Separate lane for motorcycle to reduce severity of road traffic injury among motorcyclist in Thailand

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Thailand

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A Thesis submitted in partial fulfillment of the requirement for the degree of Master in Public Health

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Table of contents

List of Tables and Figures

Tables

Figures

Picture

List of abbreviations

DDC	Department of Disease Control
GRSP	Global Road Safety Partnership
IRAP	The International Road Assessment Programmed
MoPH	Ministry of Public Health
MIROS	Malaysian Institute of Road Safety Research
OR	Odds Ratio
RTI	Road Traffic Injury
SDGs	Sustainable Development Goals
UN	United Nation
WHO	World Health Organization

Glossary

Road traffic injury: is an injury or dead caused by a crash on a public road with at least one moving vehicle.

Road traffic mortality: is death related to injury caused by road traffic accident. The death is occurred within 30 days after getting injury.

Abstract

Background: Road traffic injury is recently high concerning burden of disease globally. Thailand also aims to reduce half of mortality and morbidity of road traffic injury by 2020. Motorcycle injury is majority group as well as it is the highest number of vehicles. Intervention against behavior risks such as helmet use and alcohol drunk driving has been enforced though the target of reduction is still far. Additional intervention, especially for motorcycle, is considered to improve the situation.

Objectives: This study aim to provide evidence of benefit of motorcycle separated lane in term of injury reduction in order give recommendation to Thai national road safety committee.

Methodology: The study combines with 2 sections. Secondary data analysis of road traffic injury during New Year 2011-15 in Thailand has been done. Main focus is on association between crashing of motorcycle with larger vehicle and severity of injury outcome. Another section is reviewing on motorcycle separate lane intervention from experienced countries.

Result: Injury trend during New Year 2011-15 was slightly decreasing. Motorcycle injury was majority. One out of four motorcycle injuries was severe injury. Crashing with larger sized vehicle significantly associated with getting high level of injury severity. Alcohol drink riding, non-helmet wearing, accident on highway were also related with severity of injury outcome. Experience of motorcycle lane in Malaysia and Taiwan showed benefit on accident and injury reduction.

Conclusion: Segregating motorcycle from large vehicle is helpful. Motorcycle lane is potential to be adopted in Thailand. Intervention on behavior risks should be continuously strengthening.

Keywords: road traffic injury, motorcycle, injury severity, separate lane, Thailand

Words count: 11,634

(Excluding diagram, tables, figures, pictures and annex)

Introduction

I worked as medical epidemiologist for Department of disease control and prevention (DDC), Ministry of Public Health, Thailand, during 2011-15. I have participated in many disease prevention projects on various disease and health problem. Many communicable diseases were prevented in the pasts by using epidemiological study. Currently, burden of diseases in Thailand is changing to non-communicable diseases as well as road traffic injury. I had 2-year experience working in injury prevention section under bureau of non-communicable disease. The section works as representative of DDC, collaborate to multi sectoral organization both government and non-government. Major role of the section is providing information and evidence based research to National road traffic injury committee. The aim is to prevent road traffic accident and decrease injury and death due to accident. This health problem had big issue due to rapid increasing number of death every year. In global level, UN and WHO also raises this issue through decade of road safety in 2011-20. Currently, the road accident and injury topic is also included in Sustainable Development Goals. To solve the problem in the country, some risk factors were identified by scientific study. Result of the study leads to injury preventive measurement. However, it was mainly focused on behavior risk factors. Law enforcement and risk reducing campaign had been implemented for many years. But current situation is not improved as national target.

During 2015-16, I am joining programme of Master degree on Public Health at KIT. I have explored link between epidemiology and health prevention strategy and planning. Then, I decided to bring those components to find a solution on issue of road traffic injury in Thailand. I expected to gain more experience by practicing knowledge in all perspectives in this real situation. And the result of study will also serve function of DDC of Thailand.

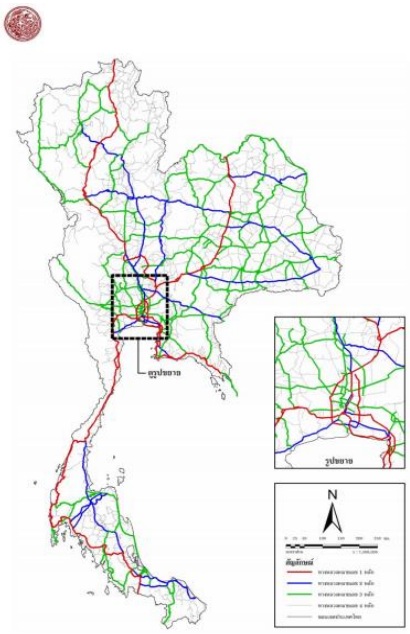
Chapter 1: Background of Country

1.1 General information

Thailand locates in South-Eastern Asian region. The country is divided 77 provinces including Bangkok, the capital city. Each province, it is administrated by district, sub-district and village level. There are central government in national level and local government in provincial and sub-district level. Total population is approximately 68 million in 513,120 square meter of land. Urban population is 50.4 %. GDP per capita in 2014 was 5977.4 US dollars. Life expectancy for female and male is 77.6 and 70.8 years, respectively (1). There are 3 seasons in Thailand. Summer is during March to May, following by rainy season until October. Winter is between December and February.

1.2 Traffic and transportation

Cumulative road length is approximately 217,797 kilometers. National highway is established entire the country connecting with smaller size of rural highway and city road, showing in the picture beside. Ninety percent of the road in the country is pavement(2). Road public transportation reaches to every provinces of the country. However, network connection to rural area is not complete. Rail public transportation also has problem on infrastructure. The rail is old and limited coverage(2). There were total 36,731,023 registered vehicles by the end of year 2015. Motorcycle is majority sharing 55.29% of total vehicle in the country(3). One important reason is its affordable price for people in this middle income country. Beside this, public transportation does not reach everywhere, especially in rural area. Then motorcycle becomes very popular for daily travelling mode of Thai people. License for motorcycle rider is allowed at age above 15 years while car driver starts from 18 years old.



Highway Network in Thailand

source: Ministry of transport

1.3 Health system

Health system in Thailand is mainly covered by public health care service. Medical service is provided in modern medicine. There are 941 government hospitals, 3 enterprise hospitals, and 235 private hospital entire the country(4). There is at least 1 general hospital in each province performing as primary and secondary care service. Among these provincial hospital, 24 hospitals are regional hospital for tertiary care service and referral center. There are at least 1 community hospital per district provides primary health care service with admitting option. In sub-district level, there are total 9,216 primary health centers for out-patient care and health promotion. There is 17,990 private clinics entire the country. For human resource in health systems, number of doctor in public and private sector are 23,731

and 4,838 doctors respectively. This is approximately 1 doctor in 3,324 populations in average of whole country. However, in Bangkok, it is 1 doctor in 1,243 populations while the ratio of other province is 1 to 3,983 populations(4). For health service expenditure, Universal health coverage (UHC) covers 99.90 % of populations(5). This system provides free-of-charge health service in public health care centres. Funding is pooled from 3 sources; taxes, government welfare and social security funding. However, for road traffic injury, user fee will be paid by national insurance funds for victim of road traffic accident. The funding comes from mandatory insurance of vehicle owner. Up to 15,000 Thai Baht (Euro 375) will be paid to health centre. The service expenditure that goes beyond this limit will be shared from UHC funds(6).

1.4 Emergency Medical Service (EMS)

It is provided by registered EMS providers under regulate by National Institute for Emergency Medice(7). The EMS providers can be EMS team of public and private health care centres, non-profit organization or local municipality. National phone contact number is 1669. Service expenditure is supported by national emergency medical service funds. All funding comes from taxes. The service is free of charge in case of matching to emergency criteria(7).

1.5 Road traffic injury (RTI) and accident management

Thailand had stated national agenda to reduce mortality and morbidity related RTI. In 2010, National Road Safety Committee was conducted(8). This multisectoral collaboration aims to drive strategic management on road traffic accident and injury in all aspects. Five pillars of issues including management, safe road, safe vehicles, safe road users, post-crashed care were developed inside the committee. Helmet and alcohol drunk driving law was enforced. Hour for alcohol selling is limited between 11:00-13:00 and 17:00-24:00 every day.

RTI data and information management was assigned to MoPH. At the beginning since 2010, national RTI prevention campaign had focused on 2 major vacations of the year, New Year and Songkran (Thai traditional New Year). The assumption was increase of travelling as well as higher rate of alcohol drinking. It was known as 7-day watching out campaign. MoPH also conducted a special surveillance system in order to records RTI data on those 2 periods.

Chapter 2: Problem statement, Justification, Objectives, Methodology

2.1 Problem statement

Road traffic injury (RTI) is sharing 2.1% of global mortality in each year. About 90% of RTI occurred in low or middle income country(9). Moreover, according to global burden of disease forecast, RTI related burden is changing of from the 10th to the 8th place during 2002 to 2030. In low and middle income countries, RTI will be 83% increasing by year 2030 if there is no major action(10, 11). Regarding sequelae of RTI, there are various bad effects such as death, disability, post traumatic suffering in terms of physical, mental and economic loss, both individual and family level. Therefore, UN and WHO purposed the decade of road safety during year 2011-20. The agenda aims to encourage actions and interventions globally in order to achieve the 50% reduction of RTI related mortality(12).

Regards to RTI situation in Thailand, national health data in year 2014 showed 1,050,088 injuries had been treated in public hospitals(4). In term of burden of disease, a study in 2004 found that RTI causes 673,000 DALYs loss, mainly 88% in premature death. In that year there were approximately 567,000 road traffic injuries which were 24,800 deaths, 417,000 visiting emergency department in hospital(13). Another study explained RTI was cause of estimated 25,316 deaths in 2005. It was ranked at the 4th cause of death, sharing 8.1 % of total death among Thai male(14). Even the country took many efforts to solve the problem though overall RTI situation was only slightly improved. According to WHO global report on Road safety (15, 16), the estimated mortality rate specific to RTI in Thailand was decreasing from 38.1 to 36.2 per 100, 000 population between year 2010 and 2013. However, the ranking was moved up to the 2nd place of country where presenting high mortality due to RTI in the world. RTI mortality rate in Thailand was two times higher than global average among low and middle income countries at the same period of time.

Mortality from road accident cause various burden in aspect of health, economic and family(17, 18). Besides, severe or serious injury also consumes health service resource. It needs advance level of health care specialist and infrastructure. While number of those resource in Thailand is scarce(4). For example, there were 1 neurosurgeon per 213,000 population compared to 1 in 85,000 population at standard recommendation. Taskforce distribution is also challenging. These reasons result high workloads of neurosurgeon in Thailand(19). They performed up to 203 operations per surgeon in a year comparing to annual average operation in European unions which was 154 cases per surgeon. Meanwhile head injury from road accident is still increasing.

Among injury and deaths due to RTI, motorcyclist shared the biggest proportion of victims according to data from injury surveillance and WHO global status report. (73-88 %) (15, 20). Male is majority. Young adult aged between 15 and 19 year olds were the highest number of injury and death as 18.8% and 14.6 % respectively following by 20-24 year olds(21). This life loss results high premature mortality. Those reports also identified some of preventable factors such as alcohol-drink driving, non-helmet wearing. Specific legislation was launched and be

enforced in implementation. Eventually, percentage of drink-driving injured cases was decreasing from 46.4% to 39.5 % during 2005 and 2010(21). In contrast, the survey on helmet using presented no improvement of helmet wearing during 2010 and 2013. There was constantly at around 43% of motorcyclist wearing helmet while riding(22).

Motorcyclist is classified as vulnerable road users along with pedestrian and cyclist who have no shell protection for accident and injury(15). In recent global status report for road safety 2015, WHO also focuses on separate lane policy for vulnerable road users. Because this group is indicated as challenging for low and middle income countries to achieve a target of WHO Sustainable Development Goals (SDGs) and the UN decade of road safety. Ninety-one countries have been implemented separate lane intervention for vulnerable vehicles(15). Among Asian country where motorcycle is big portion of vehicle, Malaysia and Taiwan are examples where separate motorcycle lane is established(23). But Thailand has not well mentioned in policy. Currently, motorcycles are mixed up to larger vehicles with higher speed on the road. If there is a collision between motorcycle and bigger vehicle, the high momentum and velocity lead to huge force in accident. Eventually, it can result to high severity of injury or death. Regards to measures to decrease injury severity, some studies showed benefits of separate lane for vulnerable road user in some countries(23). It helps to reduce potential crash and injury risks.

2.2 Justification

Even many preventive measurements for behaviour risk factors were implemented. Road traffic injury is still big problem in Thailand. Moreover, specific burden of disease is increasing. Motorcycle shared high proportion of accident and injury. Besides, motorcyclist is major road user in Thailand but road is not mainly design for them. Resulting high severity of injury consumes scarce resource in health system of the country. In order to prevent these problems of health and health systems, this study is looking for additional preventive intervention. Environmental risk factor is interesting besides known behaviour risk factors. Current road design in Thailand allows mixing traffic of various vehicle types. Motorcycle easily crashes with large sized or high speed vehicle. This type of accident is assumed to result high severity of injury outcome. Segregating motorcycle from larger vehicle by separate lane should be taken into consideration. There are experiences from countries with similar context. However, relationship between motorcycle collision with larger vehicles and high severity of injury outcome among motorcyclist needs to be proved.

As Thai National Road safety committee was set up with multisectoral collaboration in order to manage road traffic accident and injury problem. Department of disease control takes the role of information providing to the committee. The special surveillance is conducted during 2 long vacations, New Year and Song Kran (Thai traditional New Year). The dataset is usually managed to routine descriptive report. This study is designed to explore in detail with statistical analysis. The assumption of getting high severity of injury after crashing with larger sized vehicle is being focused. The data analytic result will be combining with reviewing on intervention in experienced countries. Eventually, these supportive evidences will help to drive forwards to the implementation of motorcycle separate lane.

2.3 Objectives

2.3.1 General objective:

: To provide evidence of benefit of motorcycle separated lane in term of injury reduction in order give recommendation to Thai national road safety committee.

2.3.2 Specific objectives

1. To describe characteristics of road traffic injury in Thailand during New Year Vacation
2. To confirm the association between collision of motorcycle with larger vehicles and severity levels of RTI outcome among motorcyclist in Thailand during New Year Vacation period.
3. To review and identify the separate lane interventions for vulnerable road users from experienced countries
4. To recommend potential intervention to reduce severe injury and death from motorcycle accident in in Thailand to Road Traffic Accident prevention committee

2.4 Methods

This study is combining with 2 sections. The first part is epidemiological secondary data analysis of road traffic injury during New Year Vacation 2011-15. This section will cover specific objective number 1 and 2. The second section is literature reviewing. It is focusing on separate lane for vulnerable road user and motorcycle.

2.4.1 Epidemiological Data analysis

2.4.1.1 Analytic framework

RTI Contributing factors

Personal risk factors of RTI are including speed, alcohol drink-driving, no helmet wearing, no seat-belts using, and child restraints (15). In macro level, population increasing and economic growth lead to increasing number of vehicles and transportation. It is relatively associated with number of RTI, especially in low and middle income countries. Another critical factor is unsafe vehicles. Particularly in low and middle income countries where number of two-

wheeled or three-wheeled vehicles are increasing. These vehicle users are prone to get head or brain injury during crash(10). Besides, safe road, infrastructure and environment is also another important factor. Successfulness of reducing number of injury and death from road accident in developed countries is contributed by good transport infrastructure. Though, the infrastructure should be designed appropriated to needs of road users in context of each country. In order to deal with RTI issue, country policy should be properly implemented to manage this multifactorial problem as systems approach(10).

One of well-known systematic approach on injury is Haddon's matrix model(24). It is broadly used to logically explain those factors related to accident, injury and death(25, 26). The recent version modified by WHO is showing in Figure 1. This Haddon's matrix includes specific contents to road traffic injury(10). The model arranges phase of accident and injury into 3 phases; pre-crash, crash, and post-crash care. Factors contributed to accident and injury are described in each related phase by 3 perspectives; human, vehicle, and road and environment. Risks of getting accident are describing in the first row. The risk can be single or combined and leading to crash. The second row shows factors that would adjust severity of injury while crash happening. Factors such as helmet wearing, seat belt and child restraint will reduce severity of injury. While using vehicle with non-protective shield is injury risk factor. Final injury outcome also depends on post-crash care factor. Effective medical service in all 3 dimensions; human, vehicle and environment, will result better outcome. Eventually, the model links the different level of risk factors contributed to injury and/or death. Reducing factors of accident can be proportionally decreasing morbidity and mortality as well.

Table 1 Haddon's matrix model

Phase	Purposing	Human Road user	Vehicle and equipment	Road and environment
Pre event (pre-crash)	Accident prevention	**-Alcohol drink** -Attitude -Skill -Impairment	-Lamp -Braking -Tire -Controlling system	-Road condition -Vision -Speed limitation **-Road type** **-Time**
Event (crash)	Injury prevention	**-Helmet use** -Seat belt use -Child restrain	**-Protective and safety structure**	-Forgiving road design
Post event (post-crash)	Life sustaining	**-First aid response** **-Care service utilization**	-Difficulty to move out	-Environment condition to rescue

Main focus of this study is regard to motorcycle accident and injury. It is naturally vehicle with non-protective structure. This factor would result in higher level of injury severity of crash. Helmet use is a protective factor of getting severe injury which data is available in the

database. Back to a step before, factors leading to accident which are available in this dataset are including Alcohol drink riding/driving, Road type and time of accident. Afterwards emergency response person and level of health care service are existing information in the database. These two factors would determine outcome after medical treatment for injury. All above variables are highlighted in bold characters in table 1.

2.4.1.2 Study population

Data of New Year surveillance during 2011 to 2015 were selected as period of decade of road safety. Total 128,865 victims from all road users during the period were included in descriptive data analysis. Among those, 102,573 cases were motorcycle injuries and deaths .This group was 79.60 % of all road users during the period. In statistical data analysis, only motorcyclist were included, both riders and passengers. Victims of other vehicles and pedestrians are excluded.

2.4.1.3 Data analytic frame

2.4.1.3.1 Descriptive study

Regarding injury outcome variable, the original data was classified the outcome into 7 groups. In this study, it was merged into 3 categories according to level of injury severity as definition which was mentioned in Accidental Injury: Biomechanics and Prevention(27). This categorical definition also has been used in other studies (28-30). All dead cases are defined as fatal injury. Survival cases with hospitalization were classified into serious injury. Meanwhile minor to moderate injury included non-hospitalized survival cases. All injury cases were epidemiologically described in person (vehicle type, crashing vehicle, gender, age group, severity of injury), place (road type), and time of accident (year of the vacation and hour of accident). Motorcycle injury victims were also separately described in person, place and time. Arrangement was done according to Haddon's matrix.

2.4.1.3.2 Analytical study

The main objective is to figure out relationship between motorcycle accidents and injury outcome. Types of the motorcycle accident are divided into category of the opponent crashing vehicles involving to the accident. The category is also including single-vehicle accidents of motorcycle. Factors in Haddon's matrix which are available in the dataset are considered to be confounding factors or effect modifiers.

At this analytical section, data was cleaned out to avoid error and missing value in dataset. From total 102,573 injuries of motorcycle accident, 6,996 cases which could not identified size of opponent crashing vehicle were excluded. As well as 2,495 cases with

unknown value of helmet wearing, 3,373 cases with unidentified value of alcohol drink riding and 1,618 cases without value of road type of accident were also excluded. Eventually, there were 88,091 cases have been analyzed in this section.

For statistical tests, some studies on severity of injury were reviewed. Logistic regression was mostly used in similar studies(28, 31-33). Ordered logistic regression is best fitted to the data since the outcome variable is ordinal value. As original in descriptive study, injury outcome was divided in to 3 categories; fatal, serious and minor to moderate injury. Meanwhile the main interesting factor of exposure was category of opponent crashing vehicle which was regrouped into 2 groups. It will be explained in data management section later. Exposed group was motorcyclist crashed into larger size of vehicle while unexposed group was crashed with similar sized including single-vehicle accident. Firstly, univariate analysis was processed. Crude odds ratio of main focusing exposure was calculated. This analytic process also gave 95% Confident interval and p-value. Other factors, which were suspected as confounder, were analyzed in the same way to obtain specific crude odds ratio and p-value. The factors with statistical significant association with the outcome were chosen into multivariate analysis. Finally, multivariate ordered logistic regression was done to control effect of confounders. This step gave result of adjusted odds ratio. Adjusted odds ratios of main focusing exposure, crashing with larger sized vehicle, were interpreted afterwards.

2.4.1.4 Data management

Road traffic injury Data for festival in Thailand was approached for this study. The data system is a special surveillance of MoPH for 2 major vacations of the annual national festival; New Year in December to January and Songkran festival in April (Thai traditional New Year). MoPH operates the system twice a year. The database contains all injury and death due to road traffic injury during those 2 periods of year. The special surveillance covered 7 days in the each period of the vacations. The data were collected and recorded into web-based system by public and private health centers from every province and district in Thailand. Five year period between 2011 and 2015 was abstracted to analyze in this study. The dataset contains essential variables showing in Table 2 below which are able to serve the objectives.

Table 2 Variables in special surveillance on road traffic injury during national festival vacation in Thailand

Variables	Description
Year of accident:	New Year period of accident. Cover from few days of December before that New Year period to few days after.
Date of accident	Date of accident. The period is 7 days equally in every year. But the date of surveillance was a bit vary in some years
Time of accident	Time of accident is grouping in 1 hour section. Range from 00.01-01.00 to 23.01-00.00
Age	Age of victim is round down in years old
Gender	Gender is recorded in male or female
Vehicle	Vehicle using by victims, originally 13 categories including pedestrian and identified vehicle
Crashing Vehicle	The opponent crashing vehicle with vehicle of victim. Including single vehicle without opponent vehicle.
Road category	Defining by size and area. Dividing into highway, rural road and city road
Province of accident	Province of accident occurring point. All 77 provinces including
Helmet wearing or seat belt using	Using helmet or seatbelt. Including not using and unknown value. The value must be correlated with user vehicle.
Alcohol drink riding/driving	Alcohol drink driving or riding. This value collected by subjective data collector. History taking from injured person or witness.
Rescue person	First response rescue who transfer victims to health care center
Admit or refer	Hospitalizing condition of victims.
Outcome of injury	Final outcome of victims after treatment. Followed up to 30 days after visit health center
Health care category	Level of health care center at first contact of victims.

Some variables were newly created and assigned value in order to make proper category for analysis. The value was regrouped from original data above. These variable and description are showing in table 3.

Table 3 New variables in special surveillance on road traffic injury during national festival vacation in Thailand

Variables	Description
Age group	Age of victims was regrouping into 15-year category. The last group ,aged above 75 years old was grouped together due to higher age than life expectancy in general
Crashing vehicle subgroup	Opponent crashing vehicle of injury person were grouped by size compare to motorcycle and percentage of getting fatal injury. *Larger sized vehicle group* are including pic-up car, sedan car, small and big bus, truck, and van. *Similar sized vehicle group* including single-vehicle accident, crashing with motorcycle, bicycle, 3-wheeled motorcycle and cycle
Outcome classification	All deaths were grouped into fatal injury. All survivor with admit or refer condition were defined as serious injury All survivor without admission were in minor to moderate injury

2.4.1.5 Ethical consideration

All individual data are excluded name and identification to individual victims. Permission from MoPH was asked. All abstracted dataset will be deleted in 2 years after submission. All result will be shown in statistical information. No individual data are presented.

2.4.2 Literature review for separate lane intervention

2.4.2.1 Intervention on separate Lane for vulnerable user

Articles of studies, publications and recommendations of separate lane for vulnerable road users were searched on Google by using keywords such as vulnerable road user, vulnerable vehicle, separate lane for vulnerable road user, separate lane for vulnerable vehicle intervention, motorcycle separate lane, motorcycle separate lane effectiveness. Literatures from Pubmed.com, official transportation organization and road safety organization were included.

2.4.2.2 Intervention and case study on motorcycle separate lane

Technical knowledge and case study on motorcycle lane was firstly searched on Google.com. The keywords were motorcycle lane, motorcycle separate lane, effectiveness of

motorcycle lane, motorcycle lane implementation. Only scientific articles were selected. Other source of knowledge was publication from official organization of road safety such as Malaysian Institute of Road Safety Research (MIROS), Global Road Safety Partnership (GRSP), and The International Road Assessment Programmed (IRAP).

Situation of motorcycle lane in Thailand was searched in Thai and English language. Official document was searched on website of government, ministry of transport, royal Thai police, and national road safety committee. Keywords were including motorcycle lane in Thailand, motorcycle route in Thailand, motorcycle separate lane in Thailand, law or act for motorcycle, road for motorcycle. Grey literatures were also looked for by using the same set of keywords. Google.com was chosen as search engine to track further for original source.

Chapter 3: Study result

3.1 Epidemiological study result

3.1.1 Descriptive study result

Overall injury

Total 128,865 cases of road traffic injuries and deaths were reported to MoPH special surveillance system during New Year vacation of year 2011-15 in Thailand. In term of severity category showed in figure 1, 1.66 % was fatal injury. Besides, serious injury and minor to moderate injury were 24.32% and 74.02%, respectively.

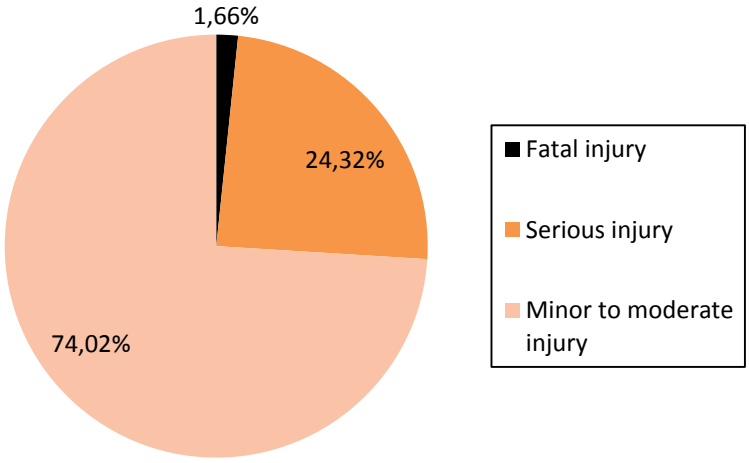


Figure 1 Percentage of injury severity among road traffic injury during New Year vacation in Thailand 2011-15

During New Year vacation of 2011-15, number of overall injury increased from 25,998 cases of year 2011 to 26,649 cases of year 2013. It afterwards decreased to 24,117 cases by year 2015, see *annex 2*. Similarly, each level of injury severity also showed slightly increasing trends to year 2013 then continuously decreased year by year as showing in figure 2. Minor to moderate injury trends was following the overall trend of injury. It had increased from 19,118 cases in New Year 2011 vacation to 19,717 cases of year 2013. The trend was moving downwards to 18,046 in year 2015. Regarding serious injury cases during this period, number of cases started from 6,424 to 6,498 cases during year 2011-13. Then it was falling downwards to 5,703 cases in New Year 2015 period. Trend of fatal injury was a bit different. It was continuously decreasing from 456 cases to 368 cases during the period of observation.

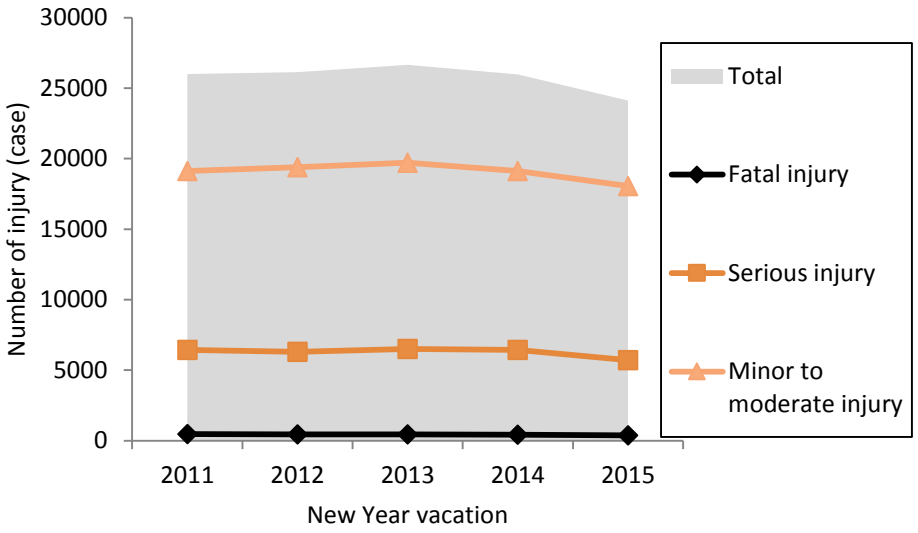


Figure 2 Percentage of injury severity among road traffic injury during New Year vacation in Thailand 2011-15

Motorcycle is major group of injury as 79.86% of total cases. *See Figure 3.* According to definition of injury severity used in this study, there were 2,136 fatal injuries or 1.69% of total injury. Meanwhile 31,345 cases got serious injury and 95,384 were minor to moderate injury cases, which were approximately equal to 24.73% and 75.27% respectively. Among the fatal injury group, motorcyclist shared 63.72% as the biggest proportion. As well as of serious injury, motorcyclist was also major group of injury as 78.08% and was 80.45% among minor to moderate injury category, *See annex 1.*

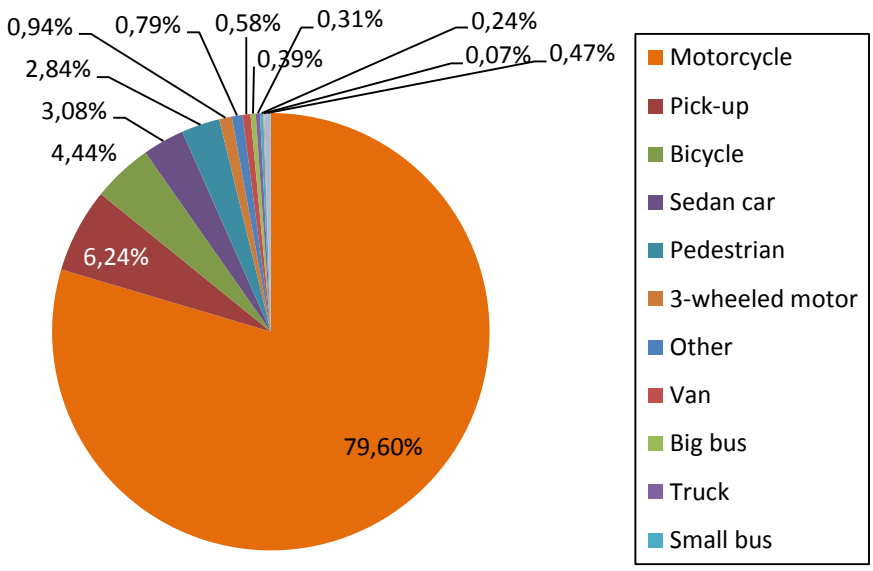


Figure 3 Percentage of road traffic injury and death by type of road users during New Year vacation in Thailand 2011-15

Motorcycle injury and severity level

Among motorcyclist injury, total numbers during the 7-day period of surveillance was 102,573 cases during 2011-15 as showed in table 4. Minor to moderate injury was 74.81% of total motorcycle injury, equal to 76,737 cases. Fatal and serious injury group were 1,361 and 24,475 cases, respectively. The fatal injury shared 1.33% while serious injury was 23.86% of total motorcycle injury.

Table 4 Number of motorcyclist injury by severity level of outcome during New Year vacation in Thailand 2011-15

Motorcycle injury	Fatal injury	Serious injury	Minor to moderate injury	Total
Number of injury	1361	24475	76737	102573
Percentage of total injury	1.33%	23.86%	74.81%	100.00%

Motorcycle injury and crashing vehicle

Number and percentage of motorcyclist injury by opponent crashing vehicle was showing in table 5. The injury of motorcyclist mainly happened in single-vehicle accident itself, not crashed into other vehicle. The single-vehicle accident among motorcycle injury was 58,962 cases. The second common crashing vehicle which caused motorcycle injury was another

motorcycle. Total 15,887 cases were reported in this group. Following by crashing with pick-up car, there were 11,016 motorcycle injuries. Despite being major group of injury, single-vehicle accident of motorcycle had only 0.74% fatal injury and 22.33% serious injury among this group. Similar to injury by crashing with another motorcycle, fatal injury in this group was 0.78% and serious injury was 23.06%. This lower percentage of fatal and serious injury could be observed among motorcyclist injury crashing with bicycle, 3-wheel motorcycle and 3-wheel cycle. Proportion of fatal injury among these groups was lower than 1%. On the other hand, high percentage of fatal injury occurred when motorcycle crashed with larger vehicles such as truck, big bus, van and pick-up car. For instance, crashing with truck resulted to 12.09% fatal injury and 36.15% serious injury.

Table 5 Number and percentage of motorcyclist injury by another crashing vehicle and severity level of outcome during New Year vacation in Thailand 2011-15

Motorcyclist injury by crashing vehicle	Fatal injury	Percentage of total injury	Serious injury	Percentage of total injury	Minor to moderate injury	Percentage of total injury	Total injury	Percentage of total injury
Single-vehicle accident	436	0.74%	13166	22.33%	45360	76.93%	58962	100%
Another motorcycle	124	0.78%	3664	23.06%	12099	76.16%	15887	100%
Pick-up car	354	3.21%	3225	29.28%	7437	67.51%	11016	100%
Sedan car	158	2.46%	1663	25.86%	4610	71.68%	6431	100%
Small bus	5	1.79%	76	27.24%	198	70.97%	279	100%
Big bus	23	11.79%	62	31.79%	110	56.41%	195	100%
Bicycle	0	0.00%	191	23.90%	608	76.10%	799	100%
Van	21	4.28%	145	29.53%	325	66.19%	491	100%
Truck	100	12.09%	299	36.15%	428	51.75%	827	100%
3-wheeled motorcycle	3	0.56%	122	22.59%	415	76.85%	540	100%
3-wheeled cycle	1	0.67%	31	20.67%	118	78.67%	150	100%
Other	63	1.42%	996	22.39%	3389	76.19%	4448	100%
Unknown	73	2.86%	835	32.77%	1640	64.36%	2548	100%
Total	1361	1.33%	24475	23.86%	76737	74.81%	102573	100%

Percentage of severe level of injury outcome among motorcyclist can be described by subgroup of size of crashing vehicle in table 6. Similar sized vehicle group including single-vehicle accident, crashing with motorcycle, bicycle, 3-wheeled motorcycle and cycle were in the same group. Larger sized vehicle group were including Pick-up car, sedan car, small bus, large

bus, van, and truck. While other and unidentified type of vehicle failed into subgroup 3. Fatal injury among motorcyclist who crashed with subgroup1 of vehicle was 0.74% in average. While serious injury was 22.50% and minor to moderate injury was 76.76 % of total 76,338 cases. In contrast, when motorcyclists got collision with larger sized vehicle group they became 3.44% fatal injury. Serious injury of this group was also higher than crashing with similar sized vehicle. It was 28.43% of total 19,239 injuries who crashed into subgroup of larger sized vehicle.

Table 6 Number and percentage of motorcyclist injury by sized grouping of another crashing vehicle and severity level of outcome during New Year vacation in Thailand 2011-15

Motorcyclist injury by crashing vehicle	Fatal injury	Serious injury	Minor to moderate injury	Total
Subgroup 1 : similar sized vehicle				
Single-vehicle accident	436	13166	45360	58962
Another motorcycle	124	3664	12099	15887
Bicycle	0	191	608	799
3-wheeled motorcycle	3	122	415	540
3-wheeled cycle	1	31	118	150
Total subgroup 1	564	17174	58600	76338
Percentage of injury	0.74%	22.50%	76.76%	100.00%
Subgroup 2 : larger sized vehicle				
Pick-up car	354	3225	7437	11016
Sedan car	158	1663	4610	6431
Small bus	5	76	198	279
Big bus	23	62	110	195
Van	21	145	325	491
Truck	100	299	428	827
Total subgroup 2	661	5470	13108	19239
Percentage of injury	3.44%	28.43%	68.13%	100.00%
Subgroup 3: unidentified sized vehicle				
Other	63	996	3389	4448
Unknown	73	835	1640	2548
Total subgroup 3	136	1831	5029	6996
Percentage of injury	1.94%	26.17%	71.88%	100.00%

Human factors on accident and injury; pre-crash and crash phase

According to first row of Haddon's matrix model, there were 3 available variables related to human factor on road traffic accident in this dataset. Apart from effect on accident occurring, these factors also result in various severity level of injury. Age group gender and alcohol drink riding were described below.

Age group

For total injury, age group of 15-29 year olds was majority. There were 47,825 cases in this group showing in table 7. This age group also had highest number of fatal and serious injury as 561 and 10,567 cases, respectively. While the smallest number of total injury was group of 75-99 year olds. However, in detail of severity level of injury outcome, percentage of fatal injury among age group was rising along with age group. It ranged between 0.60% and 3.54% fatal injury from age group of 0-14 to 75-99 year olds, respectively. It was almost similar trend in serious injury. The lowest proportion of serious injury was in the lowest age group; 0-14 year olds, as 17.39% of total injury among this age group. It was rising along with the age to 31.43% serious injury among age group of 60-74 year olds. Then the percentage slightly dropped to 28.90% among elderly 75-99 year olds. On the other hand, percentage of minor to moderate injury among each age group therefore decreased by age.

Table 7 Number and percentage of motorcyclist injury age group and severity level of outcome during New Year vacation in Thailand 2011-15

Age group	Fatal injury	percentage of total injury	Serious injury	percentage of total injury	Minor to moderate injury	percentage of total injury	Total	percentage of total injury
0-14	79	0.60%	2305	17.39%	10869	82.01%	13253	100%
15-29	561	1.17%	10567	22.10%	36697	76.73%	47825	100%
30-44	349	1.54%	6021	26.48%	16366	71.98%	22736	100%
45-59	233	1.71%	3988	29.26%	9410	69.03%	13631	100%
60-74	114	2.58%	1390	31.43%	2918	65.99%	4422	100%
75-99	25	3.54%	204	28.90%	477	67.56%	706	100%
Total	1361	1.33%	24475	23.86%	76737	74.81%	102573	100%

Gender

There was total 69,713 motorcycle injury among male and 32,860 cases among female. Moreover, male had higher percentage of fatal injury as 1.66% compared to 0.62% in female. As well as serious injury who was 26.78% of motorcycle injury. While there was 17.66% serious injury happened to female motorcyclist injury. See table 8

Table 8 Number and percentage of motorcyclist injury by gender and severity level of outcome during New Year vacation in Thailand 2011-15

Gender		Fatal injury	Serious injury	Minor to moderate injury	Total
Male	Number	1157	18672	49884	69713
	Percentage of total injury	1.66%	26.78%	71.56%	100.00%
Female	Number	204	5803	26853	32860
	Percentage of total injury	0.62%	17.66%	81.72%	100.00%

Alcohol drink riding

Alcohol drink driving or riding has been well identified as a major risk factor of accident. It was also showing effect on getting more severity of injury in this study as presented in table 9. Despite lower number of total injury among motorcycle drink rider, percentage of getting fatal and serious was higher than non-drink riding group. There was 1.14% fatal injury among alcohol drink riding group compare to 0.59% among motorcyclist who did not drink. Percentage of getting serious injury among drink rider was 33.55% compare to 17.19% among another group. Meanwhile unidentified group was taking the largest number of fatal injury as 576 cases.

Table 9 Number and percentage of motorcyclist injury by helmet wearing and severity level of outcome during New Year vacation in Thailand 2011-15

Alcohol drinking	Fatal injury	percentage of total injury	Serious injury	percentage of total injury	Minor to moderate injury	percentage of total injury	Total	percentage of total injury
Not drink	348	0.59%	10201	17.19%	48803	82.23%	59352	100%
Drink	437	1.14%	12819	33.55%	24958	65.31%	38214	100%
Unknown	576	11.50%	1455	29.06%	2976	59.44%	5007	100%
Total	1361	1.33%	24475	23.86%	76737	74.81%	102573	100%

Environmental factors on accident and injury; pre-crash phase

For environmental factors on accident and injury, different road category, year, date, and time were existing variable in this dataset

Road category

Among 3 categories of road, result of getting each level of injury severity is showing in table 10. Rural road was in highest total number of injury as 54,313 cases. City road had 20,344

injuries as the lowest number while there were total 25,749 cases on highway. However, Number of fatal injury was highest in highway category of road as well as percentage of getting fatal injury. It was 633 fatal injuries or equal to 2.46% of total injury on highway. City road presented the lowest number and percentage of fatal injury as 145 cases and 0.71% respectively. For percentage of getting serious injury, it was highest in highway following by rural road and city road. The proportions were 26.33%, 24.25% and 19.77% serious injury, respectively.

Table 10 Number and percentage of motorcyclist injury by road category and severity level of outcome during New Year vacation in Thailand 2011-15

Road category	Fatal injury	percentage of total injury	Serious injury	percentage of total injury	Minor to moderate injury	percentage of total injury	Total	percentage of total injury
City road	145	0.71%	4021	19.77%	16178	79.52%	20344	100%
Rural road	564	1.04%	13170	24.25%	40579	74.71%	54313	100%
Highway	633	2.46%	6780	26.33%	18336	71.21%	25749	100%
Unknown	19	0.88%	504	23.26%	1644	75.87%	2167	100%
Total	1361	1.33%	24475	23.86%	76737	74.81%	102573	100%

Year of accident

It was 20,242.40 cases per year in average (min 19,027 and max 20,559). Average number of injury in each severity category was 272.20 cases per year (min 222 and max 310) for fatal injury and 4,895 cases per year (min 4,507 and max 5,104) for severe injury. Meanwhile, average of minor to moderate injury was 15,347.40 cases per year (min 19,027 and max 20,559). Trend of overall injury is showing in Figure 4. It was slightly decreasing between last 3 years, 2013-15. In this period, number of fatal injury and severe injury were also in downward trend as well as minor to moderate injury. However, in term of proportion of injury outcome category in each year, the percentage of injury in each classification was almost similar. *See annex 3.*

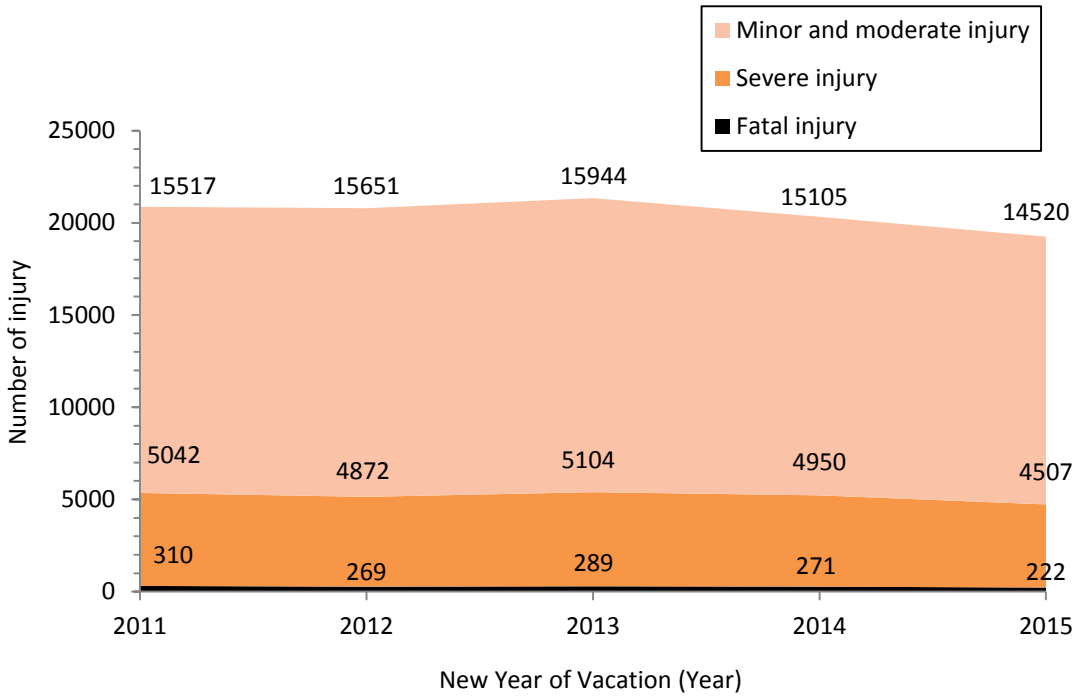


Figure 4 Number of motorcyclist injury and death by severity level of outcome and year of New Year vacation during New Year vacation in Thailand 2011-15

Date of accident

Distribution of injury by date of accident in each year was presented in *annex 4.* Whether it was 7-day special surveillance but the date of monitoring in each year was different. Number of overall injury on each day was ranked between 1,681 cases on 5th January 2015 (New Year 2015) and 4,363 cases on 31st December 2010 (New Year 2011). The highest average number of case per day was 3,048.14 cases in year 2013. On the other hand, the lowest average number was 2,749.86 cases in year 2015. Average number of case specific to fatal injury was between 15.00 to 58.08 cases per day. Median of average case per day was 31.5 cases. See Table 11.

Figure 5 is showing average number of cases per day by each severity level of injury outcome. Bell shaped pattern of trends presented in every year. Number of injury in every severity level increased before the end of the year. On 31st December of New Year vacation, number of injury was the highest peak. Then on 1st of January afterwards, number of injury continuously decreased until end of surveillance period. This pattern can be noticed similarly in every category of outcome.

Table 11 Number of motorcyclist injury by New Year of vacation, date of accident and level of injury during New Year vacation 2011-2015 in Thailand

Date	New Year					Total	Average per day
	2011	2012	2013	2014	2015		
Fatal injury							
27-Dec			30	33		63	31.50
28-Dec			36	48		84	42.00
29-Dec	31	38	64	33		166	41.50
30-Dec	57	52	39	35	46	229	45.80
31-Dec	80	54	45	53	62	294	58.80
01-Jan	59	54	51	51	41	256	51.20
02-Jan	41	35	24	18	18	136	27.20
03-Jan	26	22			18	66	22.00
04-Jan	16	14			15	45	15.00
05-Jan					22	22	22.00
Serious injury							
27-Dec			566	609		1175	587.50
28-Dec			753	749		1502	751.00
29-Dec	621	682	755	696		2754	688.50
30-Dec	934	865	791	726	786	4102	820.40
31-Dec	1036	1080	869	934	1052	4971	994.20
01-Jan	1059	907	893	798	954	4611	922.20
02-Jan	605	543	477	438	524	2587	517.40
03-Jan	458	423			452	1333	444.33
04-Jan	329	372			398	1099	366.33
05-Jan					341	341	341.00
Minor to moderate injury							
27-Dec			1817	2021		3838	1919.00
28-Dec			2199	2147		4346	2173.00
29-Dec	1930	2052	2419	2142		8543	2135.75
30-Dec	2619	2616	2464	2120	2416	12235	2447.00
31-Dec	3247	3046	2785	2574	3026	14678	2935.60
01-Jan	2796	2941	2600	2474	2840	13651	2730.20
02-Jan	1946	1892	1660	1626	1786	8910	1782.00
03-Jan	1624	1706			1574	4904	1634.67
04-Jan	1355	1398			1560	4313	1437.67
05-Jan					1318	1318	1318.00

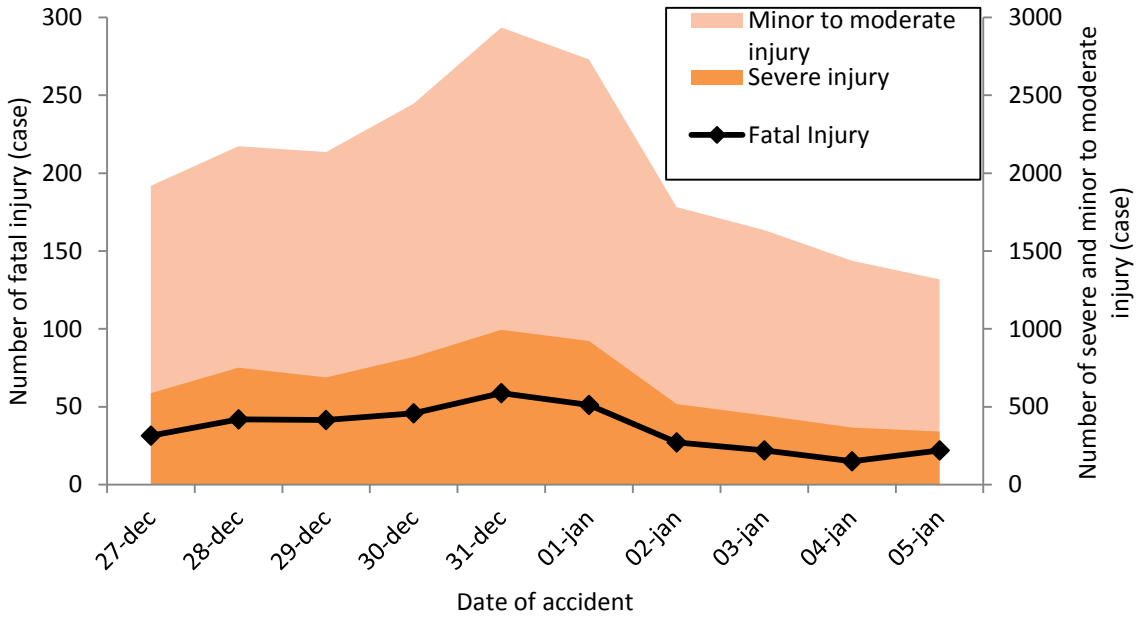


Figure 5 Average number of motorcyclist fatal, severe and minor to moderate injury per day by date of accident during New Year vacation in Thailand 2011-15

Time of accident

Numbers of motorcycle injury by time of accident are shown in table 12. Number of total injury per hour ranged from 966 to 8,412 cases of 18:01-19:00 hour and 05:01-06:00 hour, respectively. Average number of total injuries per hour was 4242.88 cases. This was excluding group of unidentified time of accident. For each level of injury severity, maximum number of cases also happened during 18:01-19:00 hour. On another side, period of 05:01-06:00 hour had the lowest numbers of injury in every single level. Average number of cases per hour among fatal and serious injury were 56.17 and 1,012.88 cases, respectively. While minor to moderate injuries were average 3173.83 cases in an hour.

Trends of number motorcycle injury in each single hour of accident were displayed in figure 6. Number of cases was slightly decreasing by hour after midnight until 6 AM. After that, number of injury was continuously increasing again during daytime. Peak of the trends was at hour of 18:01-19:00. Then it was going downwards by 6 AM. This pattern had been observed in every severity level of injury outcome.

Table 12 Number of motorcycle injury by time of accident and level of injury during New Year vacation 2011-2015 in Thailand

Time of accident	Fatal injury	Serious injury	Minor to moderate injury	Total
00:01-01:00	68	1267	2924	4259
01:01-02:00	57	838	1977	2872
02:01-03:00	46	630	1518	2194
03:01-04:00	40	458	1020	1518
04:01-05:00	33	307	724	1064
05:01-06:00	20	236	710	966
06:01-07:00	28	309	978	1315
07:01-08:00	36	545	2123	2704
08:01-09:00	38	734	2976	3748
09:01-10:00	35	691	2913	3639
10:01-11:00	44	883	3203	4130
11:01-12:00	43	936	3476	4455
12:01-13:00	44	1009	3707	4760
13:01-14:00	45	1007	3809	4861
14:01-15:00	54	1116	3910	5080
15:01-16:00	69	1327	4405	5801
16:01-17:00	82	1635	5731	7448
17:01-18:00	94	1740	6138	7972
18:01-19:00	142	2050	6220	8412
19:01-20:00	71	1764	5128	6963
20:01-21:00	76	1519	4158	5753
21:01-22:00	62	1370	3384	4816
22:01-23:00	74	1063	2863	4000
23:01-24:00	47	875	2177	3099
Unidentified	13	166	565	843
Min	20	236	710	966
Max	142	2050	6220	8412
Average	56.17	1012.88	3173.83	4242.88
Median	46.50	971.50	3089.50	4194.50

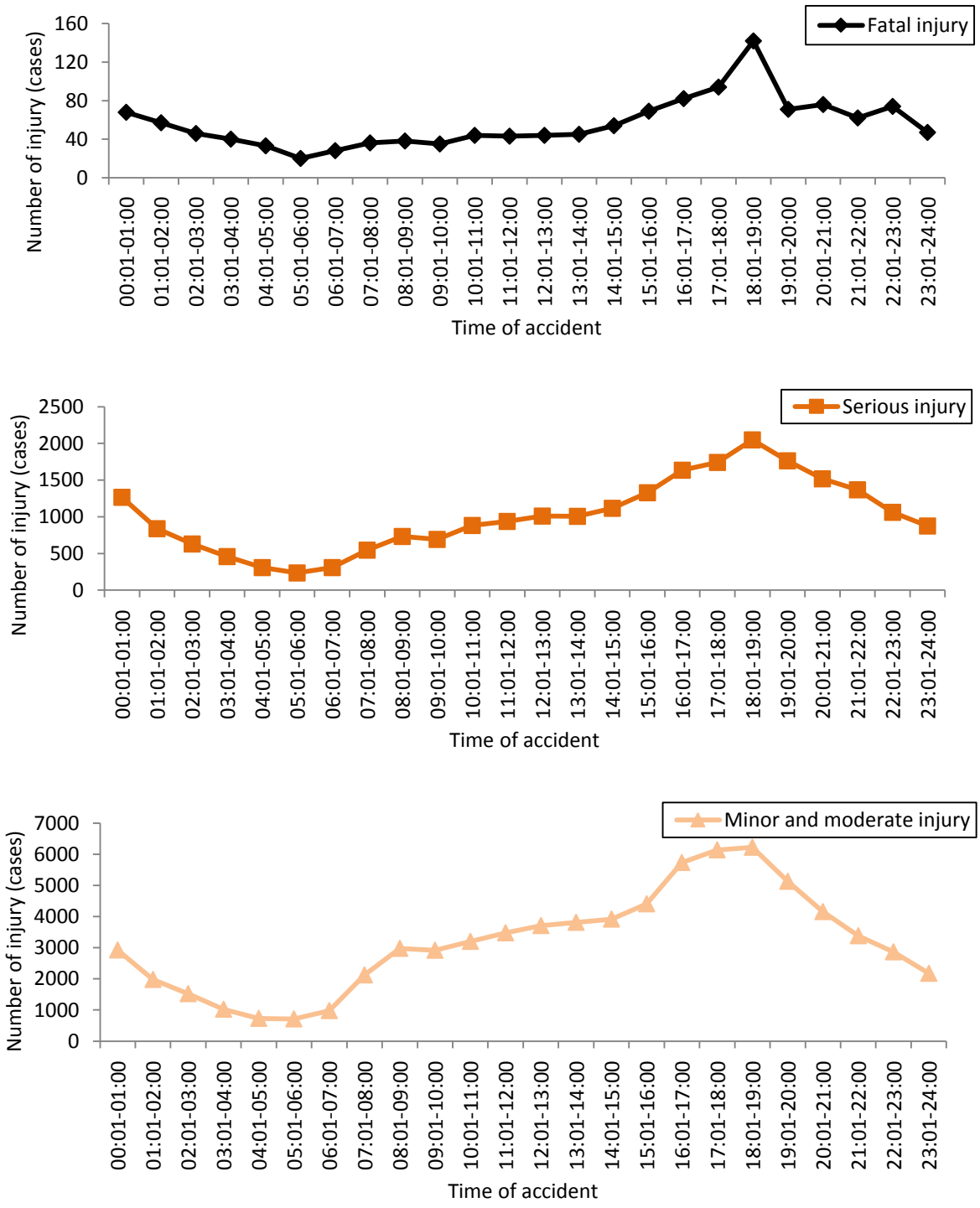


Figure 6 number of motorcyclist fatal, severe and minor to moderate injury by time of accident during New Year vacation in Thailand 2011-15

Human factors on road traffic injury; crash phase

Helmet use was only one variable in this dataset that specifically affected on injury severity level.

Helmet wearing

Helmet wearing is also clearly known as preventive intervention to reduce severity of injury. Result in table 13 showed that 80,914 injuries out of total 102,573 cases did not wear helmet. Besides, the non-helmet wearing group also presented with high percentage of fatal injury as 1.26%. While fatal injury among motorcyclist with helmet wearing was 0.74% of total 18,744 cases in this group. Moreover, proportion of serious injury among helmet wearing group was lower than non-helmet wearing. It was 18.56% compared to 24.80% serious injury respectively.

Table 13 Number and percentage of motorcyclist injury by helmet wearing and severity level of outcome during New Year vacation in Thailand 2011-15

Helmet wearing	Fatal injury	percentage of total injury	Serious injury	percentage of total injury	Minor to moderate injury	percentage of total injury	Total	percentage of total injury
Not wearing	1021	1.26%	20070	24.80%	59823	73.93%	80914	100%
Wearing	138	0.74%	3478	18.56%	15128	80.71%	18744	100%
Unknown	202	6.93%	927	31.80%	1786	61.27%	2915	100%
Total	1361	1.33%	24475	23.86%	76737	74.81%	102573	100%

Factors related to injury outcome; post-crash care phase

This phase is focusing on rescue and medical service after crash. There were 2 variables available in this dataset, rescue person and health care category.

Rescue person

Table 14 presents number and percentage of motorcycle injury by classification of rescue person. Injury rescue by Samaritan or relatives was majority as 59,565 cases in total injury. If excluding of dead on scene whom did not need rescue, intermediated life-support team shared the lowest number of injury as 689 cases. The highest percentage of getting fatal injury was 5.50% of injured person who was rescue by advance life-support team (ALS), apart from dead on scene category. Meanwhile the lowest chance was motorcycle injury rescue by Samaritan or their relatives, 0.12%. Regarding serious injury, percentage of serious injury

outcome was increasing by more advance level of rescue person. It was ranked between 12.16% of injured person who was self-rescue and 57.63% in ALS rescue category.

Table 14 Number and percentage of motorcyclist injury by rescue person and severity level of outcome during New Year vacation in Thailand 2011-15

Rescue person	Fatal injury	% of total injury	Serious injury	% of total injury	Minor to moderate injury	% of total injury	Total	% of total injury
Self-rescue	5	0.19%	328	12.16%	2365	87.66%	2698	100%
Dead on scene	812	100.00%	0	0.00%	0	0.00%	812	100%
Samaritan /relative	74	0.12%	9540	16.02%	49951	83.86%	59565	100%
Police	10	1.01%	272	27.53%	706	71.46%	988	100%
Rescue volunteer	69	0.72%	3121	32.52%	6408	66.76%	9598	100%
FR	105	0.59%	6302	35.14%	11526	64.27%	17933	100%
ILS	6	0.87%	246	35.70%	437	63.43%	689	100%
BLS	31	0.54%	2057	35.69%	3675	63.77%	5763	100%
ALS	249	5.50%	2609	57.63%	1669	36.87%	4527	100%
Total	1361	1.33%	24475	23.86%	76737	74.81%	102573	100%

FR = First response team
ILS = Intermediate life support team
BLS = Basic life support team
ALS = Advance life support team

Health care category

Result was showing in table 15. The highest number of total injury was taken care by district level hospitals. In this category, 63,840 out of total 102,573 motorcycle injury were recorded. On another side, only 1 case was reported from primary health care center. For fatal injury, even 2 cases were reported from OPD health care center but it was 3.51% of total 57 cases in this level. Then it was ranked as the highest group with percentage of getting fatal injury outcome. Meanwhile general hospital, district hospital and tertiary hospital level were showing almost percentage as 1.46%, 1.44% and 1.40%, respectively. This extreme proportion also had been noticed in serious injury outcome level. In health collage level of health care, 80% serious injury had been calculated from 4 serious injuries out of total 5 injuries. Therefore, result of this variable has to be carefully interpreted. It was recorded as the first contact health care level of the injured person. Numbers of health care center in each category are not equal. Besides, chance of reaching different health care level depended on site of accident.

Table 15 Number and percentage of motorcyclist injury by health care category and severity level of outcome during New Year vacation in Thailand 2011-15

Health care category	Fatal injury	% of total injury	Serious injury	% of total injury	Minor to moderate injury	% of total injury	Total	% of total injury
Medical university hospital	8	0.87%	191	20.81%	719	78.32%	918	100%
Tertiary hospital	144	1.40%	2783	26.99%	7385	71.62%	10312	100%
General hospital	243	1.46%	3773	22.72%	12587	75.81%	16603	100%
District hospital	918	1.44%	15038	23.56%	47884	75.01%	63840	100%
Private hospital	45	0.42%	2663	24.67%	8088	74.92%	10796	100%
Primary health care center	0	0.00%	0	0.00%	1	100.00%	1	100%
Health collage	0	0.00%	4	80.00%	1	20.00%	5	100%
OPD health center	2	3.51%	12	21.05%	43	75.44%	57	100%
Health science center	0	0.00%	7	24.14%	22	75.86%	29	100%
Unidentified	1	8.33%	4	33.33%	7	58.33%	12	100%
Total	1361	1.33%	24475	23.86%	76737	74.81%	102573	100%

3.1.2 Analytical study result

3.1.2.1 Data processing

As it was mentioned above in methodology session, some samples were excluded by exclusion criteria before statistical analytical processing. Absolute number of injury by severity level of outcome which was using eventually showed in table 16.

3.1.2.2 Univaritate Analysis

Table 17 is presenting crude odds ratio with 95% confident interval (95% CI) from univariate logistic regression analysis. Crashing with larger-sized vehicle is statistically significant risk factor of getting more severity of injury among motorcyclist. Larger-sized of vehicle group were including truck, big and small bus, sedan car, van and pick-up. Odd of getting high severity of injury among motorcycle injury who crashed into this group was 49.2 % higher than crashing with similar-sized vehicle (Odds ratio; 1.492, 95% CI, 1.438 to 1.548). Almost of other factors also showed significant association to severity level of injury. Odds ratio of biological factor such as age, categorized in age-group, and gender were positively associated with severity level of injury. Regard to human behavior risk factors, motorcyclist without

helmet wearing presented crude odds ratio as 1.471 at statistical significant level. Besides, alcohol-drink riding also had clearly higher chance to get higher injury severity than non-drink riding injury. For environmental factors, bigger level of road type was identified as risk of getting more severe injury. In contrast, different New Year period of accident was not associated with severity of injury significantly. However, different date of accident had presented odds ratio as 1.003 with 95% CI between 1.002 and 1.004. Lastly, at post-crashed care level, higher level of rescue person significantly associated with severity level of injury outcome. Crude odds ratio as 1.324 with 95% CI, 1.314 to 1.324 was calculated.

Table 16 Number of motorcyclist injury by level of severity using in descriptive study and analytical study

Category using in	Fatal injury	Serious injury	Minor to moderate injury	Total
Descriptive study	1361	24475	76737	102573
- exclude unidentified sized of opponent crashing vehicle	136	1831	5029	6996
- exclude unidentified helmet wearing	171	772	1552	2495
- exclude unidentified alcohol drink riding	361	914	2098	3373
- exclude unidentified road of accident	9	367	1242	1618
Absolute total number in Analytical study	684	20591	66816	88091

Table 17 Specific crude odds ratio (OR) of factors contributed to motorcycle injury during New Year vacation in Thailand 2011-15

Factors	Number of injury			Statistical result	
	Fatal injury	Serious injury	Minor to moderate injury	Crude OR	p-value
Opponent crashing vehicle					
Larger sized vehicle	335	4858	12043	1.492 (1.438 , 1.548)	<0.05
Similar sized vehicle	349	15733	54773		
Age group					
0-14	46	1971	9511	1.229 (1.212 , 1.247)	<0.05
15-29	267	8835	31909		
30-44	159	5035	14199		
45-59	129	3381	8231		
60-74	70	1203	2547		
75-99	13	166	419		
Gender					
Male	559	15649	43281	1.742 (1.682 , 1.805)	<0.05
Female	125	4942	23535		
Helmet wearing					
Not wearing	592	17557	53306	1.471 (1.410 , 1.535)	<0.05
Wearing	92	3034	13510		
Alcohol drink riding					
Drink riding	378	11402	22698	2.406 (2.331 , 2.482)	<0.05
Non drink riding	306	9189	44118		
Road type of accident					
Highway	293	5752	16411	1.223 (1.195 , 1.251)	<0.05
Rural road	308	11452	36150		
City road	83	3387	14255		
Rescue person					
Self-rescue	4	234	1815	1.324 (1.314 , 1.334)	<0.05
Dead on scene	347	0	0		
Samaritan/relative	60	8192	43594		
Police	5	228	619		
Rescue volunteer	39	2521	5475		
FR	59	5365	10169		
ILS	6	221	389		
BLS	16	1742	3297		
ALS	148	2088	1458		
Year of accident					
2011	148	4224	13377	0.997 (0.986 , 1.008)	0.579
2012	126	4038	13595		
2013	154	4341	14080		

2014	130	4202	13148		
2015	126	3786	12616		
Date of accident					
27-Dec	42	970	3315	1.003 (1.002 , 1.004)	<0.05
28-Dec	33	1263	3777		
29-Dec	80	2292	7394		
30-Dec	107	3443	10664		
31-Dec	150	4206	12813		
01-Jan	132	3904	11922		
02-Jan	75	2183	7749		
03-Jan	26	1123	4238		
04-Jan	25	922	3779		
05-Jan	14	285	1165		
Time of accident				0.999 (0.998 , 1.001)	0.525
00:01-01:00	2600	1034	32		
01:01-02:00	1713	712	31		
02:01-03:00	1298	522	20		
03:01-04:00	871	377	20		
04:01-05:00	613	245	15		
05:01-06:00	597	184	8		
06:01-07:00	809	242	17		
07:01-08:00	1813	453	20		
08:01-09:00	2574	629	20		
09:01-10:00	2556	580	19		
10:01-11:00	2804	742	27		
11:01-12:00	3059	792	28		
12:01-13:00	3303	861	23		
13:01-14:00	3381	865	19		
14:01-15:00	3459	949	28		
15:01-16:00	3882	1135	35		
16:01-17:00	5088	1386	48		
17:01-18:00	5384	1496	45		
18:01-19:00	5353	1739	72		
19:01-20:00	4377	1478	34		
20:01-21:00	3624	1289	29		
21:01-22:00	2905	1157	35		
22:01-23:00	2425	886	32		
23:01-24:00	1888	715	22		
Unidentified	440	123	5		

3.1.2.3 Multivariate analysis

Main focus of this step is the association between crashing into larger size vehicle among motorcycle injury and severity level of injury outcome**.** Crude odds ratio of single univariate analysis in previous section was considered. Other factors that significantly associated with severity level of injury were treated as suspected confounding factors. Those factors were including age group, gender, helmet use, alcohol drink riding, road type of accident, rescue person, and date of accident. Multivariate ordered logistic regression was performed in order to control effect of those confounder. This will result clearer relationship between major exposure and outcome. Table 18 is showing the result of adjusted OR of those risk factors contributed to high severity of injury. Crashing with larger sized vehicle was still showing significant relationship. The odds ratio was 1.440 with p-value less than 0.05. In other words, odds of getting higher severity of outcome among motorcycle injury who crashed into larger size of vehicle is 44% higher than another group of crashing into similar sized vehicle. Besides, other factors are still showing significantly association.

Table 18 Crude odds ratio (OR) and adjusted OR of factors contributed to motorcycle injury during New Year vacation in Thailand 2011-15

actors	Statistical result			
	Crude OR	p-value	Adjusted OR	p-value
Opponent crashing vehicle				
Larger sized vehicle	1.492 (1.438 , 1.548)	<0.05	1.440 (1.382 , 1.498)	<0.05
Similar sized vehicle				
Age group				
0-14	1.229 (1.212 , 1.247)	<0.05	1.187 (1.169 , 1.205)	<0.05
15-29				
30-44				
45-59				
60-74				
75-99				
Gender				
Male	1.742 (1.682 , 1.805)	<0.05	1.250 (1.200 , 1.300)	<0.05
Female				
Helmet wearing				
Not wearing	1.471 (1.410 , 1.535)	<0.05	1.361 (1.300 , 1.422)	<0.05
Wearing				
Alcohol drink riding				
Drink riding	2.406 (2.331 , 2.482)	<0.05	2.052 (1.977 , 2.127)	<0.05
Non drink riding				
Road type of accident				
Highway	1.223 (1.195 , 1.251)	<0.05	1.161 (1.133 , 1.189)	<0.05

Rural road					
City road					
Rescue person					
Self-rescue	1.344 (1.333 , 1.355)	<0.05	1.290 (1.280 , 1.300)	<0.05	
Dead on scene					
Samaritan/relative					
Police					
Rescue volunteer					
FR					
ILS					
BLS					
ALS					
Date of accident					
27-Dec	1.003 (1.002 , 1.004)	<0.05	1.001 (1.000, 1.002)	0.02	
28-Dec					
29-Dec					
30-Dec					
31-Dec					
01-Jan					
02-Jan					
03-Jan					
04-Jan					
05-Jan					

Table 19 is summarizing adjusted ORs of those factors above. Haddon's matrix model was used as original frame work of analysis. Factors in pre-crash phase showed positive relationship to getting higher level of injury severity. While motorcycle crashing with larger sized of vehicle and not wearing helmet were risks in crash phase. Rescue person also associated with injury outcome in post-crash care phase.

Table 19 Haddon's matrix summary Adjusted OR of factors contributed to motorcycle injury during New Year vacation in Thailand 2011-15

Phase	Purposing	Human Road user	Vehicle and equipment	Road and environment
Pre event (pre-crash)	Accident prevention	**Alcohol drink** 2.052 **Higher Age** 1.187 **Male gender** 1.250	Not available	**Bigger road type** 1.161 **Date** 1.001
Event (crash)	Injury prevention	**Not wearing helmet** 1.361	**Crashing with larger sized vehicle** 1.420	Not available
Post event (post-crash)	Life sustaining	**Rescue person** 1.290	Not available	Not available

3.2 Result of separate lane intervention review

3.2.1 Global issue on separate lane policy and intervention

In WHO Global status report for road safety 2015, separate lane for vulnerable road user was mention as one important key to reduce burden of road traffic injury. The vulnerable road users in the report referred to people who travel with slower speed and low protection such as pedestrian, cyclist and motorcyclist. The lane helps to divide those groups from crashing to larger vehicle with higher speed. An evidence in Denmark presented benefit of cycle track. Road injury victim among cyclist was decreased by 35%(15). The Netherlands and Germany also put a lot of effort and investment in infrastructure for cyclist. Declining of cyclist fatality in both countries were part of the successful intervention(34). In the Netherlands during 1978-1990, fatality rate of cyclist was 81% reduction(35). Regarding transportation context of developing country in South East Asia, especially Thailand, motorcycle is biggest proportion of vulnerable road users. In fact, demand of road space for motorcycle is high, nonetheless safe road for motorcyclist is less concern. WHO also purpose that similar separate lane intervention would be helpful in these countries as well(15). Safety road for all users policy is now turned on global road safety issue.

3.2.2 Motorcycle lane

Motorcycle lane is a type of separate lane for vulnerable vehicle. The lane can be provided along with main road or on separated route. The objective of installing this structure is to reduce chance of collision between motorcycle and large vehicle and higher speed. Lower number of accident can decrease number of road traffic injury. In Malaysia where the lane was implemented as pilot project, low speed cyclist is also allowed to travel on the motorcycle lane(36).

3.2.2.1 Type of motorcycle lane

There are 3 major types of motorcycle separate lane. It is simply define by structure of the lane(37). Picture 2, 3 and 4 are showing different types of motorcycle lane constructed in Malaysia.

1. Exclusive motorcycle lane

The lane is totally segregated from main road used by larger vehicle or higher speed. It is located separately from the main road. The underpass is also constructed together to avoid joining of traffic with other large motor vehicle. This type of motorcycle lane could avoid of collision at road junction.

2. Inclusive motorcycle lane

This type of lane is constructed on the same surface of usual road. There is space provided on a side of main road. Motorcycle or other low speed vehicle will be separated from larger vehicle by the painted color line on the road. Sometimes physical barrier was also used for lane separation. However, the accident can happen at the junction where the separate lane rejoins the main road(38).

3. Paved shoulder motorcycle lane

This structure is made from sharing space of main road. Normally it is designed to be shoulder of existing road. Therefore, it is not separate from the main carriage way. Motorcycle can swap across the line into the main lane as well as the larger vehicle can invade to motorcycle lane. The chance of crash between different sizes of vehicle is still.

Picture 2 The world's first exclusive motorcycle lane, on Federal Highway 2 in Malaysia

Source: the Malaysian Institute of Road Safety (MIROS)

Picture 3 Inclusive motorcycle lane in Malaysia

Source: the Malaysian Institute of Road Safety (MIROS)

Paved shoulder motorcycle lane

3.2.2.3 Case Study of Motorcycle lane

Malaysia

There is high number of motorcycle in Malaysia as well as other Asian countries. Motorcycle is contributed to around 50% of registered vehicle in the country. Besides, it shared 60% of road traffic injury. The idea for separating vulnerable road users from high rate traffic road had been adopted for long time ago. Motorcycle and bicycle lane was also included in the concept. It was firstly introduced to Malaysian road since 1980(39). However, there was not much experience on exclusive lane combining with lack of financing and no strong commitment of road safety. At that moment, line mark on road was used to make the inclusive lane. The traffic flow between motorists was mixed. From time to time, Malaysia was keeping promote safety road by using motorcycle lane. It was continuously developed and improved quality. Eventually, in 1992, the first exclusive motorcycle lane was constructed along the Federal Highway route2. This highway was considered as one of business route. The lane was opened for public use in 1993. Maximum speed on the route was limited at most 60 kilometers per hour. A study was conducted to evaluate effectiveness of the lane on this route(39). Result of the study presented 25% reduction of accident in year 1993, after implementation. In 2000, another reassessment showed improvement of effectiveness. At this time, motorcycle accident on the route decreased by 35%.

One challenging for implementation of motorcycle lane is conflict with other road users. In some area it is difficult to exclude the lane from other vehicle route. Therefore, mutual benefit of all road users would be considered to bring maximum effectiveness(36).

Taiwan

Road safety concerning was clearly promoted in Taiwan since 1983. National Road Traffic Safety Committee was established in that year. It was operated by representatives from central and local departments. Academic institute and transport specialist was also included. There were various programs for motorcycle safety from time to time. Recent information showed that motorcycle contributed to approximately 68% of total 22.3 million vehicles in Taiwan in year 2012. It was 88 percent of total road traffic injury during 2011(40). Law and campaign on helmet wearing and against drunk driving were implemented. Besides control of behavior risk factors, road designed for safety of motorcyclist was considered. Installing motorcycle separate lane was one of intervention(41). First exclusive motorcycle lane was established in 1978. The lane for motorcycle was continuously adjusting for safety reason. Two-phase turning and stopping area at intersection were developed afterwards. A study on injury likelihood of motorcycle on different lane showed 14% lower likelihood of injury on motorcycle

exclusive lane. Using mixed traffic lane with slow movement as reference point, fast moving lane mixed with car was 51% higher injury likelihood.

In extending phase, some of inclusive motorcycle lane also constructed, especially in urban area with limited road space. This type of lane was also known as motorcycle priority lane. Recent study described some challenging of motorcycle lane in urban street of Taiwan. It was noticed of misuse such as car parking. Motorcyclist could get chance of accident and injury while swapping into higher speeding lane. Moreover, there was no specific traffic signal for motorcycle at the junction. This leaded to confusing traffic and accident on intersection. The report also gave recommendations for improvement. Motorcycle exclusive lane was recommended in rural road, especially highway. Traffic light specific to motorcycle should be installed(40).

Table 20 Summary of studies on motorcycle lane in Malaysian and Taiwan

Country	Type of separate lane	vehicle and condition	Outcome
Malaysia	Exclusive motorcycle lane	Motorcycle at 60 km/hr maximum speed limit, cycle	39% accident reduction
Taiwan	Exclusive motorcycle lane with waiting zone on intersection	Motorcycle or low speed vehicle sized under 250 cc.	14% lower injury likelihood

3.2.2.2 Lane for motorcycle in Thailand

For physical infrastructure, there is no clear defined lane for motorcycle in Thailand. Some road type was designed paved shoulder besides. However, act of land transportation mentioned a rule for motorcycle. The motorcycle should stay close to left side of the road(42). It is not forbidden to use other lane of the road if necessary. No vehicle is allowed to use the road shoulder. Motorcyclists have to ride closely to the line on left-hand side of the road. Moreover, some routes, there was no shoulder along with the main road. In this case, motorcycle is mixed with other motor vehicle.

Picture 5 Lane for motorcycle in Thailand

Source: pantip.com/topic/31061640

Chapter 4: Discussion

4.1 Secondary data analysis findings

During New Year vacation 2011-15 in Thailand, the trend of road traffic was slightly decreasing in all level of injury severity. However, the number of injury had been far from the target of 50% decreasing of road traffic injury during the decade of global road safety. This information came from the special surveillance in certain period of year. Even though it was not covered all injury for whole year, but it can be useful for monitoring the trend of injury and related factors.

Over this five-year period, 1 in 4 road traffic injuries who visits health care center were fatal and serious injury. This group usually requires more advance health care resource such as surgeon, operating room and equipment and also intensive care unit. Meanwhile secondary and tertiary hospital is limited in number and area coverage entire the country. As well as requirement of advance emergency medical service which is high cost. Even user fee of those services are paid by road traffic victims funding, but the high cost exceeding limit of 15,000 Thai Baht will be charged from national health funds under UHC. While the budget of the funds is arrived from taxes in order to use for the health system processing and improvement. Reduction in number and proportion of this severe injury will result to increasing of total health budget. The budget gaining back from these preventable patients could be remobilized to improve other perspective on country health system. Besides, workload of specialist health staff will be decreased to reasonable rate. It might help to improve quality of care in general.

The severe injury is referring to fatal and serious injury. Among this group, motorcyclist shared the biggest portion as well as of total injury. One of the reasons is high number of motorcycle in the country. It is a non-protective shield vehicle which is vulnerable to severe injury.

In this study, crashing of motorcycle with larger sized vehicle was focusing as risk factor of getting fatal and serious injury outcome. Chance of getting fatal injury by crashing with another motorcycle, bicycle, tricycle and 3-wheeled motorcycle was lower than 1 percent. As well as the motorcyclist got single-vehicle accident. Meanwhile collision with larger size of vehicle can bring up to 11.79% fatal injury. In simulative situation, if motorcycle is segregate into separate lane, those similar sized vehicles might be allowed to travel on the same lane. Crash between motorcycle and other similar sized vehicle would be possible. But percentage of getting fatal injury might be low as 0.74% compared to crashing with larger vehicle at 3.44%. Proportion of getting serious injury was also lower. The reasons might be both size and speed of opponent vehicle.

In human biological factors, number of injury in 15-29 year olds age group was highest. Population in this age is usually working-age group including adolescent. Higher rate of travelling might be a reason of high number of injury. Besides, economical status and income of this group of population is not enough to buy a car. Meanwhile cost of motorcycle is affordable and public transport system does not match their demand. Even rising of age is presenting less number of injuries though increasing percentage of getting severe injury. For gender, injury in male was 3 times higher than female. Moreover, percentage of getting severe injury was also much higher. Beside of riding behavior in high speed and less carefulness, alcohol consumption could be additional risk for male motorcyclist. Alcohol drunk riding has been clearly identified as risk of accident worldwide. In this study, alcohol drink rider who got injury had approximately 2 times higher than rider who did not drink. This finding showed relationship between alcohol and getting more severe injury apart from risk of accident. Low consciousness of drink rider might lead to careless riding, speedy. Besides, body response while crashing might not be rapid enough to protect themselves. Physical response to medical treatment is also poor. Unfortunately, data collection of alcohol drinking in this system is based on history taking. There is right of patients to refuse to give this information. Therefore it is not possible to identified status of drink riding in many cases.

Different road category showed different proportion of severe injury. Highway had higher percentage of getting severe injury than rural road and city road. Almost of highways in the country allow motorcycle to access. Since there is no separate lane, motorcycle can either travel mixing with large vehicles or swap to lane of high speed vehicle. Moreover, there are lots of junctions beside the national highway without traffic light. This open connection from rural road also easily causes accident of motorcycle and high speed car on highway. On the other side, City road had low chance to get severe injury cause of slower traffic flow and lower speed limit. On dimension of injury number, motorcycle injury mostly occurred in rural road. It might because of total coverage is more than other types. However, information on total length of each road type is not available. From 2013 to 2015, number of motorcycle in all severity level was decreasing. This might be effect of national road traffic agenda campaign, especially on risk behavior control. In term of date, average number of injury presented in bell shape where the peak was on 31th December. All category of injury severity was almost changing in number proportionally. Increasing of travelling and alcohol drinking on New Year Eve and New Year day might causes high number of injury. In cycle of day, number of injury was increasing from early morning to the peak at 18:01-19:00 hour. Then it was decreasing by next morning. Higher rate of travelling in the afternoon and evening might increase chance of accident and injury. Alcohol accessibility is another reason. Although alcohol selling is allowed after 17:00, drinking culture in the country is usually starting in the evening through the night. Drunk driving is still there in the evening through the night.

Helmet wearing was seen as less likely to get high severe injury among motorcycle injury. It is also clearly identified as protective factor for motorcyclist. Information from regular injury surveillance showed that head injury is most common causes of dead among motorcycle injury. Number of total injury of motorcyclist without helmet was also much higher than helmet wearing group. Some cases were not record helmet using status. This data might not be available in some cases because data collection point is at the health care center. Some patients were rescued from the scene and helmet had been brought out.

In post-crash care perspective, motorcycle injury mostly got help by Samaritan or relatives. This group also had the lowest percentage of severe injury outcome. In contrast, the cases that were rescued by highest advance medical team showed high percentage of geeing severe injury. In this factor, severity injury on scene is probably related. Naturally, in Thailand, minor injury cases always brought to hospital by the witness or their relatives. Meanwhile high severe injury usually asks for help from EMS system by phone call. Even though the EMS service is available entire the country with free service, number of serious injury rescue by Samaritan was still high. This might because it is difficult for general people to evaluate level of injury severity at first see. Thai people are naturally willing to help the victims but might be lack of knowledge in complication or sequelae from improper first aid and rescue. Besides, phone number of emergency service might not be widely recognized.

Comparing among hospital levels, from district hospital to Medical University, percentage of getting severe injury was decreasing from hospital with lower to higher capacity. Facilities and specialist might affect to outcome of injury. However, number of total Injury in category of health care center varied to number of each health care service category. District hospitals locate in every district in the country. It is fastest to access this level of health service at first. Even Injury could happen anywhere but high capacity of health service could not be distributed widely to serve. For mortality, number of fatal injury was highest in districts hospital. This record could be mixed up with injured person who died afterwards and death on scene cases. Death body was firstly brought to be kept at the nearest district hospital.

In statistical data analysis, the association between crashing with large sized vehicle and getting high severity of injury had been significantly proved. This type of accident is tending to happen easily because of mixed traffic on the same road in Thailand. Bigger road type such as highway is also significant factors. Non-helmet wearing and alcohol drink riding were confirmed as behavior risk factors of getting more severe injury. Male and high-aged group is human factors linking to severe outcome of injury .On health service aspect, even advance level of rescue team related to getting high severe injury outcome though the result must be carefully interpreted. Normally, severe cases at crash site always call for advanced skill of rescue team.

4.2 Separate lane Intervention

Segregating motorcycle from larger vehicle by separate lane is proved as a benefit intervention. The lane can reduce percentage of motorcyclist injury in Malaysia and Taiwan. Similar intervention which was applied in developed countries for other vulnerable vehicle such as bicycle is also the evidence of benefit. In The Netherlands and Germany, number and percentage of injury and death was decreasing from time to time since the lane was established along with improvement other road infrastructure. Even though, there is no study mentioned on reduction of severity outcome. However, analytical result in this study is evidence which can be implied that fatal and serious injury could be prevented if motorcycle does not crash into larger sized vehicle.

The most safety lane to prevent accident and injury is the exclusive motorcycle lane. The lane completely divides vulnerable vehicle from main traffic stream even at the intersection. However construction needs more land space than inclusive lane. Traffic light specific to motorcycle is an issue to be considered. This function will avoid confusing and crash at the junction. Generally for bicycle lane in Netherlands and Germany, specific traffic light is also provided separately.

4.3 Potential on implementation

Since motorcycle is sharing the highest percentage of vehicle in Thailand. This context is similar to Malaysia and Taiwan as well as other Asian countries. Motorcycle lane could be adopted to implement in Thailand by applying experience from those two countries.

Policy commitment is important at starting point. Story in Malaysia showed big movement on road safety design for motorcycle when policy was clear. Taiwan also included specific issue of road providing for all users in their national road safety agenda. Thailand also declared road safety agenda since 2010. National committee on road safety is still looking for intervention on motorcycle because it is the biggest portion of injury in the country.

At implementation level, investment budget and effectiveness of separate lane intervention are important issues. Case study in Malaysia is possible steps to follow. At the beginning of implementation, the lane was firstly constructed in pilot area. The study of cost-effectiveness and point for improvement was done afterwards before expanding the intervention to other area. For Thailand, the lane could be trial in some selected road such as area with high incidence of severe injury. Highway could be an option for pilot site because proportion of severe injury is higher than rural and city road. Land space besides highway which is currently reserved is also wide enough. Experience from Taiwan also recommended

the exclusive lane on rural street and highway. Therefore, implementing the lane on highway would be priority at the beginning.

Base on result of a study on motorcycle accident in Thailand, transition number from motorcycle to car is expected to reduce numbers of injury among motorcycle(43). However, in context of Thailand as middle income country, motorcycle is still the most popular vehicle because of affordable cost. Expanding network of public transportation could be helpful to be a substituted travelling option. But currently, distribution of public transportation could not reach to every living area of population.

4.4 Limitation of study

This dataset is sample of road traffic injury from a short duration of whole year. It is difficult to imply similarity other period of the year. This situation might be different by increasing travelling during vacation or higher alcohol consumption during New Year celebration. Data collection for whole year might be useful in case it does not consume too much resource.

This database has limitation at data collection. All information is recorded at health care center. Information of vehicle condition, road and environment condition on scene is not reached. For health staff, it is also difficult to get those factors outside health area. Then some factors related to accident and injury, according to Haddon's matrix, were not all included. There were some missing dimensions of nine blocks in the matrix. Those variables are not available in this dataset. Data analytic result in this study might not be precise.

According to missing value in essential variables, 14% of records from total motorcycle injury were excluded before statistical analytic processing. High proportion of data loss might make effects on statistical result. Besides, the subtraction was also not proportionally in each category of injury severity outcome. Records of fatal injury was decreased half, while data of serious injury and minor to moderate injury were 15 % and 13 % reduction of records from the beginning. This nonhomogeneous reduction might effect to odds and odds ratio.

Chapter 5: Conclusion and recommendation

5.1 Conclusion

During New Year vacation 2011-15, Number of road traffic injury in Thailand was slightly decreasing. Even downward trends were noticed in last 3 years, but Thailand is still far from the target at 50% reduction of road traffic injury. Motorcycle was 78% of the total injury. Twenty five percentage of motorcycle injury got serious and fatal injury. Crashing with large size vehicle resulted high proportion of getting severe injury outcome among motorcycle injury. Working age group who was between 15-29 years old was majority in number of total motorcycle injury. However, rising age group increased percentage of getting severe injury. Male gender got higher number of injury and percentage of getting severe injury than female. Careless riding and alcohol drunk riding behavior could be explanation. For behavior risks, alcohol drink riding showed higher proportion of getting more severe injury as well as non-helmet wearing. Injury on highway presented higher proportion of getting fatal and serious injury than rural and city road. As all type of road in the country was similarly mixed up with every type of vehicle, higher speed of traffic flow might be the explanation. During New Year period, number of injury was highest on 31st December follows by 1st January. On these two days people might travel more than other days for celebration. Number of drink driver on the days was possible increasing. On medical service after crash, advance EMS is always assigned to pick up high severe injury from the scene. Then, higher skilled rescue teams were related to higher chance of severe outcome. However, number of serious injury rescued by Samaritan or relatives was highest. Number of medical service utilization in district hospitals was highest because this health care level is proper for first contact in term of distance, facilities and coverage in the country. Anyway, result of injury outcome was worse than high capacity hospital. Percentage of getting severe injury at this level was higher than tertiary level health center. However, total number of death in this level might be mixed up with death on scene.

Motorcycle crashing with larger size of vehicle is significantly associated to getting high severity level of injury outcome, confirmed by statistical analysis. Other risk factors also showed statistical significant relationship to the outcome. These factors were including age, male gender, alcohol drink riding, non-helmet wearing, being rescue by advance skilled EMS. The finding was an evidence to reconsider about this situation. Avoiding this accident and injury can be done by separating this vulnerable vehicle from other larger size on the road.

Issue of separate lane for vulnerable road users has been discussed in global level. According to WHO, many developed countries had implemented the lane for bicycle as majority

of vulnerable vehicle in the countries. Accident and fatality of injury was decreased from time to time. In Malaysia and Taiwan where motorcycle is high proportion of vehicle, separate lane for motorcycle had been piloted and implemented more than 10 years. According to the following up evaluations, accident was decreased in total but severity of injury was not mentioned. There is potential to adopt this intervention into Thailand since motorcycle is highest number of vehicle. Affordable price of motorcycle is reason of popularity for people in this middle income country. As long as public transportation is not in good coverage, motorcycle is still favorite option of travelling. Even law on helmet and drink rider has been enforced though non-helmet wearing and alcohol drink riding are still main factors of motorcycle injury. Since number of injury among motorcycle is still high and not well decreased, additional intervention such as motorcycle separate lane might be an option.

5.2 Recommendations

Motorcycle injury is majority of road traffic injury. Accident and injury involving motorcycle also happen through the year because it is favorable vehicle in Thailand. Therefore, intervention which can make good impact for whole year should be considered to implement. Current interventions are still needed to strengthen on implementation. New additional intervention is needed to consider.

This study is intending to provide recommendation of potential intervention to National Road Safety Committee, in order to improve situation of motorcycle injury in Thailand. The result will be passed through department of disease control (DDC) who works as information provider for the committee. On other side, DDC also works collaborate with other departments under MoPH to improve post- crash care service on road traffic injury. The recommendations, therefore, separate to2 sections; prevention and post-crash care.

5. 1 Motorcycle injury Prevention

This section is provided to National Road Safety Committee.

1. Motorcycle separate lane should be considered as additional intervention
2. Policy commitment of road safety for all users is needed for developing motorcycle lane project.
3. At the beginning, motorcycle lane should starts in proper pilot site. Along the Highway is good option since there is high proportion of severe injury and land reserved is wide enough.

4. Following up Study on effectiveness of the pilot motorcycle lane should be planned and conducted

5. Intervention against behavior risk factors, especially helmet wearing and alcohol drink riding must be strengthening.

5.2 Post-crash care of injury

This section is provided for MoPH and Institute of national emergency medical service. Since medical care service on road traffic injury is one important pillar for road traffic accident and injury management, these interventions could help to improve.

1. Emergency medical service should be promoted widely to encourage using, especially in case of severe road traffic injury.

2. Basic life support training should be widely conducted to general population.

3. Network of medical service for injury should be developed and strengthened from primary to tertiary to fill the gap of service coverage.

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Annex

Annex 1. Table of number of road traffic injury and death by type of road user and level of injury severity during New Year vacation 2011-2015 in Thailand

Vehicle	Fatal injury	Percentage of total fatal injury	Severe injury	Percentage of total severe injury	Minor and moderate injury	Percentage of total minor and moderate injury	Total	Percentage of total injury
Motorcycle	1361	63.72%	24475	78.08%	76737	80.45%	102573	79.60%
Pick-up	278	13.01%	2290	7.31%	5474	5.74%	8042	6.24%
Bicycle	72	3.37%	1221	3.90%	4434	4.65%	5727	4.44%
Sedan car	137	6.41%	1043	3.33%	2787	2.92%	3967	3.08%
Pedestrian	164	7.68%	1029	3.28%	2470	2.59%	3663	2.84%
3-wheeled motorcycle	26	1.22%	316	1.01%	866	0.91%	1208	0.94%
Other	38	1.78%	302	0.96%	678	0.71%	1018	0.79%
Van	19	0.89%	185	0.59%	542	0.57%	746	0.58%
Big bus	7	0.33%	132	0.42%	360	0.38%	499	0.39%
Truck	13	0.61%	113	0.36%	278	0.29%	404	0.31%
Small bus	3	0.14%	76	0.24%	232	0.24%	311	0.24%
3-wheeled cycle	2	0.09%	25	0.08%	69	0.07%	96	0.07%
Unknown	16	0.75%	138	0.44%	457	0.48%	611	0.47%
Total	2136	100.00%	31345	100.00%	95384	100.00%	128865	100.00%

Annex 2. Number road traffic injury and death by year and level of injury severity during New Year vacation 2011-2015 in Thailand

Year	Fatal injury	Severe injury	Minor and moderate injury	Total
2011	456	6424	19118	25998
2012	454	6296	19381	26131
2013	434	6498	19717	26649
2014	424	6424	19122	25970
2015	368	5703	18046	24117
Total	2136	31345	95384	128865

Annex 3. Number and percentage of motorcyclist injury and death by year and level of injury severity during New Year vacation 2011-2015 in Thailand

Year	Fatal injury	Severe injury	Minor and moderate injury	Total
2011	310	5042	15517	20559
2012	269	4872	15651	20523
2013	289	5104	15944	21048
2014	271	4950	15105	20055
2015	222	4507	14520	19027
Total	1361	24475	76737	101212
Max	310	5104	15944	20559
Min	222	4507	14520	19027
Mean	272.20	4895.00	15347.40	20242.40
Median	271	4950	15517	20523