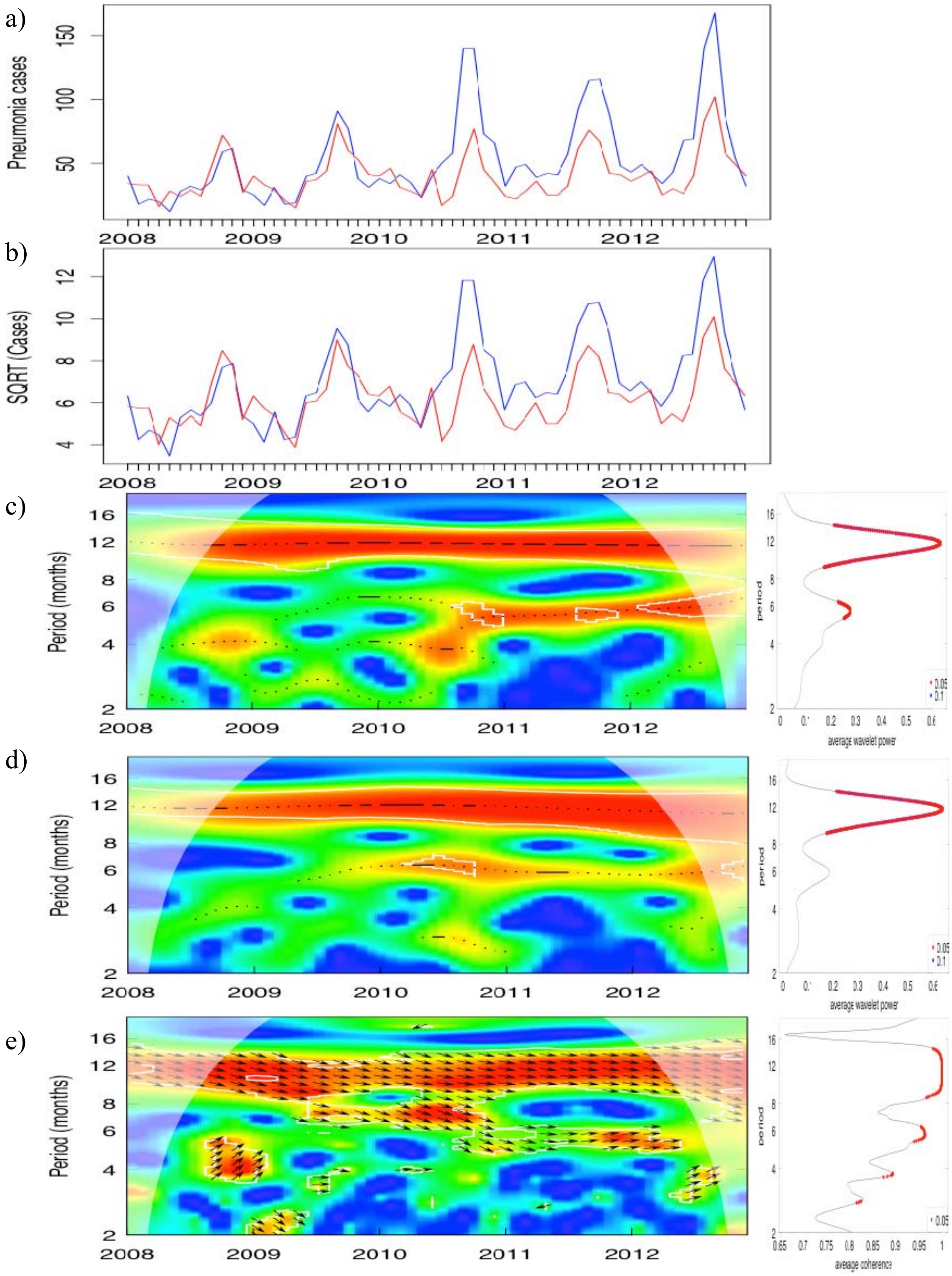


Figure 4.5 Wavelet analyses of pneumonia (as single infection disease) time series of visiting at MTC among two groups of Burmese (transient migrants side as "red line" and permanent migrants side as "blue line"). Panel a: the time series of monthly cases. Panel b: the time series of monthly cases

transformed and normalized by square root (SQRT). Panel c-b (left): the wavelet power spectrum of disease cases (transformed and normalized) in each group of Burmese respectively; colors code for increasing spectrum intensity, from blue to red; the white line show statistically significant area (threshold of 5% confidence interval); the black curve or the area of non-shading delimits the cone of influence (region not influenced by edge effects. Panel c-b (right): to the average power spectrum (solid line) with its threshold value of 5% as “red dotted line”. Panel e (left): Wavelet coherence between two groups of Burmese. The colors are coded a dark blue, low coherence and dark red, high coherence. Panel e (right): the average power of coherence between both Burmese groups (solid line) with its threshold value of 5% as “red dotted line”.

Measles: For the case incidence of measles in transient migrants (Figure 4.3, part c), an approximate 14-month period was detected during 2009 until the first half of year 2010. After that, no clear periodicity was detected. However the temporal periodicity of measles was shown in an approximately 3-month period during July 2008 to February 2009 and a 5-month period in 2012.

While in permanent migrants (Figure 4.3, part d), an approximate 16-month period was only detected from March 2009 to February 2011. Moreover the hidden periodicity of measles in permanent migrants was shown in a 3-4-month period (from the mid-2008 to the mid -2009) and a 5-month period (from September 2011 to May 2012).

Dengue: For the episode incidence of consultation for treatment of dengue at MTC in transient migrants (Figure 4.4, part c), a clear 12-month period was significantly detected during the entire period under study. In addition a slight periodicity of 4-months was shown during 2010.

The dengue dynamics among permanent migrants (Figure 4.4, part d) showed a significant 12-month period during the entire period of study, and a 6-month period during the second and third quarter of 2010.

Pneumonia: For the episode incidence of consultation for treatment of pneumonia at MTC in transient migrants (Figure 4.5, part c-d), a clear 12-month period during the entire period under study was significantly detected for both groups of Burmese. Moreover the temporal periodicity of 6 months was detected in transient migrants since mid-2010, and observed in permanent migrants during February-October of 2010.

2.2 Investigation the association of dynamic patterns of consultation for potential diseases between two groups of Burmese clients of Mae Tao Clinic using coherence.

The result for coherence between two Burmese groups (transient migrants and permanent migrants) of case incidence for measles and the episode incidence of consultation for dengue and pneumonia are presented in part e of Figure 4.3-4.5.

Measles: Comparing the temporal dynamics of case incidence of measles (Figure 4.3, part e) between both Burmese groups, in-phase coherence was significantly detected at a period between 12 and 16 months from the last quarter of 2008 to around 2010, although this effect was not observed since 2011. Furthermore, slight coherence at a 10-month period was observed during 2010.

Dengue: Comparing the temporal dynamics of the episode incidence of consultation at MTC for receiving treatment of dengue (Figure 4.4, part e) between both Burmese groups, strong in-phase coherence was detected at a period between 10 and 16 months during the entire period under study, indicating that the seasonal peak of dengue were temporally and positively correlated between two groups of Burmese. Furthermore the in-phase coherence was observed at a 6-month period during April 2010- June 2011.

Pneumonia: Comparing the temporal dynamics of the episode incidence of consultation at MTC for receiving treatment of pneumonia (Figure 4.5, part e) between two Burmese groups, strong in-phase coherence was detected at a period between 10 and 14 months during the entire period under study, indicating that the seasonal peak of pneumonia were temporal positive correlated between two groups of Burmese. Moreover there was significant coherence of pneumonia between both groups of Burmese at an approximate 4-month period during May 2008 - March 2009 and at a 5-6-month period during August 2010 until the mid-2012.

2.3 Considering the difference of dynamic patterns of consultation for potential diseases between two groups of Burmese clients of Mae Tao Clinic using phase difference

Results for coherence and the main oscillating components for measles, dengue, and pneumonia are presented in Figure 4.6-4.8. Wavelet coherence of pair-wise comparisons reveals only a discontinuous association between the temporal dynamics of the different groups of Burmese clients accessing the medical services at MTC. Nevertheless, the majority of these associations (high coherence) are in the 12-16-month periodic band for measles, the 10-16-month periodic band for dengue, and the 10-14-month periodic band for pneumonia.

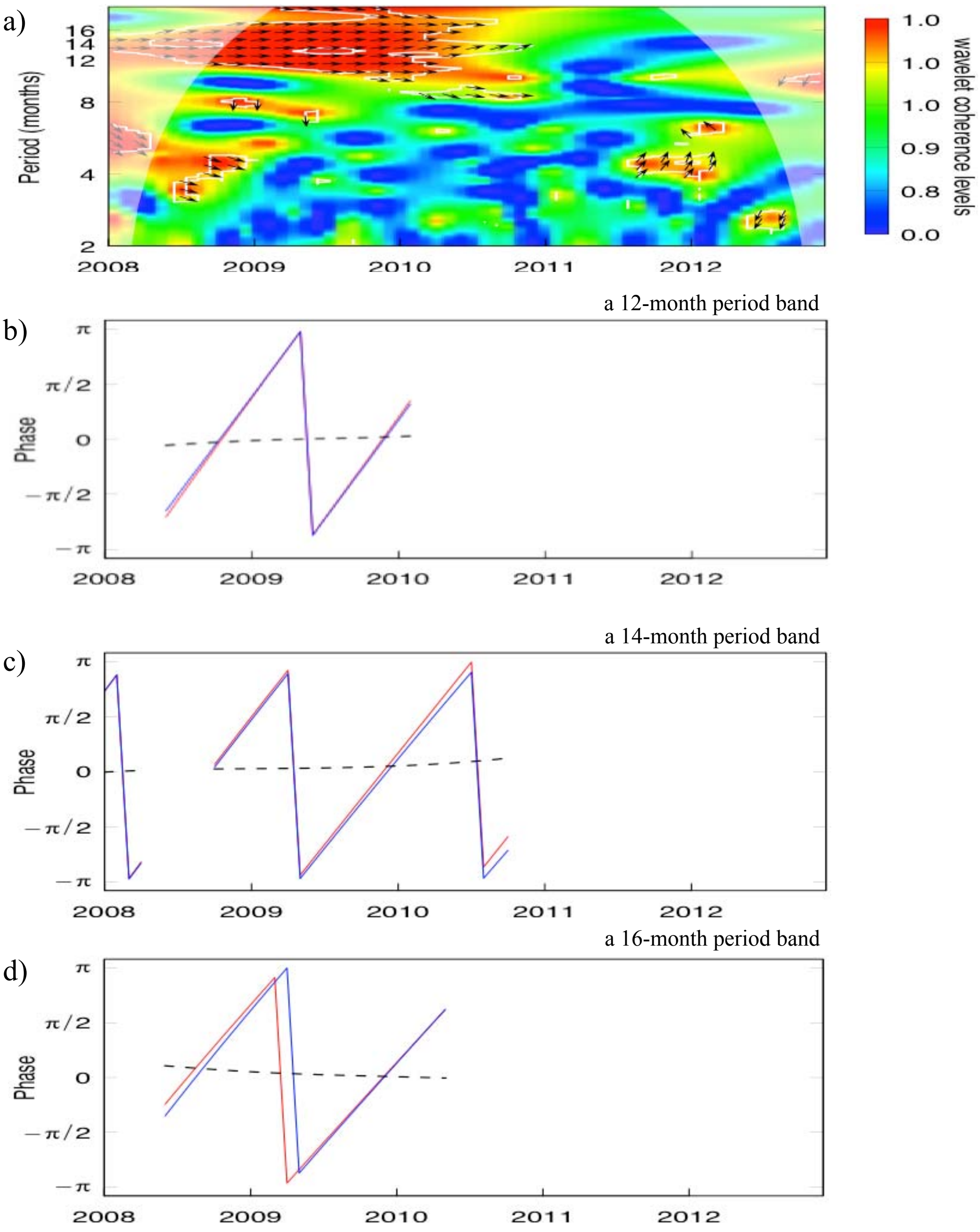


Figure 4.6 Wavelet coherence and phase analyses of measles (as single infection disease) time series among two groups of Burmese (transient migrants, and permanent migrants). The top panel represents the wavelet coherence. The colors are coded a dark blue, low coherence and dark red, high coherence. The next panels represent the phase analyses between two Burmese groups, based on wavelets for a significant periodic band. The graph represents ONLY the period of time where coherency is significant, when interpretation of analysis was possible. Red lines: transient migrants; blue lines: permanent migrants; dashed black lines: phase difference between the two oscillating components.

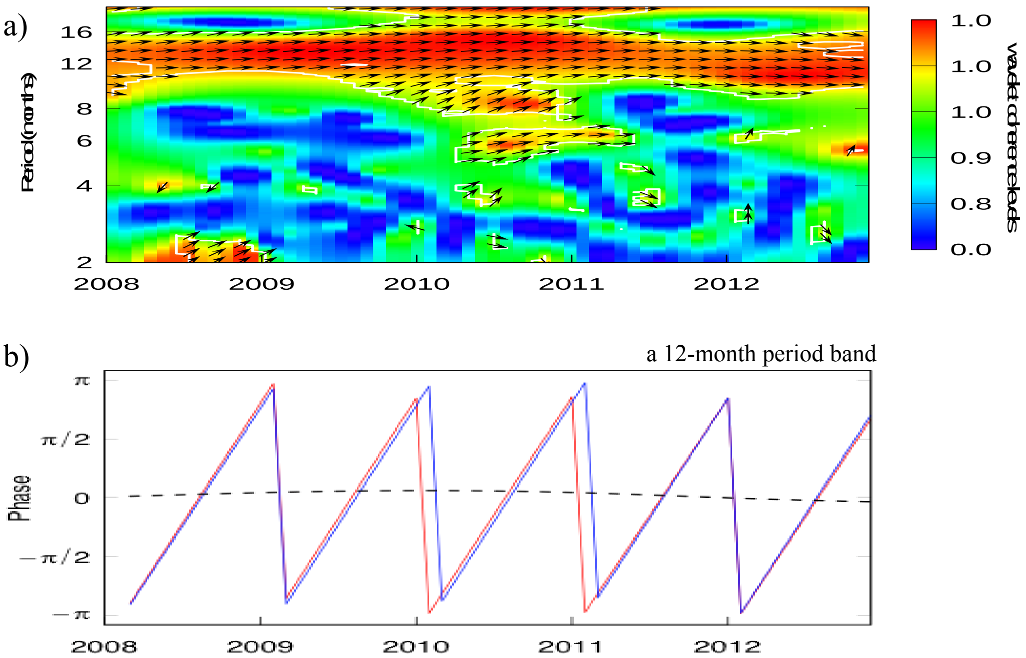


Figure 4.7 Wavelet coherence and phase analyses of dengue (as multiple infection disease) time series among two groups of Burmese (transient migrants, and permanent migrants). The top panel represents the wavelet coherence. The colors are coded a dark blue, low coherence and dark red, high coherence. The next panels represent the phase analyses between two Burmese groups, based on wavelets for a significant periodic band. The graph represents ONLY the period of time where coherency is significant, when interpretation of analysis was possible. Red lines: transient migrants; blue lines: permanent migrants; dashed black lines: phase difference between the two oscillating components.

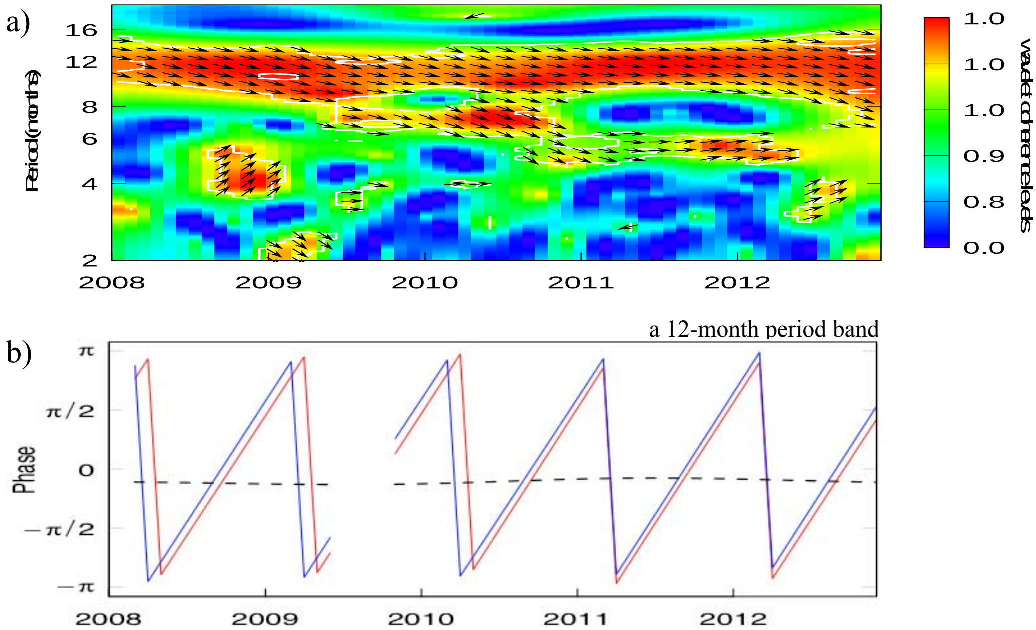


Figure 4.8 Wavelet coherence and phase analyses of pneumonia (as multiple infection disease) time series among two groups of Burmese (transient migrants, and permanent migrants). The top panel represents the wavelet coherence. The colors are coded a dark blue, low coherence and dark red, high coherence. The next panels represent the phase analyses between two Burmese groups, based on wavelets for a significant periodic band. The graph represents ONLY the period of time where coherency is significant, when interpretation of analysis was possible. Red lines: transient migrants; blue lines: permanent migrants; dashed black lines: phase difference between the two oscillating components.

Measles: The case incidence of measles between transient migrants and permanent migrants were clearly synchrony from October 2008 to October 2010 (at a 14-month periodic band) (Figure 4.6, part c). Furthermore there was some synchronous from the mid-2008 to February 2010 (at a 12-month periodic band) and during June 2008 - May 2010 (at a 16-month periodic band) (part b, d).

Dengue: The consultation for receiving treatment of dengue at MTC between transient migrants and permanent migrants were clearly synchronous at a 12-month periodic band during the entire common period (2008-2012) (Figure 4.7, part b).

Pneumonia: The consultation for receiving treatment of pneumonia at MTC between transient migrants and permanent migrants showed clearly an average delay of one month at a 12-month periodic band during the entire of the study period, except in July-October 2009 (Figure 4.8, part b).

CHAPTER V
DISCUSSION

This longitudinal study was aimed to explore the frequency and temporal variation of infectious disease consultation among Burmese clients of MTC, Maesot district, Tak province (connected to eastern Burma). The secondary data of the monthly number of patients presenting to MTC for consultation of those diseases was analyzed in both descriptive and comparative analysis.

This study focused on the distribution and temporal dynamics of infectious disease consultation between both groups of Burmese clients (transient migrants, and permanent migrants) between 2008 and 2012.

5.1 Descriptive Analysis

Comparing two groups of Burmese who received medical services at MTC between 2008 and 2012, the episode incidence rate for the five-year period in transient migrants was significantly higher than the rate in permanent migrants for the hepatitis, HIV, TB and malaria. This result is consistent with the conclusion of Beyrer et al (2006) [93] that the high prevalence of HIV, TB and malaria is in the eastern Burma.

For the multiple infectious diseases, the highest episode incidences in two Burmese groups are for malaria, diarrhea and ARI. This result reflected that these diseases were a major problem of health for both groups. Which corresponded to the population survey in the eastern Burma in 2008 [94] and in 2012 [95] found that the top three most causes of mortality for all age groups were malaria, diarrhea and ARI.

The episode incidence rate of malaria in both Burmese groups at MTC declined steadily since 2008. That according with decreasing of the number of malaria cases by *Plasmodium falciparum* and the number of malaria consultation at SMRU clinics along the Thailand-Burma border since 2008 [96].

The vaccine-preventable diseases are still found Burmese clients of MTC, which indicated the low vaccination coverage of Burmese children (under 5 years). According to the study of Canavati et al (2011) [74], barriers related to the low rates of immunization coverage in Burmese migrant children in Tak province include distance to immunization services, fear to arrest, not remembering immunization appointments, and the disruption of parental work.

Other results of this study found that the episode incidence rate of diarrhea in permanent migrants was higher than the rate in transient migrants. While the population survey in 2008 and 2013 [94-95] found that diarrhea disease is the leading cause of death in Burmese living in the eastern Burma. Burmese living in the eastern Burma was likely to seek for health services when their illness being severe or risk to death. A demographic survey during July-September 2013 [15] found that most (69.8%) of the local population in the survey areas had used the health service of the community-based organizations or the ethnic organizations within the last 12 months. Moreover in this survey, 37% of the respondents reported no seeking of healthcare for illness in the last year for a range of reasons. These included that the respondents or family members do not feel that much illness (43.7%), the hospital or clinic is too far (30%), treatment cost was too expensive (14.8%), and no health worker nearby (10.8%).

Transient migrants still need to seek the medical services in Thailand side, which is unavailable in their communities in Burma. While the study of Bochaton (2015) [97] concluded that the Lao people in urban areas along the border cross the border to access the medical services in Thailand as follow their satisfaction.

The multiple infectious diseases were not considered in terms of case incidence due to the limitations of the data. The results of this study can refer to Burmese people accessing the medical services of MTC only, and not imply to Burmese populations living along the Thai-Burmese border during the study period.

5.2 Comparative Analysis

We performed a short-scale comparative analysis of temporal dynamics of the disease emergence of measles and the consultation for dengue and pneumonia among two groups of Burmese (transient migrants, and permanent migrants). In this study, we have demonstrated the annual periodicity of measles (a 14-16-month cycle), dengue (a 12-month cycle), and pneumonia (a 12-month cycle) is statistically demonstrated among both Burmese groups who accessed the health services of MTC between 2008 and 2012.

In this study, regarding the periodicity of consultation for measles, dengue, and pneumonia in both groups of Burmese clients of MTC, only an annual cycle (seasonal mode) was observed for all three diseases during the entire of study period. While the results of the pervious study found that the oscillations of dengue incidence in Bangkok and the rest of Thailand in 1983-1997 were dominated by annual mode and a period of 2-3 year [78]. Moreover the study of Grenfell (2001) [98] found that the 1.5-3 year cycle was detected in the weekly reported cases of measles for Cambridge, Norwich and London in the pre-vaccine era (1944-1994)

The periodicity of pneumonia consultation in both groups of Burmese clients of MTC was detected at 12 months in the entire of study period and having the endemic peak in September-November. Similarly, the study of Turner et al (2012) [18] found that the majority of pneumonia episode in Burmese refugee children (under two years) in Maela camp, Tak province occurred during October-November over the study period (November 2007-October 2010). These children are mostly malnourished, which has an association with their risk of pneumonia [12, 15].

Based on the nature of seasonal infectious diseases (such as measles, cholera, dengue, and malaria), many studies found the climate variation (seasonal factors) has the significant association with the temporal dynamic of consultation for those diseases in a multi-annual period. Therefore this multi-annual period can tend to dominate their disease dynamics over the seasonal cycle [78]. For example, there was the synchronous of dengue dynamics between Bangkok and the rest of Thailand at the multi-annual oscillation mode (2-3-year cycle). And that synchronous appears to be influenced by El Nino (climate variations) [81].

In this study, we described the temporal pattern of consultation by using mean phase differences, which suggested that the seasonal waves of measles (at a 14-month periodic band during October 2008 – October 2010) and dengue (at a 12-month periodic band for the entire of study period) were synchronous between transient migrants and permanent migrants. The phase locking of pneumonia was seen in the seasonal mode (at a 12-month periodic band) during the entire common period (except July-October 2009), which suggests that the episode incidence of consultation for pneumonia in transient migrants follows those incidence in permanent migrants with an average delay of one month.

It has been suggested, for example by Broutin et al (2005) and van Panhuis et at (2015) [79, 99], that synchronous disease dynamics between populations living in the different areas or countries may be due to interactions between populations, for example through travel and trade exchange, and that the topography and human settlement pattern (mobility of population) can therefore affect those dynamics of that disease. Because this study focused on the Burmese clients of MTC who live in the border city between Thailand and Burma, from the result of this study, the complexity of measles and dengue dynamic between two groups of Burmese is emphasized by the positive correlation (in-phase coherence) and synchronous in the seasonal mode. Therefore the population mobility across the nation border may impact to the occurrence of those disease population dynamics. However it is difficult to disentangle the relative contributions of population movements (and transmission) versus the temporal coincidence of environmental and climatic factors, in terms of their impact on synchronicity of disease incidence observed between the two groups.

For the wavelet study of the vaccine-preventable diseases [79, 98], the variation of cyclicity of disease dynamics was detected in difference period of vaccination era in each counties depending on their vaccination history parameters.

Although this study focuses on monthly cycles of infectious disease consultation using wavelet approach; unfortunately we did not have access to the long-term time series, which would have allowed the study of multi-annual periodicity. However, this approach cannot be used to comprehensively explore the underlying epidemiological mechanism (the dynamics relationships between human, pathogen and the global environment) [81]. The advantage of wavelet analysis is that it can provide useful clues about the nature of underlying epidemiological process, which can then be used to inform future mechanistic modeling approaches. Therefore, further studies applying wavelet method to more extensive time series data are needed to quantify the seasonal and the longer-term cycle of different diseases, and identify the dominant of disease dynamics in order to assign the disease control strategies effectively, and to investigate the association of the disease dynamics and climate factors, especially for seasonal infectious diseases.

5.3 Limitation of the Study

The findings of measles, dengue, and pneumonia in wavelet analysis were only the annual disease cycle and the strong association of disease consultation between both Burmese groups. The results of this study need to consider the potential effect of related factors at regional and local levels on the epidemiology of specific disease among each group of population (such as environment/ climate factor, socio-economics, public health intervention, behaviors of seeking medical case when ill, and preventive health behaviors) in order to generalize the health policy for controlling the transmission of infectious diseases in difference areas or populations.

The names of infectious diseases in Burmese clients of MTC, recorded in the patient's medical record, were unspecified and unseparated by its serotype of pathogens of each disease. Therefore in case of infectious diseases with several serotypes (such as hepatitis, dengue, malaria, pneumonia), the results of the study cannot capture the real distribution of disease in each serotype between both groups of Burmese. Moreover, the practical health implementations of those diseases (such as vaccination program) in aspect of the immunological interactions between different serotypes should be considered [80].

Although this study focuses on monthly cycles of infectious diseases using wavelet approach; unfortunately we did not have access to the long-term time series, which would have allowed the study of multi-annual periodicity. However, this approach cannot be used to comprehensively explore the underlying epidemiological mechanism (the dynamics relationships between human, pathogen and the global environment) [81]. The advantage of wavelet analysis is that it can provide useful clues about the nature of underlying epidemiological process, which can then be used to inform future mechanistic modeling approaches. Therefore, further studies applying wavelet method to more extensive time series data are needed to quantify the seasonal and the longer-term cycle of different diseases, and identify the dominant of disease dynamics in order to assign the disease control strategies effectively, and to investigate the association of the disease dynamics and climate factors, especially for seasonal infectious diseases.

In this study, the descriptive analysis has presented the frequency of consultations for infectious diseases among two groups of MTC's Burmese clients who lived in the different sides of international border in two aspects. First, "case incidence" indicated the severity of single infectious diseases between both groups of Burmese (such as hepatitis, measles, HIV, chickenpox, and pertussis). And second, "episode incidence" described the distribution of all local infectious disease situation in two Burmese groups as a burden of MTC's health service (such as malaria, diarrhea, ARI, pneumonia, and dengue). The wavelet analysis has revealed the seasonal pattern and the related variation of consultation for measles, dengue and pneumonia between two Burmese groups. The study results of wavelet approach were used to suggest a direction of disease surveillance, as well as outbreak prevention and control. However, there were the limitations of disease data used in this study. The potential in accuracies in residence data may be misclassification of the Burmese group. The assumption on the 50:50 ratio of Burmese clients living in between Burma side and Thailand side was approximated and assumed by MTC. The different characteristics between the two Burmese groups were unconsidered in this study as potential bias/confounders (e.g. health seeking behavior, demographics, and socio-economic factors). Furthermore, the potential reporting bias over the study period may be an under- or over-estimation of true case incidence (or episode incidence), including the increase in diagnosis may not necessarily reflect and actual increase in incidence. As the different level of health system in the border areas between western Thailand and eastern Burma was not likely to change during the study period. Then there was the consistent underreports of each infectious disease in both areas.

CHAPTER VI
CONCLUSIONS

The results of the study found that transient migrants were likely to access the consultation for hepatitis, HIV, TB and malaria than the consultation of permanent migrants. In the five-year of study period (2008-2012), the situation of these four diseases in transient migrants was severe than another group. Apart from role as the provider of medical facilities for Burmese peoples along the Thai-Burmese border, MTC could be a public health sector of surveillance and control of infectious diseases in Burmese along this border, especially for hepatitis, HIV, TB and malaria in order to prevent the spread of the disease transmission across different Burmese group. In addition, the immunization program of MTC should expand the coverage over Burmese children in both site of Tak border continuously, including the support of health-related government agencies in the local area.

There is the concept of population movement along the border for accessing the medical services in the neighboring countries via the social networks of these patients. These networks have greatly influenced to their decision of traveling for that purpose. Moreover the areas in the eastern Burma have become more urbanized through the efforts of developing country in Burma, especially in the border areas. Therefore, further studies should consider the social networks of patients and the changing of community from rural to urban community along this border. We should link the concept of urbanization with the characteristics of crossing the border in Burmese people to access the health services in Thailand site. In addition, further study is needed on the changing of disease patterns relating to the social factors in Burmese.

The comparative results of disease dynamic between either transient or permanent migrants using wavelet analysis showed significant seasonal periodicity of consultation for measles, dengue, and pneumonia in the context of Burma clients who living along Tak border and accessing the medical services of MTC between 2008 and

2012. Further studies of wavelet analysis, using time series data collected over longer time-periods, combined with mechanistic (transmission) modelling approaches, could help elucidate the relative importance of cross-border transmission versus environmental/climatic factors, in explaining temporal coincidence of infectious diseases across borders areas with high rates of migration.

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APPENDICES

APPENDIX A

Adding part: technical methods of WaveletComp in R package version 1.0

WaveletComp is an R package for continuous wavelet-based analysis of univariate and bivariate time series under the null hypothesis that there is no (joint) periodicity in the series is tested via p-values obtained from simulation, where the model to be simulated can be chosen from a wide variety of options [1].

In the theoretical, all non-stationary time series of original data have to be detrended before analyzing with wavelet analysis. As the WaveletComp in R package applied in the study already has a function (called "loess.span") as a parameter in loess controlling the degree of time series smoothing by the local polynomial regression. According to the periodogram is a tool for identify the dominant cyclical behavior in a time series, particularly when the cycles are not related to the commonly encountered monthly or quarterly seasonal [2]. The researcher has applied the raw periodogram plot of time series for considering the essential of the detrending of time series in order to set the number of loess.span parameter for wavelet analysis in WaveletComp.

The original method of wavelet analysis localized the wavelet power spectrum and the time-average wavelet spectrum in the study of Torrence and Compo (1998), there is a bias problem in the estimation of wavelet spectrum for a time series comprised of sine wave with the same amplitude at the different frequencies. Especially at small scales (high frequency), the wavelet is very broad in frequency, then any peaks in the spectrum get smoothed out (i.e. the underestimated power of wavelet spectrum at small scales) [1]. In contrast at large scales, the wavelet is narrower in frequency, so the peaks are sharper and have a larger amplitude.

However this bias problem was adapted by Liu et al (2007), [2] that explained the spectral peaks are distorted at the high frequency (small scale) lower than the low frequency. Also to rectify the bias in wavelet power spectrum, the spectrum is divided by the scale *(a)*, and then those spectral peaks have about the same height.

According to the rectified version of wavelet power for analyzing time series in WaveletComp. The wavelet power spectrum for single time series in the rectified version of $S_x(a,\tau)$ [3]:

$$rectified\ S_x(a^{-1},\tau) = \frac{1}{a}|W_x(a,\tau)|^2$$

While the cross-wavelet transform for two time series in the rectified version according to the study of Veleda et al. (2012) [4], the cross-wavelet transform between two series *(x_t)* and *(y_t)was rectified by scale (a)*:

$$rectified\ W_{x.y}(a^{-1},\tau) - \frac{1}{a} W_x(a^{-1},\tau)\, W_y{}^*(a^{-1},\tau)\ .$$

Then the rectified version of cross-wavelet power for two time series in the time-frequency (or time-scale) domain as:

$$rectified\ Power_{x.y}(a^{-1},\tau) = \left|\frac{1}{a}\cdot rectified\ W_{x.y}(a^{-1},\tau)\right|.$$

However using phase analysis for characterize of the association between two time series, we will know the information on the sign of the relationship (in phase or out of phase) through considering the phase difference of *x(t)* over *y(t)* on a selected period band at overall time position:

$$rectified\ \phi_{x.y}(a^{-1},\tau) = tan^{-1}\frac{\Im\left(\langle\frac{1}{a}W_{x.y}(a^{-1},\tau)\rangle\right)}{\Re\left(\langle\frac{1}{a}W_{x.y}(a^{-1},\tau)\rangle\right)}.$$

Arrow signs of phase difference plotting on the significant area of high coherence wavelet in WaveletComp refer to the direction of the relationship at a significant period band over all time position as follow:

$\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$: out of phase, y(t) leading

$$rectified\ \phi_{x,y}\left(\frac{1}{a}, \tau\right) = \begin{cases} \frac{\pi}{2} : \text{x(t) leads y(t) by } \frac{\pi}{2} \\ \left(\frac{\pi}{2}, 0\right) : \text{in phase, x(t) leading} \\ 0 : \text{x(t) and y(t) move together (positive} \\ \quad \text{correlation / in phase)} \\ \left(-\frac{\pi}{2}, 0\right) : \text{in phase, y(t) leading} \\ -\frac{\pi}{2} : \text{y(t) leads x(t) by } \frac{\pi}{2} \\ \left(-\pi, \frac{\pi}{2}\right) : \text{out of phase, x(t) leading} \end{cases}$$

An image plot in WaveletComp usually illustrate the wavelet spectrum between domain of time location (x-axis) and period (y-axis) for single or two time series, consists of the optional functions as follow [1]:

1.1 The ridge of power spectrum (the black line) is a function line to determine the position of power spectrum within a band of neighboring periods through the transformation of wavelet or cross-wavelet.

1.2 The area inside the cone of influence (inside the area of non-shadding) is the area without the edge effects of wavelet transformation.

For the purpose of testing the null hypothesis of "no periodicity", significance is assessed with simulation algorithms; a variety of alternatives to test against is available, for which surrogate time series are provided: white noise, shuffling the given time series, time series with a similar spectrum, AR, and ARIMA.

1.3 The contour lines (the white line) indicate the spectrum area of single wavelet, cross-wavelet, or coherence wavelet having the high significant of a (joint) periodic band (periodicity)

1.4 A time-averaged power spectrum is useful to investigate the (joint) overall strength of periodic phenomena for single wavelet, or cross-wavelet.

APPENDIX B

Documentary Proof of Exemption
Ethical Review Committee for Human Research
Faculty of Public Health, Mahidol University

Protocol Title : INCIDENCE PATTERN OF INFECTIOUS DISEASES AMONG MIGRANT POPULATIONS ALONG THE THAI-BURMESE BORDER

Protocol No. : 76/2558

Principal Investigator : Miss Warapree Tangseefa

Affiliation : Master of Science (Public Health) Program in Infectious Diseases and Epidemiology
Faculty of Public Health, Mahidol University

This protocol complies with a "Research with Exemption" category

Date of Issue : 9 March 2015

The aforementioned project have been reviewed and approved according to the Standard Operating Procedures of Ethical Review Committee for Human Research, Faculty of Public Health, Mahidol University.

(Assoc. Prof. Dr. Sutham Nanthamongkolchai)

Chairman of Ethical Review Committee for Human Research

420/1 Rajvithi Road, Bangkok, Thailand 10400
Tel. (662) 3548543-9 ext. 1127, 7404 Fax. (662) 6409854

APPENDIX C

Community Ethics Advisory Board
Mae Tao Clinic
Mae Sod, Tak Province

June 24, 2015

Miss Warapree Tangseefa
M. Sc Candidate
Department of Epidemiology, Faculty of Public Health
Mahidol University, Bangkok

Subject: **Letter of approval to conduct a study on "Disease Pattern among Burmese People Seeking Health Care Services along Tak Border, Thailand"**

Dear Miss Warapree,

This letter serves as an approval for the study "Disease Pattern among Burmese People Seeking Health Care Services along Tak Border, Thailand". As mentioned before we have found that the research objectives were clear, and the research looked well designed. For the ethical and community aspects of the study, the CAB has no concern and agrees on the study.

We are glad that you addressed all the comments and suggestions that where formulated by the CAB after you presented your proposal and study method. Therefore we are happy to let you continue your study. We hope that valuable information will come out of your research and are looking forward to hear about it.

If we (CAB) has any concern during undertaking of this study or require additional information, we will contact you.

Sincerely,

On behalf of Community Ethics Advisory Board

SAW AUNG THAN WAI

Date: 24 June 2015

Signature:


สมาคมนักประชากรไทย
ขอมอบเกียรติบัตรฉบับนี้ให้แก่
คุณวรปรีย์ ตั้งสีฟ้า
ผู้นำเสนอผลงานวิจัยเรื่อง
รูปแบบโรคติดเชื้อในชาวพม่าที่แสวงหาบริการสุขภาพตามแนวชายแดนจังหวัดตาก ประเทศไทย
ในการประชุมวิชาการประชากรศาสตร์แห่งชาติ ๒๕๕๘
วันที่ ๒๐ พฤศจิกายน ๒๕๕๘
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