ESTIMATING LIFETIME INDIRECT COSTS OF ALCOHOL DRINKING IN THAILAND: A SIMULATION STUDY

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Thesis
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ESTIMATING LIFETIME INDIRECT COSTS OF ALCOHOL DRINKING IN THAILAND: A SIMULATION STUDY

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ABSTRACT

The objectives of this incidence-based cost-of-illness study were (1) to estimate lifetime indirect cost and life expectancy of Thai drinkers in each drinking category (i.e. responsible drinker, hazardous drinker, harmful drinker), and (2) to estimate the cost-savings associated with drinking cessation at different drinking categories and age. The Markov model using societal viewpoint was employed. In this study, lifetime indirect cost of drinkers comprised productivity loss due to absenteeism and presenteeism, and premature mortality. All costs were converted to the base year of 2010.

In the case of males, the cost of one new responsible drinker, hazardous drinker, and harmful drinker was estimated at 24,297 baht, 293,140 baht and 338,472 baht, respectively. For the female drinker, the indirect cost of an individual who was responsible, hazardous and harmful drinkers were 29,180 baht, 194,066 baht and 232,486 baht, respectively.

For males, the costs saved in the event that one hazardous drinker able to quit drinking at the age of 25, 35 and 45 years was found to be 263,000 baht, 126,000 baht and 9,600 baht, respectively. The costs saved in the event that one harmful drinker was able to quit drinking at the age of 25, 35, and 45 years was found to be 270,000 baht, 111,000 baht and 15,000 baht, respectively. For females, the costs saved in the event that one hazardous drinker able to quit drinking at the age of 30, 35, and 45 years was found to be 171,000 baht, 167,000 baht and 73,000 baht, respectively. The costs saved in the event that one harmful drinker who was able to quit drinking at the age of 30, 35, and 45 years was found to be 179,000 baht, 164,000 baht and 60,000 baht, respectively.

The results indicated that the economic burden of alcohol is substantial. Any intervention or policy aimed at reducing new incidence of drinking as well as encouraging new drinkers to quit at earlier should be emphasized.

KEY WORDS: ALCOHOL/ DRINKING/ LIFETIME INDIRECT COST/ INCIDENCE-BASE APPROACH/ COST-OF-ILLNESS

50 pages

การประเมินต้นทุนทางอ้อมตลอดชีพของการดื่มเครื่องดื่มแอลกอฮอล์ในประเทศไทย: การศึกษาโดยใช้แบบจำลอง
ESTIMATING LIFETIME INDIRECT COSTS OF ALCOHOL DRINKING IN THAILAND:
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บทคัดย่อ

การศึกษาต้นทุนความเจ็บป่วยด้วยวิธีอิงอุบัติการณ์ครั้งนี้มีวัตถุประสงค์เพื่อ (1) ประมาณต้นทุนทางอ้อมและจำนวนปีที่เสียชีวิตก่อนวัยอันควรของประชากรไทยที่บริโภคเครื่องดื่มแอลกอฮอล์ในแต่ละระดับการดื่ม ได้แก่ การดื่มบ้าง การดื่มอย่างอันตราย และการดื่มอย่างอันตรายมาก (2) ประมาณค่าต้นทุนที่ป้องกันได้หากทำให้ผู้ที่ดื่มเลิกดื่มที่อายุต่างๆ ทั้งนี้ต้นทุนทางอ้อมที่ทำการประเมินครอบคลุมต้นทุนการสูญเสียประสิทธิภาพในการทำงานทั้งจากการขาดงานและขาดประสิทธิภาพขณะทำงานและต้นทุนจากการเสียชีวิตก่อนวัยอันควร ในการศึกษาครั้งนี้แบบจำลองมาร์คอฟได้ถูกนำมาใช้เพื่อคำนวณหาค่าต้นทุนตลอดชีพและอายุขัยเฉลี่ยของผู้ดื่มแอลกอฮอล์ผ่านมุมมองของสังคม โดยมูลค่าต้นทุนที่คำนวณได้นำเสนอในค่าของปีฐาน 2553

ผลการประเมินต้นทุนตลอดชีพของผู้ดื่มแอลกอฮอล์เทียบกับผู้ไม่ดื่มแอลกอฮอล์ในประเทศไทย พบว่าต้นทุนตลอดชีพของประชากรชายที่ดื่มบ้าง ดื่มอย่างอันตราย และดื่มอย่างอันตรายมาก คือ 24,297 บาท, 293,140 บาท และ 338,472 บาท ตามลำดับ สำหรับในผู้หญิงที่ดื่มบ้าง ดื่มอย่างอันตราย และดื่มอย่างอันตรายมากสูญเสียต้นทุนตลอดชีพเท่ากับ 29,180 บาท, 194,066 บาท และ 232,486 บาท ตามลำดับ ต้นทุนที่ป้องกันได้หากทำให้ผู้ชายที่ดื่มแบบอันตรายเลิกดื่มที่อายุ 25, 35 และ 45 ปี มีค่าเท่ากับ 263,000 บาท, 126,000 บาท และ 9,600 บาท ตามลำดับ สำหรับต้นทุนที่ป้องกันได้หากทำให้เพศชายที่ดื่มแบบอันตรายมากเลิกดื่มได้ที่อายุ 25, 35, และ 45 ปี คือ 270,000 บาท, 111,000 บาท และ 15,000 บาทตามลำดับ หากทำให้เพศหญิงที่ดื่มแบบอันตรายเลิกดื่มได้ที่อายุ 30, 35, และ 45 ปี พบว่าต้นทุนที่ป้องกันได้มีมูลค่าเท่ากับ 171,000 บาท, 167,000 บาท และ 73,000 บาท ตามลำดับ ทั้งนี้หากทำให้เพศหญิงซึ่งดื่มแบบอันตรายมากเลิกดื่มได้ที่อายุ 30, 35, และ 40 ปี ต้นทุนที่ป้องกันได้จะมีมูลค่าเท่ากับ 179,000บาท, 164,000 บาท, และ 60,000 บาทตามลำดับ

จากผลการศึกษาแสดงให้เห็นว่าค่าความสูญเสียจากการดื่มแอลกอฮอล์มีมูลค่าสูง ทั้งนี้มาตรการหรือนโยบายใดที่เน้นไปที่การลดอุบัติการณ์ของนักดื่มหน้าใหม่ ตลอดจนการทำให้ผู้ดื่มรายใหม่เลิกดื่มได้ตั้งแต่อายุยังน้อยจัดเป็นมาตรการหรือนโยบายที่ควรให้ความสำคัญ

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(A-Z)

APC	Alcohol Per Capita
AUDIT	Alcohol Use Disorders Identification Test
BOD	Burden of Disease Project
CHD	Coronary Heart Disease
DALYs	Disability-Adjusted Life Years
GDP	Gross Domestic Product
NHES	National Health Examination Survey
P	Probability
PPP	Purchasing Power Parity
RR	Relative Risk
UK	United Kingdom
US	United State
WHO	World Health Organization
YLD	Years Lost due to Disability
YLL	Years of Life Lost

CHAPTER I
INTRODUCTION

Alcohol is a major avoidable cause of morbidity and mortality worldwide. It is a causal factor of more than 60 diseases and injuries. (1) The major diseases caused by alcohol include neuropsychiatric disorders, gastrointestinal disorders, cancer, intentional injuries, unintentional injuries, cardiovascular diseases, fetal alcohol syndrome and pre-term birth complications, and diabetes mellitus. A recent World Health Organization (WHO) report on Global Health Risks (1) indicated that alcohol was the 3rd leading risk factors contributed to burden of diseases as measured in term of disability-adjusted life years (DALYs). It was also found that alcohol was attributable to about 4.4 % of global DALYs loss while accounted for about 3.6% of all global deaths. (1) This burden was closely related to average volume of alcohol consumption, and was strongest in the poor people and those who are marginalized from the society. (2)

Alcohol drinking leads to substantial negative economic consequences. According to the recent systematic review, the economic burden of alcohol in the 12 countries was found to be substantial, ranging from 0.45 to 5.44% of Gross Domestic Product (GDP). (3)According to the review, indirect costs represented for the largest proportion of the total costs in several studies, accounted for 23% to 96% of the total cost. (3) For the components of indirect cost, the cost associated with premature mortality played the largest part in contributing to the total indirect costs, followed by the costs of reduced productivity. (3)

In Thailand 2006, the economic cost of alcohol consumption was estimated at 156 billion baht. This was equal to 1.99% Gross Domestic Product (GDP) or approximately 2,391 baht per capita. (4) The largest economic burden attributable to alcohol consumption is productivity loss due to premature mortality and morbidity (95.8% of the total cost) followed by the health care costs (3.5%), cost of property

damage due to road traffic accidents (0.5%), and costs associated with law enforcement (0.2%), respectively (4).

According to the WHO report, per capita consumption of alcohol beverage (APC) among Thai population was estimated at 7.08 liters (5).The Thai National Health Examination Survey (NHES) IV conducted during 2008-2009 reported that the average alcohol consumption in male and female was about 29.5 and 6.2 gram per day, respectively. (6) According to the survey, 24.3 % of all Thai population aged over 15 years were responsible drinker while 2.8% and 4.4% were classified as hazardous and harmful drinkers, respectively. (6) In Thailand, alcohol was ranked the 4thand the 1st leading cause of DALY loss among male in 2004 (7) and 2009 (8), respectively. Furthermore, the increasing trend of burden from alcohol was clearly observed in Thailand. (7)

Estimating the economic impact of alcohol consumption is essential as it can provide important evidence in supporting policies to reduce alcohol-related harm. Currently, two approaches, namely the prevalence and incidence-based have been widely used in estimating economic cost of several diseases including alcohol. These two approaches are used to address different research questions. The incidence approach estimates the costs and consequences associated with new drinkers in the current and future years, while the prevalence approach estimates costs associated with past and current use in a given year. As the result, the prevalence approach may be useful for government budgeting purpose, while the incidence approach is more relevant for measuring the impact of alcohol policy.

According to our knowledge, no previous study was conducted to estimate the economic cost of alcohol using incidence-based approach before. According to the previous review (3) and recent study conducted in Thailand (4), indirect cost represented the largest proportion of the total economic cost of alcohol. Therefore, this study aims to estimate lifetime indirect cost for each drinking category as well as the cost saving associated with drinking cessation at varying drinking category and age, using incidence-based approach among Thai population. Indirect cost estimated in the study is composed of cost of productivity loss due to reduced productivity and premature mortality.

Objectives

The objectives of this study are

1) to estimate lifetime indirect cost as well as life expectancy of Thai drinker according to the drinking category (i.e. responsible drinker, hazardous drinker, harmful drinker) ; and

2) to estimate life expectancy as well as the cost saving associated with drinking cessation according to the drinking category and age at stop drinking (i.e. the age of 25, 35, and 45 in males and 30, 35, and 45 in females).

Expected benefits and applications

The finding of this study is particularly useful to draw public's awareness of the negative economic burden of alcohol and to facilitate the formulation of alcohol-related policies or interventions aimed at improving drinking cessation and reducing alcohol drinking uptake. Moreover, this study could also provide the essential information to conduct the cost-benefit analysis of alcohol intervention/policy in Thailand.

Definition of terms

Disability Adjusted Life Year (DALY)

DALY is calculated as the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for incident cases of the health condition. One DALY can be thought of as one lost year of healthy life.

Absenteeism

Absenteeism is can be described as the number of days missed from the workplace.

Presenteeism

Presenteeism illustrates the situation that employee cannot work as effective as his/her optimal condition because of the negative health condition(s). The impact of presenteeism including time not on task, lessen work quality and quantity, inadequate interpersonal relationship and work culture**.**

Reduced productivity

In this study, reduced productivity comprised the productivity loss due to absenteeism and presenteeism.

CHAPTER II
LITERATURE REVIEW

Literature review was performed in the following topics:

1. Prevalence of alcohol drinking
2. Conceptual model of alcohol consumption and health consequences
3. Impact of alcohol drinking on productivity loss
    - 3.1 Impact of alcohol drinking on mortality
    - 3.2 Impact of alcohol drinking on reduced productivity
4. Alcohol cessation and relapsing behavior

Prevalence of alcohol drinking

According to the WHO global health risks report in 2009(1), alcohol was ranked as the 8thleading risk for mortality in the world. In addition, it was ranked as the 3rd leading cause of global burden when measured in term of DALY (1).

Alcohol drinking can be classified into four different categories according to the average consumption of pure alcohol, measured in grams per day. These four groups are abstainers (no alcohol within last year), responsible drinking (women 0-19.9 g/day, men 0-39.9 g/day), hazardous drinking (women 20.0-39.9 g/day, men 40.0-59.9 g/day), and harmful drinking (women >40.0 g/day, men >60.0 g/day), as shown in table 2.1 (9).

Table 2.1 Classification of alcohol drinking category by volume of alcohol consumption

Classification	**Alcohol per day (grams)**	
	Male	**Female**
Abstainer*	0	0
Responsible	> 0 and < 40	> 0 and < 20
Hazardous	≥ 40 and <60	≥ 20 and <40
Harmful	≥ 60	≥ 40

*Abstainer is person who did not drink in the past 12 months.

According to the National Household Survey for Substance and Alcohol Use 2007(10), about 63% of Thais aged 12–65 years were abstainers (men - 40.9% and women - 81.5%). The prevalence of current drinkers (defined as individuals who drank at least 10 g of alcohol during 12 months before the survey) was 28.6% (men - 48.4% and women - 12.7%). Based on the Alcohol Use Disorders Identification Test (AUDIT) score, 6.7% of the Thai population could be classified as hazardous drinkers, 0.9% as harmful drinkers and 0.6% as probable alcohol dependents. The median drinking intensity was 50.8 g in men and 25.4 g in women.

According to the National Health Examination Survey (NHES) IV conducted during 2008-2009 about 54.9 % and 12.4 % of Thai male and female aged over 15 years old were classified as drinkers.(6)Average alcohol consumption in male and female was about 29.5 and 6.2 gram per day, respectively. Age at start drinking was 19 years in male and 26.3 years in female. According to the survey, 24.3 % were responsible drinker while 2.8% and 4.4% were classified as hazardous and harmful drinkers, respectively. Prevalence of alcohol drinkers among Thai population by age, gender and drinking category in 2008-2009(6) are shown in Table 2.2.

Table 2.2 Prevalence of alcohol drinkers among Thai by age, gender and drinking category in 2008-2009

Age (year)	Abstainer		Responsible		Harmful		Hazardous	
	Male	Female	Male	Female	Male	Female	Male	Female
15-29	40	86.6	41.4	10.2	6.6	0.6	10.5	1.4
30-44	34.5	86.6	48.5	10.8	5.4	0.9	6.5	1.1
45-59	48.5	87.1	38.1	10.2	4.9	0.7	6.8	0.8
60-69	65.4	91.3	26.3	4.5	1.6	0.5	2.8	0.5
70-79	74.2	92.9	18.9	2.9	1.3	0.5	1.3	0.3
80+	8.5	91.1	12	4.4	0.2	0	1.9	0.4
Total	45.1	87.6	40	9.4	5.0	0.7	8.1	0.9

According to the survey, more than 85% and 98% of male and female population were in abstainers and responsible drinking group. The prevalence of drinking was inversely associated with age. Prevalence of abstainer in female was higher in that of male in each age category. Similarly, in all age groups, female had lower prevalence alcohol drinking, as compared to male.

Prevalence of binge drinking estimated from the NHES IV was found to be 31.5% in male and 4.4% in female, respectively. According to the survey, average number of binge drinking per year in male was 28.1 days while it was 18.3 days in female. (6)

Conceptual model of alcohol consumption and health consequences

The conceptual model for the consequences of alcohol on morbidity and mortality were divided to 2 dimensions of alcohol consumption: overall total volume of consumption, and pattern of drinking. Volume of drinking can be measured as the total absolute alcohol consumed over a time-period, such as 1 year. Pattern of drinking was defined using indicators of high-volume drinking occasions and types of drinking situation (e.g. drinking with meals, heavy drinking occasion or “Binge drinking”, and

drinking in public place). Pattern of drinking has often been linked to two main categories of disease outcome, injuries (both unintentional and intentional) and cardiovascular risk.

The net effect of alcohol on cardiovascular diseases may be protective in the region where alcohol is lightly to moderate in a regular fashion rather than binge drinking. (11-12) Evidence from a meta-analysis also indicated that drinking pattern modify the risk of coronary heart disease. (13) Furthermore, it was found that the frequency of binge drinking occasions seems to be a better predictor of alcohol-related social problems than volume. (14) Joint association of average heavy consumption and binge drinking was also found to be significantly increasing the risk of traffic crashes. (15)

Impact of alcohol drinking on productivity loss

Productivity loss due to alcohol can be classified into 2 types; mortality-related productivity loss or productivity loss due to premature mortality and reduced productivity due to absenteeism and presenteeism.

According to the review, cost of productivity loss represented for the largest proportion of the total costs in 16 of the total 22 studies, accounted for 23% to 96% of the total cost. (3) For the components of the cost of productivity loss, the cost associated with premature mortality played the largest part in contributing to the total indirect costs followed by the costs of reduced productivity. (3)

According to the previous study in Thailand, the largest cost attributable to alcohol consumption was that of productivity loss due to premature mortality (104,128 million baht/6,422 million US$ PPP), followed by cost of productivity loss due to reduced productivity (45,464.6 million baht/2,804 million US$ PPP). (4)

1 Impact of alcohol drinking on mortality

According to the recent WHO report, alcohol is attributable to about 3.6% of all global deaths. (1) In Thailand, it was estimated that there were 39,460 premature deaths, or approximately 1.39 million potential life years lost, due to alcohol in 2006, Thailand. (4)

According to the review, relationship between alcohol and mortality has been illustrated as a J-shaped curve, attributable to its combination of beneficial and harmful effect (16-19). In other word, non-drinkers have higher mortality risk than moderate drinkers, and heaviest drinkers have the highest risk. J-shaped curve explains the protective effect of alcohol consumption on coronary heart disease and all causes mortality in light to moderate drinkers, and negative effect in heavier drinkers. However, the biological effective dose of alcohol on mortality in women is approximately 2 standard drinks per day less than in men. (16) Women are more exposed than men to death for cause at moderate to high levels of alcohol consumption. (20) Experimental evidence indicated that when men and women consume the same amount of alcohol, women experience higher blood alcohol concentration. This is probably due to the fact that women metabolize ethanol differently and have a lower gastric alcohol dehydrogenase activity, resulting in higher blood ethanol levels. (21)

The meta-analysis of 16 cohort studies (16) (mostly of adults over 35 years) indicated that the relative risks of mortality were 0.93 (0.93-0.94) in responsible drinkers, 1.24 (1.22-1.27) in hazardous drinkers, 1.37 (1.35-1.49) in harmful drinkers, as shown in table 2.3.

Table 2.3 Relative risks of mortality by drinking category (16)

Drinking category	**Relative risk (95% confidential interval**
Abstainer	1 (baseline)
Responsible	0.93(0.93-0.94)
Hazardous	1.24 (1.22-1.27)
Harmful	1.37(1.35-1.49)

A meta-analysis of 34 prospective studies (17) indicated that consumption of alcohol up to 4 drinks per day in men and 2 drinks per day in female was inversely associated with total mortality. The maximum protection of drinking was 17 % in male

(99% confidence interval, 15-19%) and 18% in female (99% confidence interval, 13-22%). Higher doses of alcohol were associated with increased mortality. The dose-response in J-shaped curves are similar for both genders with low alcohol intake, but they differ when alcohol intake is heavier. In fact, the inverse associations in females disappear at doses lower than in male.

Systematic review conducted in the UK 1997 (19) found that the level of alcohol consumption that carries the lowest mortality ranges from 0 in men and women aged under 35 to 3 units a week in women aged over 65 and 8 units a week in men aged over 65. Substantially increased risks of all causes mortality can occur even in people drinking lower than recommended limits, and especially among younger people.

Most studies to date, however, have limitations (22-24). A major drawback is that limited information has been collected regarding the complex issue of alcohol consumption. In many studies, ascertainment of alcohol consumption frequently focused only on quantity of alcohol consumed without considering the many different components of alcohol consumption, particularly drinking pattern (22). Problems regarding residual confounding (25), selection bias (22, 24, 26-27), and choice of reference groups (23-24) should also be noted. Concerning the selection bias, it was found that abstention may be a specific risk factor for all-cause mortality, which partly explained the J-curve relationship between alcohol consumption and mortality. Regarding the choice of reference group, Shaper et al (23-24), argued that the appearance of a cardioprotective effect could be mainly due to the “sick quitter effect”, that is the fact that some people stop drinking for health reasons and thus artificially inflate the risk of CHD among abstainers. As the result, separate former drinkers from the references category should be done to obtain unbiased effect estimates.

2 Impact of alcohol drinking on reduced productivity

Concerning impact of alcohol drinking on reduced productivity, alcohol consumption can affect both the amount of time worked (through absenteeism) and the productivity of workers while at work by making them less quality-conscious and more mistake-prone (presenteeism).

Empirical evidences from various countries consistently revealed that alcohol has substantial negative impact on productivity among workers. A study in Sweden found that 1 liter increase in total consumption was associated with a 13% increase in sickness absences among men. (28) On the other hand, frequently cited US figure estimated that a 25% reduction in work performance were found among heavy alcohol users.(29) In UK, 10% of male reported hangover-related problem at work at least once a month. (30) In the Netherlands, it is estimated that 1% of employee expressed problem at work as a result of excessive alcohol consumption with the overall impairment rate of 20%.(31) In Australia, it was found that harmful alcohol consumption are about 1.2 times more likely to be absent than other drinkers and those who were not drink. (32) By using self-reported measures absenteeism due to alcohol use, recent study (33) found that higher risk drinkers were up to 22 times more likely to be absent from work due to alcohol use compared to low-risk drinker.

Workday loss associated with alcohol drinking is considerable. In Scotland, it was found that 1,164,344 sick days per annum would be lost from the work place in Scotland due to alcohol dependency. (34) In the UK, It was found that in 2001, nearly 11 million (10,988,096) days were lost in England among alcohol dependent employees. (35)In Australia 2001, The use of self-reported measures of illness or injury absenteeism to determine the extent of absenteeism attributable to alcohol use resulted in an estimate of 7,402,341 work days lost. (36)

In Thailand, recent study found that the percentages of overall impairment (from both absenteeism and presenteeism) among former drinkers, responsible drinkers, and harmful drinkers was 5.6%, 1.7%, and 5.7%, respectively, were significantly higher than that of the abstainer, as shown in table 2.4. However, it should be noted that no information on the productivity loss according to the duration of drinking existed.

Table 2.4 Percent of overall impairment in each alcohol drinking category (4)

Drinking category	Percent of overall impairment (95% confidential interval)
Abstainer	7.6 (6.7-8.5)
Responsible	9.3* (8.6-10.1)
Hazardous	8.4 (6.1-10.6)
Harmful	13.3* (10.7-15.9)

* Significantly difference from abstainers

Alcohol cessation and Alcohol relapsing behavior

Continued heavy drinking causes the development of dependence that is associated with a withdrawal syndrome when alcohol consumption is substantially reduced. This syndrome comprises physical signs as well as psychological symptoms that contribute to distress and psychological discomfort. For some people the fear of withdrawal symptoms may help perpetuate alcohol abuse. In the other hand, the presence of withdrawal symptoms may contribute to relapse after periods of abstinence**.** Many evidences demonstrated that nicotine, heroin, and alcohol produced highly similar rates (approximately 70-80 %) of relapse over 1-year period (37, 38).

According to the review, prevalence of cessation attempts and success attempt among drinkers are unknown. Furthermore, no previous data on the prevalence of relapse among drinkers who had attempted cessation exists.

CHAPTER III
METHODOLOGY

This chapter consisted of

1. Study design
2. Perspective
3. Target population
4. Approach
    - 4.1 Model structure
    - 4.2 Model assumption
5. Time Horizon
6. Data material/ sources of data
    - 6.1 Transitional probability of health state
    - 6.2 Cost variables
7. Discounting rate
8. Sensitivity analysis

Study design

This cost of illness study was performed to estimate lifetime indirect cost of new alcohol drinkers as well as the cost saving associated with drinking cessation at varying drinking category and age, using incidence-based approach. Indirect costs estimated from this study include cost of productivity loss due to absenteeism and presenteeism, and cost of premature mortality.

Perspective

The research was conducted based on societal perspective.

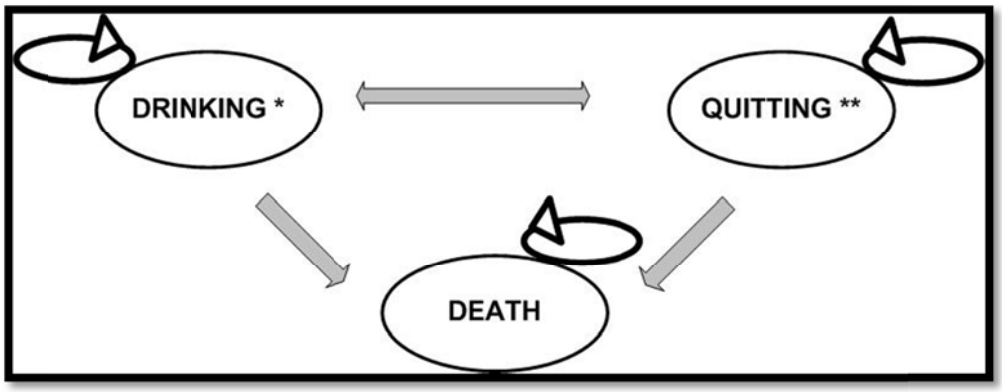
Target population

This study focused on Thai population classified by gender. From Thailand annual report on alcohol 2008-2009 (6), the average ages of new drinker in Thai male and female were 19 and 26 years old, respectively. Therefore, in this study, the hypothetical cohort of Thai males aged 19 and females aged 26 years were entered into the model and were followed up for the next 99 years. To find the impact of making drinker quit on life expectancy and economic, ages at stop drinking were assumed as follows; 25, 35, and 45 in males and 30, 35, and 45 in females.

Approach

1 Model structure

Figure 3.1 shows the Markov model structure, which was used to estimate life time cost of alcohol drinker in this study. The following 3 health states were included in the model: drinking, quitting, and death. Drinking states were further defined by average volume of consumption, grams of pure alcohol consumption per day as followed, responsible drinking (women 0-19.9 g/day, men 0-39.9 g/day), hazardous drinking (women 20.0-39.9 g/day, men 40.0-59.9 g/day), and harmful drinking (women >40.0 g/day, men >60.0 g/day). Each drinking category was analyzed separately. Possible transitions between the states are shown by the arrows in figure 3.1. According to the model, every drinking state has natural remission which means cessation of alcohol occurred without any intervention. Every health states has probability of moving to death state which is an absorbing state (population who transit to this state cannot escape from it). A one-year cycle length was chosen.



***Drinking**

Drinking category was classified according to the average volume of grams of alcohol consumption per day in to responsible, hazardous, and harmful. Each drinking category was analyzed separately

****Quitting**

To study the effect of drinking cessation, probability of quitting and relapsing were set at 1 and 0, respectively. Impacts of drinking cessation at age of 25, 35, and 45 in males and 30, 35, and 45 in females were examined

Figure 3.1 A markov model

2 Model assumptions

These following assumptions were applied in the study;

1. Changing across three drinking health states (responsible, hazardous, and harmful drinking) was not allowed.

2. As no previous information available, relative risk associated with death among quitter was equal to that of non-drinker. This assumption was used for all drinking categories and duration of drinking.

3. Percentage of increase productivity loss among hazardous drinker was equal to 1.7 (if drinking duration< 10 years), 8 (if drinking duration = 10- 19 years) and 17.6 (if drinking duration ≥20 years), as shown in figure 3.2.

According to the previous Thai study (4), as shown in table 2.4, non significant difference on productivity loss between hazardous drinkers and abstainers was found due to the fact that inadequate sample size among hazardous drinker were examined. As the result, in the case that duration of drinking was less than 10 year, percentage of increase productivity loss among hazardous drinker was assumed to be 1.7, which was similar to that of responsible drinker. However, in the case that duration of drinking was longer than 20 year, it was assumed to be equal to 17.6,

which was the productivity loss among drinkers who currently had health problems according to the previous study. (4) Lastly, in the case that duration of drinking was between 10 to 20 years, it was assumed to be equal to 8, which was about the middle point between productivity loss if drinking less than 10 years and longer than 20 years.

4. Percentage of increase productivity loss among harmful drinker was equal to 9.95 (if drinking duration = 10- 19 years) and17.6 (if drinking duration ≥20 years), as shown in figure 3.2.

According to the previous study (4), productivity loss among harmful drinker was about 5.7%. No information on the productivity loss according to the duration of drinking existed. In this study, we then assumed that the productivity loss in the case that duration of drinking was longer than 20 year was equal to 17.6, which was the productivity loss among drinkers who currently had health problems according to the previous study. (4) Lastly, in the case that duration of drinking was between 10 to 20 years, it was assumed to be equal to 9.95, which was about the middle point between productivity loss if drinking less than 10 years and longer than 20 years.

5. Among responsible drinkers, if quit drinking within 10 years or less we assumed that there was no increase in productivity loss. However, if quit after drinking for 10-19 years or ≥ 20 years percentage of increase productivity is 0.5 and 1, respectively. This assumption was displayed in figure 3.3.

6. Among hazardous drinkers, if quit drinking within 10 years or less percentage increase in productivity loss was assumed to be 1%, as shown in figure 3.3. However, if quit after drinking for 10-19 years or ≥ 20 years percentage of increase productivity was equal 8 and 17.6, respectively. These figures were similar to the situations that the drinker continued to drink during such period of time.

7. Among harmful drinkers, if quit drinking within 10 years or less percentage increase in productivity loss was assumed to be 2.3%. However, if quit after drinking for ≥ 20 years percentage of increase productivity is 17.6, which was equal to the productivity loss among drinkers who currently had health problems according to the previous study. (4) Lastly, in the case that duration of drinking was between 10 to 20 years, it was assumed to be equal to 9.95, which was similar to the situation that the drinker continued to drink during such period of time.

Drinking category	Duration of drinking (year) 10	20
Responsible	1.7	1.7	1.7
Hazardous	1.7*	8*	17.6*
Harmful	5.7	9.95*	17.6*

Thavorncharoensap et al.(4)

*assumption

Figure 3.2 Percentage of increase productivity loss among current drinkers according to drinking category and duration of drinking

Drinking category	Duration of drinking before quitting (year) 10	20
Responsible	0*	0.5*	1.0*
Hazardous	1*	8*	17.6*
Harmful	2.3*	9.95*	17.6*

*assumption

Figure 3.3 Percentage of increase productivity loss among quitters according to drinking category and duration of drinking

Time horizon

99-years period were used to cover lifetime horizon.

Data material/ sources of data

1 Transitional probability of health state

The transitional probability of health state includes probability of death among each drinking category, probability of alcohol quitting and probability of alcohol relapsing.

Probability of death in each drinking category were calculated from probability of death among general Thai population(39) and relative risks (RRs) of mortality among drinkers given the difference in drinking patterns i.e. responsible, hazardous and harmful levels. Probability of death among general Thai population by age and gender was displayed in Appendix A.

To calculate the probability of death among abstainers, the following formula was used;

P (event | abstainer) = P (event) / (1-P (drinker) + RR * P (drinker))

Where;

P (event | abstainer)	= probability of death in abstainer
P (event)	= probability of death in general population including abstainer and drinker
P (drinker)	=average probability of every alcohol drinking categories
RR	=average relative risk of mortality of every drinking categories

As no Thai-specific information available, the mortality risks associated with each drinking pattern were derived from meta-analysis.(16) RRs among responsible drinkers, hazardous drinkers, harmful drinkers were 0.93 1.24 and 1.37, respectively. (16)

As no current information available, the probabilities of stop drinking and relapsing were derived from one recent Thai survey. (40) The probabilities of stop drinking in males and females were 0.56 and 0.70, respectively while the probabilities of getting back to drink again among those stopped drinking were 0.66 for males and 0.47 for females, respectively. (40) Summary of parameters used in the model was displayed in table 3.1, figure 3.2 and 3.3

Table 3.1 Summary of parameters and sources of information

Data	Gender		References
	Male	Female	
1. Mortality rate of general Thai population in 2004	Appendix A		BOD(39)
2. Relative risk of mortality in responsible drinker	0.93		Holman C.D. et al(16)
3. Relative risk of mortality in hazardous drinker	1.24		Holman C.D. et al(16)
4. Relative risk of mortality in harmful drinker	1.37		Holman C.D. et al(16)
5. Probability of alcohol quitting	0.56	0.70	Leelahavarong et al(40)
6. Probability of relapsing among quitter	0.66	0.47	Leelahavarong et al(40)
7. Percentage of increase productivity loss among responsible drinker (at drinking duration< 10 years, 10 -19 years, and ≥20 years)	1.7		Thavorncharoensap et al(4)
8. Percentage of increase productivity loss among hazardous drinker (at drinking duration < 10 years, 10 -19 years, and ≥20 years)	1.7, 8, 17.6		Assumption
9. Percentage of increase productivity loss among harmful drinker (at drinking duration <10 years)	5.7		Thavorncharoensap et al(4)
10. Percentage of increase productivity loss among harmful drinker (at drinking duration 10 -19 years, and ≥20 years)	9.95, 17.6		Assumption

Table 3.1 Parameters and sources of information (continue)

Data	Gender		References
	Male	Female	
11. Percentage of increase productivity loss among ex- responsible drinker (after quitting for< 10 years, 10 -19 years and ≥20 years)	0, 0.5, 1		Assumption
12. Percentage of increase productivity loss among ex- hazardous drinker (after quitting for< 10 years, 10 -19 years)	1, 8		Assumption
13. Percentage of increase productivity loss among ex- harmful drinker (after quitting for< 10 years, 10 -19 years)	2.3, 9.95		Assumption
14. Percentage of increase productivity loss among ex- hazardous, or ex-harmful drinker (after quitting for≥20 years)	17.6		Assumption

2 Cost

These variables consisted of the percentages of productivity loss in each alcohol drinking category and premature mortality cost.

In this study, human capital method was applied to calculate the premature mortality cost. This outcome was calculated as the summation of workforce participation rate, by age and gender, multiply by the average wage each person per year would receive if he or she lived through his or her lifespan. These data was derived from National Economic and Social Survey 2009 by National Statistic Office using, as shown in table 3.2.

Table 3.2 Average income per year and work force participation rate by age and gender

Age (years)	Annual income (Baht)		Work force participation rate (percent)	
	Male	Female	Male	Female
15 – 29	70,933	78,144	69.3	54
30 – 44	106,252	103,190	96.5	85
45 - 59	153,767	142,193	93.7	76
60 - 69	107,745	51,485	68.1	43
70 - 79	87,989	29,069	35.2	17
80 +	135,664	32,036	12.5	4

Discounting rate

As the time horizon was longer than 1 year, the future costs were discounted at 3% per annum. The base year in this study is 2010. The formula is show below

$$\text{Present value} = \frac{\text{Future value}}{(1+\text{Discounting rate})^{t}}$$

Where;

t = term in number of period.

Sensitivity analysis

One-way sensitivity analysis was used to test the robustness of the model. The following parameters were examined; discounting rate, age of drinker, probability of quitting and relapsing, and relative risk associated with mortality, as shown in table 3.3. In summary, the maximum and minimum values for this univariate sensitivity analysis were relied on each parameter's characters. For the probability of quitting and

relapsing, changing +/- 10% from baseline value was explored. Regarding the relative risks, their upper & lower bound of 95% confidential intervals were tested. For average age of new drinker, 1 year increase of age from baseline was examined. Regarding discount rate, effects of using discount rate at 0% and 6% were explored.

Table 3.3 Sensitivity analysis

Variables
1.Discounting rate
None
3% (Base case)
6%
2. Average age of new drinker in male and female
No examine lower bound due to the limitation of the model.
19 years old and 26 years old (Base case)
20 years old and 27 years old
3. Probability of alcohol quitting in male and female
0.50 and 0.63
0.56 and 0.70 (Base case)
0.62 and 0.77
4. Probability of alcohol relapsing in male and female
0.59 and 0.42
0.66 and 0.47 (Base case)
0.73 and 0.52
5. Relative risk of mortality (Use 95% confidential interval except*)
5.1 Relative risk of mortality in responsible drinker
0.90*
0.93 (Base case)
0.96*
5.2 Relative risk of mortality in hazardous drinker
1.22
1.24 (Base case)
1.27
5.3 Relative risk of mortality in harmful drinker
1.35
1.37 (Base case)
1.49

CHAPTER IV
RESULTS

The results of this study were divided into 3 parts:

Part I Life expectancy and life year loss of Thai drinkers.

Part II Lifetime cost of Thai drinkers and lifetime cost-saving.

Part III Sensitivity analysis.

Part I: Life expectancy and life year loss of Thai drinkers

The results indicated that life expectancy of a Thai male who was non-drinker, responsible, hazardous and harmful drinker was 69.83, 70.42, 67.95, and 67.02 years, respectively. In other word, life year losses among responsible, hazardous, and harmful drinker male were about -0.59, 1.87, and 2.81 years, respectively. Similarly, life expectancy of a Thai woman who was non-drinker, responsible, hazardous, and harmful drinker was 76.91, 77.24, 75.85 and 75.32 years, respectively. In other word, life year losses among responsible, hazardous, and harmful drinker female were about -0.33, 1.06, and 1.59 years, respectively.

When looking at the impact of drinking cessation in male, as compared to non-drinker, it was found that life-year losses of male with responsible drinking who stopped drinking at the age of 25, 35, and 45 years were about -0.04, -0.15, and -0.22 years, respectively. On the other hand, life-year losses of male with hazardous drinking who stopped drinking at the age of 25, 35, and 45 years were about 0.15, 0.51, and 0.74 years, respectively. For male with harmful drinking, life-year losses of male who stopped drinking at the age of 25, 35, and 45 years were about 0.23, 0.78, 1.14 years, respectively.

Similarly to male counterpart, life-year losses of female with responsible drinking who stopped drinking at the age of 30, 35, and 45 years were about-0.02, -0.03, and -0.06 years, respectively. For hazardous drinker, life-year losses of female

who stopped drinking at the age of 30, 35, and 45 years were about 0.06, 0.11, 0.20 years, respectively. Life-year losses of female with harmful drinking who stopped drinking at the age of 30, 35, and 45 years were about 0.10, 0.17, 0.31 years, respectively. The results are displayed in table 4.1, figure 4.1 and figure 4.2.

Table 4.1 Life expectancy and life year loss of drinker compared with non-drinker, by drinking category and gender

Population	Life expectancy (years)		Life year loss (years)	
	Male	Female	Male	Female
Non-drinker	69.83	76.91	0	0
Responsible drinker				
Lifetime drinking	70.42	77.24	-0.59	-0.33
Stop at age 25 years in male / 30 years in female	69.87	76.93	-0.04	-0.02
Stop at age 35 years	69.98	76.94	-0.15	-0.03
Stop at age 45 years	70.05	76.97	-0.22	-0.06
Hazardous drinker				
Lifetime drinking	67.95	75.85	1.87	1.06
Stop at age 25 years in male / 30 years in female	69.68	76.84	0.15	0.06
Stop at age 35 years	69.32	76.80	0.51	0.11
Stop at age 45 years	69.09	76.71	0.74	0.20
Harmful drinker				
Lifetime drinking	67.02	75.32	2.81	1.59
Stop at age 25 years in male / 30 years in female	69.60	76.81	0.23	0.10
Stop at age 35 years	69.05	76.73	0.78	0.17
Stop at age 45 years	68.69	76.60	1.14	0.31

Figure 4.1 Life year loss of male drinker compared with non-drinker, by age of quitting and drinking category

Figure 4.2 Life year loss of female drinker compared with non-drinker, by age of quitting and drinking category

Part II: Lifetime cost of Thai drinkers and lifetime cost-saving

The lifetime indirect costs of alcohol drinking and total cost-saving from making drinker quit at different age, classified by gender and drinking category are displayed in table 4.2 figure 4.3 and figure 4.4.

Our findings indicated that lifetime indirect cost of one new responsible drinking male was equivalent to 24,297 baht. For one new hazardous male drinker and one new harmful drinking male, the costs were estimated at 293,140 baht and 338,472 baht, respectively. Similarly, lifetime indirect cost of Thai female who was responsible, hazardous and harmful drinker, was estimated at 29,180 baht, 194,066 baht and 232,486 baht, respectively.

When considered the lifetime cost of drinker who stopped drinking at different age, the result showed that lifetime costs of a responsible male drinker who stopped drinking at the age of 25, 35, and 45 years were 2,709 baht, 14,347 baht and 22,182 baht, respectively. Whereas, lifetime costs of a hazardous male drinker who stopped drinking at the age of 25, 35, and 45 years were about 29,781 baht, 167,028 baht and 283,491 baht, respectively. For last drinking category, lifetime costs of a male harmful drinker who stopped drinking at the age of 25, 35, and 45 years were 68,313 baht, 226,709 baht and 323,960 baht, respectively.

Similarly, lifetime costs of a responsible female drinker who stopped at age of 30, 35 and 45 years were 2,730 baht, 8,406 baht and 21,307 baht, respectively. It was found that lifetime costs of a female with hazardous drinking who stopped drink at age of 30,35 and 45 years were estimated at 22,668 baht, 26,866 baht and 121,220 baht, respectively. For harmful drinking, lifetime cost of a female who stopped drinking at age of 30, 35 and 40 were 53,870 baht 68,691 baht 172,610 baht, respectively.

In terms of the cost savings from making drinkers quit, the costs saved in the event that one responsible drinking male is able to quit drinking at the age of 25 years, 35 years and 45 years was found to be 21,588 baht, 9,950 baht and 2,115 baht, respectively. The costs saved in the event that one responsible drinking female is able to quit drinking at the age of 30 years, 35 years and 45 years was found to be 26,450 baht, 20,775 baht and 7,873 baht, respectively.

The costs saved in the event that one hazardous drinking male is able to quit drinking at the age of 25 years, 35 years and 45 years was found to be 263,359 baht, 126,113 baht and 9,649 baht, respectively. The costs saved in the event that one hazardous drinking female is able to quit drinking at the age of 30 years, 35 years and 45 years was found to be 171,398 baht, 167,200 baht and 72,846 baht, respectively.

The costs saved in the event that one harmful drinking male is able to quit drinking at the age of 25 years, 35 years and 45 years was found to be 270,159 baht, 111,763 baht and 14,512 baht, respectively. The costs saved in the event that one harmful drinking female is able to quit drinking at the age of 30 years, 35 years and 45 years was found to be 178,616 baht 163,794 baht 59,876 baht, respectively.

As shown, in figure 4.3-4.4, the proportion of cost related to reduced productivity accounted for the largest part of the total indirect cost for both genders and drinking category.

Table 4.2 Lifetime indirect cost, cost-saving from drinking cessation categorized by gender and drinking category

Population	Reduced productivity cost (baht)		Premature mortality cost (baht)		Lifetime cost (baht)		Total cost-saving (baht)	
	Male	Female	Male	Female	Male	Female	Male	Female
Responsible drinker								
Lifetime drinking	36,686	32,073	-12,389	-2,893	24,297	29,180	24,297	29,180
Stop at age 25 years in male / 30 years in female	4,608	3,442	-1,899	-712	2,709	2,730	21,588	26,450
Stop at age 35 years	20,628	9,610	-6,281	-1,204	14,347	8,406	9,950	20,775
Stop at age 45 years	30,939	23,232	-8,758	-1,925	22,182	21,307	2,115	7,873
Hazardous drinker								
Lifetime drinking	251,740	184,222	41,400	9,844	293,140	194,066	293,140	194,066
Stop at age 25 years in male / 30 years in female	23,284	20,229	6,497	2,439	29,781	22,668	263,359	171,398
Stop at age 35 years	145,653	22,745	21,375	4,121	167,028	26,866	126,113	167,200
Stop at age 45 years	253,801	114,638	29,690	6,582	283,491	121,220	9,649	72,846
Harmful drinker								
Lifetime drinking	275,302	217,356	63,170	15,129	338,472	232,486	338,472	232,486
Stop at age 25 years in male / 30 years in female	58,305	50,112	10,008	3,758	68,313	53,870	270,159	178,616
Stop at age 35 years	193,860	62,342	32,849	6,349	226,709	68,691	111,763	163,794
Stop at age 45 years	278,402	162,475	45,558	10,135	323,960	172,610	14,512	59,876

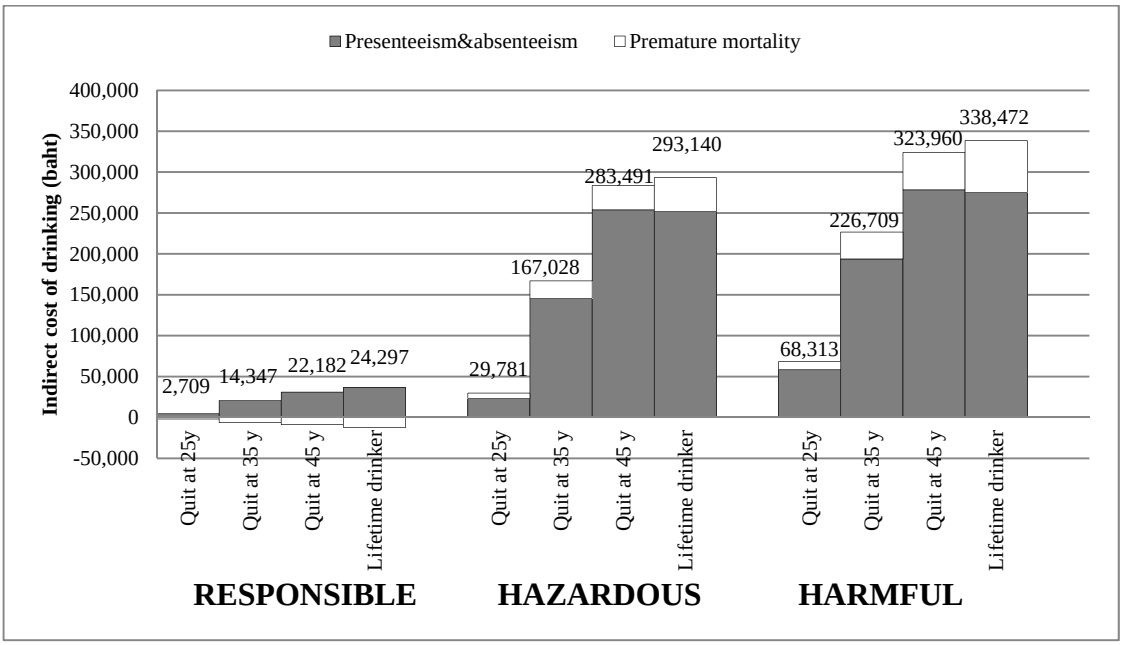


Figure 4.3 Productivity loss due to presenteeism and absenteeism, premature mortality cost, and total lifetime indirect cost of male drinkers categorized by age of quitting and drinking category

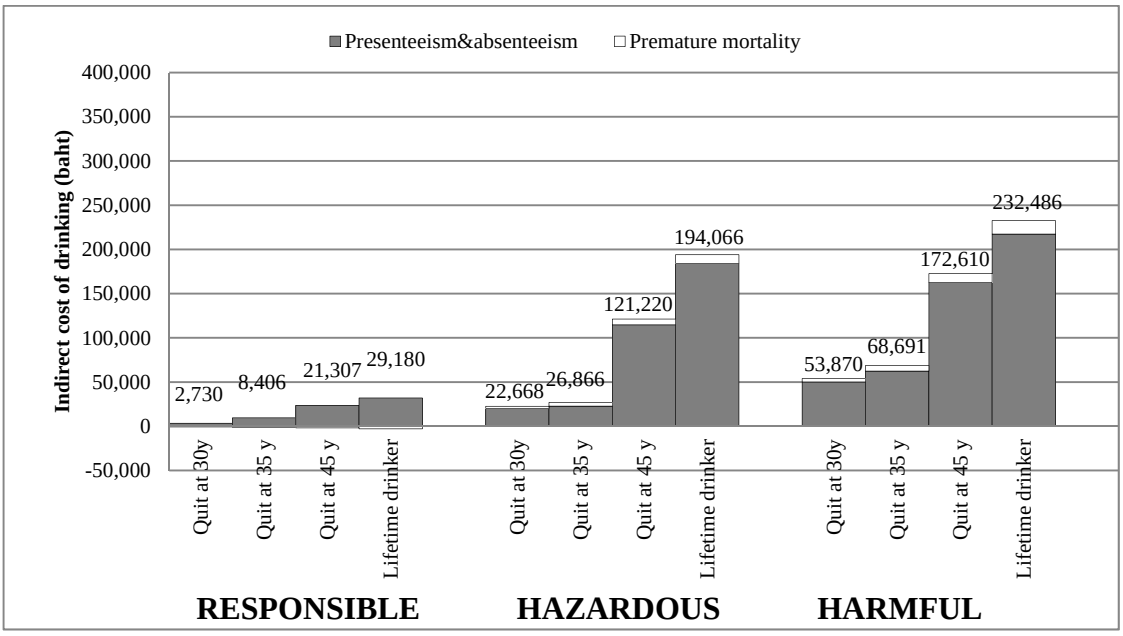


Figure 4.4 Productivity loss due to presenteeism and absenteeism, premature mortality cost, and total lifetime indirect cost of female drinkers categorized by age of quitting and drinking category

Part III: Sensitivity analysis

In this study, one-way sensitivity analysis was used to explore the uncertainty of the findings. Table 4.3 shows the summary of result of sensitivity analysis. It is indicated that the discounting rate was the most important factor affecting the result of the model in every scenario and drinking category, as shown in table 4.3. Details of the sensitivity analysis, shown in Tornado diagrams were displayed in Appendix C

Table 4.3 Summary of result of sensitivity analysis: maximum and minimum of percent of total cost changing in each drinking category and gender

Drinking category	**Gender**	**Percent of total cost changing**	
		Minimum	**Maximum**
Responsible	Male	-62.12 %[(a)]	72.82 %[(b)]
	Female	-34.30 %[(c)]	66.44 %[(d)]
Hazardous	Male	-53.65 %[(c)]	147.77 %[(d)]
	Female	-46.58 %[(c)]	103.40 %[(d)]
Harmful	Male	-51.29 %[(c)]	140.37 %[(d)]
	Female	-42.83 %[(c)]	92.91 %[(d)]

The discounting rate was the most sensitive to the model in every scenario and drinking category.

(a) percent of total cost changing of male drinker who quited at age of 25 with 0% discounting rate.

(b) percent of total cost changing of male drinker who quited at age of 45 with 0% discounting rate.

(c) percent of total cost changing of lifetime drinker with 6% discounting rate.

(d) percent of total cost changing of lifetime drinker with 0% discounting rate.

CHAPTER V
DISCUSSIONS

The findings of this study clearly confirm that the larger the amount of alcohol consumption the larger negative economic consequences and that the earlier age at stop drinking the better outcomes in term of cost-saving.

According to the study, the lifetime indirect costs of drinking in female were obviously lower than male in every drinking category and aged of quitting. In term of policy decision, the Government should not pay more attention to male group than to female group just because it seems to be the most cost effective in term of economic aspect. Other factors such as ethical issues should also be taken into account. In addition, the lower lifetime cost among female found in this study may mainly due to the fact that female has lower income and work participation rate. However, it should be noted that the opportunity cost of female in term of career opportunities, leisure time, and earns since the constraints of physics, household activities and child guidance should be taken into accounted. Nevertheless, when opportunity cost of female are adjusted based on the number of hours they spent with family activities, the result may be overestimated as family responsibilities are indirect value to society.

Although the positive effects of responsible drinking on longevity and mortality cost indicated in this study, it should be considered with cautions due to the fact that the drinking pattern was not taken into account. According to the previous studies, binge drinking or heavy irregular drinking can reduce the cardioprotective benefit of alcohol while increase the risk of death (11, 22). In Thailand, according to the average ethanol consumption per day, majority of drinkers were classified as responsible drinker. However, when looking at the drinking pattern, it was found that prevalence of binge drinking are more common, as compared to the Western population where moderate amounts of alcohol are regularly taken with meals. Moreover, the negative impact of responsible drinking may be underestimated in this

study as the main assumption used in the Markov model was that transitional state from responsible to higher drinking category was not allowed while, in fact, responsible drinking may lead to hazardous and harmful drinking.

This estimating of alcohol consumption may be underestimated due to the fact that only indirect costs were estimated, whereas, the other costs such as health care cost and other negative outcomes (i.e. drink-driving accidents, crime, and violence) as well as intangible cost, including pain and suffering were not included in the study.

Like other model-based studies, the reliable of the finding highly depended on the accuracy of epidemiological data used in the model. Firstly, in this study, pooled relative risks of mortality associated with drinking were derived from one meta-analysis study, which could not be distinguished between male and female drinkers. In fact, there were other systematic review studies examining the relative risks of death among drinkers. (17-19) In addition, there were several evidences indicated that females are at the higher risk than male counterparts given that they drink at the same level. Regarding the probability of spontaneous quit and relapse, these probabilities did not exist in the previous literatures. In this study, these probabilities were taken from a recent survey in Thailand 2011, which conducted among 7,300 Thai people from 11 provinces. However, the validity of this parameter especially over each time period need to be further examined. Similarly, as no previous information available, productivity loss due to absenteeism and presenteeism was also derived from previous study in Thailand (40) and assumptions. Since the parameters on productivity loss due to absenteeism and presenteeism were very important, as shown in the findings that the reduced productivity due to absenteeism and presenteeism accounted for the largest part of the total costs, more studies should be conducted to examine the impact of productivity loss classified by drinking category (including ex-drinker) as well as drinking duration.

In additional, it should be noted that the benefit of stop drinking may be overestimated since the model assumed that relative risk of mortality after stop drinking was equal to the relative risk of non-drinker. Other limitation was that the changing across 3 drinking states was not allowed in fact this could happen in the real situation.

CHAPTER VI
CONCLUSIONS AND RECOMMENDATIONS

The lifetime indirect cost of a Thai drinker for each drinking category was estimated in this study. Unsurprisingly, the findings from this study found that the higher amount of alcohol drinking the more negative consequences in terms of economic loss. In term of the cost savings from making drinkers quit, it was found that the faster they were able to quit, the more economic benefits society would receive.

The results indicated that economic cost of Thai male who were responsible, hazardous and harmful drinker was 24,297 baht (productivity loss was 36,686 baht and premature mortality cost was -12,389 baht), 293,140 baht (productivity loss was 251,740 baht and premature mortality cost was 41,400 baht) and 338,472 baht (productivity loss was 275,302 baht and premature mortality cost was 63,170 baht), respectively.

For female, the lifetime costs of those with responsible, hazardous and harmful drinking were 29,180 baht (productivity loss was 32,073 baht and premature mortality cost was -2,893 baht), 194,066 baht (productivity loss was 184,222 baht and premature mortality cost was 9,844 baht) and 232,486 baht (productivity loss was 217,356 baht and premature mortality cost was 15,129 baht), respectively.

On the other hand, the lifetime cost of drinking can be used to estimate the benefit of stop drinking in terms of the total cost-saving. In responsible drinking, the total saving costs if one male stopped drinking at age 25, 35 and 45 were 21,588 baht, 9,950 baht and 2,115 baht, respectively. For female, the total saving costs if 1 female stopped drinking at age 30, 35 and 45 were 26,450 baht, 20,775 baht and 7,873 baht, respectively

In hazardous drinking, the total saving costs if 1 male stopped drinking at age 25, 35 and 45 were 263,359 baht, 126,113 baht and 9,649 baht, respectively. For female, the total saving costs if 1 female stopped drinking at age 30, 35 and 45 were 171,398 baht, 167,200 baht and 72,846 baht, respectively.

In harmful drinking, the total saving costs if 1 male stopped drinking at age 25, 35 and 45 were 270,159 baht, 111,763 baht and 14,512 baht, respectively. For female, the total saving costs if 1 female stopped drinking at age 30, 35 and 45 were 178,616 baht, 163,794 baht and 59,876 baht, respectively

According to the sensitivity analysis, the model was the most sensitive to the discounting rate for both genders and every degree of drinking.

In conclusion, any policy or intervention aimed at reduce new incidence of drinkers or encourage new drinkers to quit at the early age should receive priority attention.

Recommendations for further study

1) Data on important parameters, especially relative risks of mortality associated with drinking, classified by drinking amount as well as drinking pattern as well as relative risk should be developed from Thai population for future studies.

2) Probability of quitting and relapsing should be collected from prospective trial to reduce the limitations from cross-sectional studies.

3) Productivity loss due to absenteeism and presenteeism among drinker and quitter, classified by amount of drinking as well as duration of drinking should be examined in further studies.

4) Cost-benefit analysis of alcohol interventions/policies in Thailand can be conducted using the findings from this study.

Recommendations for policy maker

The findings from this study are particularly useful for policy makers and related organizations. According to the study, substantial economic loss can be prevented from discouraging new drinkers as well as from making drinkers in every category refrain from consuming alcohol as fast as possible, especially for those engaged in hazardous and harmful drinking. As the result, any policy or intervention aimed at reducing new drinker or encouraging drinker to stop drinking at the early age should be set as priority.

The study also highlighted the significant impact of the reduced productivity on the total indirect cost. This was quite evident, even in those who were responsible drinkers. As the result, Government and related organization should raise awareness among other employers as well as support the campaigns aim to reduce alcohol consumption among workers and employee. In addition, the results of this study can be used in the campaign to draw public's awareness to the negative economic burden of alcohol.

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APPENDICES

APPENDIX A

Probability of death among general Thai population by age and gender

Age (year)	Probability of death		Age (year)	Probability of death	
	Male	Female		Male	Female
0	0.02975	0.02713	25	0.00561	0.00226
1	0.00598	0.00598	26	0.00625	0.00245
2	0.00200	0.00200	27	0.00689	0.00264
3	0.00100	0.00100	28	0.00704	0.00259
4	0.00075	0.00054	29	0.00719	0.00255
5	0.00075	0.00053	30	0.00724	0.00238
6	0.00073	0.00052	31	0.00739	0.00234
7	0.00072	0.00050	32	0.00754	0.00230
8	0.00068	0.00048	33	0.00732	0.00226
9	0.00064	0.00045	34	0.00710	0.00221
10	0.00044	0.00036	35	0.00657	0.00208
11	0.00042	0.00033	36	0.00636	0.00204
12	0.00039	0.00031	37	0.00615	0.00199
13	0.00058	0.00036	38	0.00608	0.00210
14	0.00077	0.00041	39	0.00602	0.00221
15	0.00125	0.00048	40	0.00591	0.00240
16	0.00150	0.00053	41	0.00585	0.00251
17	0.00175	0.00059	42	0.00579	0.00262
18	0.00209	0.00076	43	0.00596	0.00278
19	0.00242	0.00093	44	0.00613	0.00294
20	0.00272	0.00123	45	0.00637	0.00307
21	0.00305	0.00142	46	0.00654	0.00323
22	0.00338	0.00162	47	0.00671	0.00339
23	0.00397	0.00180	48	0.00706	0.00369
24	0.00456	0.00198	49	0.00741	0.00398

Probability of death among general Thai population by age and gender (continue)

Age (year)	Probability of death		Age (year)	Probability of death	
	Male	Female		Male	Female
50	0.00769	0.00428	75	0.05142	0.03900
51	0.00804	0.00457	76	0.05610	0.04296
52	0.00838	0.00486	77	0.06075	0.04691
53	0.00912	0.00537	78	0.06702	0.05287
54	0.00987	0.00587	79	0.07325	0.05879
55	0.01061	0.00631	80	0.07972	0.06390
56	0.01135	0.00681	81	0.08588	0.06968
57	0.01210	0.00731	82	0.09200	0.07542
58	0.01342	0.00822	83	0.09856	0.08520
59	0.01475	0.00914	84	0.10507	0.09487
60	0.01654	0.01030	85	0.09654	0.10210
61	0.01790	0.01124	86	0.10214	0.11137
62	0.01926	0.01218	87	0.10771	0.12054
63	0.02055	0.01327	88	0.11324	0.12962
64	0.02184	0.01436	89	0.11874	0.13861
65	0.02256	0.01518	90	0.14004	0.15578
66	0.02382	0.01625	91	0.15092	0.16790
67	0.02507	0.01731	92	0.16256	0.18085
68	0.02734	0.01917	93	0.17500	0.19467
69	0.02961	0.02102	94	0.18828	0.20941
70	0.03174	0.02268	95	0.20243	0.22511
71	0.03399	0.02451	96	0.21751	0.24179
72	0.03623	0.02634	97	0.23353	0.25949
73	0.04085	0.03025	98	0.25054	0.27823
74	0.04545	0.03415	99	0.26855	0.29804

APPENDIX B

Result of sensitivity analysis classified by drinking category, gender, and duration of drinking

Parameter	Value	Gender		Total indirect cost (baht)						Percent changing of total cost						Scenario
		Male	Female	Male			Female			Male			Female			
				Res*	HZ**	HM***	Res*	HZ**	HM***	Res*	HZ**	HM***	Res*	HZ**	HM***	
Discounting rate	Minimum	0		40,359	726,320	813,574	48,569	394,721	448,482	66.11	147.77	140.37	66.44	103.40	92.91	Lifetime drinker
	Base-case	3		24,297	293,140	338,472	29,180	194,066	232,486	-	-	-	-	-	-	
	Maximum	6		15,524	135,868	164,865	19,171	103,669	132,916	-36.11	-53.65	-51.29	-34.30	-46.58	-42.83	
	Minimum	0		1,026	60,604	133,973	2,507	37,992	88,055	-62.12	103.50	96.12	-8.16	67.60	63.46	Quitted at age of 25(male) / 30 (female)
	Base-case	3		2,709	29,781	68,313	2,730	22,668	53,870	-	-	-	-	-	-	
	Maximum	6		3,156	17,311	41,487	2,727	14,980	36,598	16.50	-41.87	-39.27	-0.12	-33.91	-32.06	
	Minimum	0		21,165	374,444	493,382	9,177	44,177	107,826	47.52	124.18	117.63	9.18	64.44	56.97	Quitted at age of 35
	Base-case	3		14,347	167,028	226,709	8,406	26,866	68,691	-	-	-	-	-	-	
	Maximum	6		10,574	85,494	121,009	7,496	18,038	48,166	-26.30	-48.81	-46.62	-10.83	-32.86	-29.88	
	Minimum	0		38,334	686,656	754,290	31,265	227,842	310,238	72.82	142.21	132.83	46.74	87.96	79.73	Quitted at age of 45
	Base-case	3		22,182	283,491	323,960	21,307	121,220	172,610	-	-	-	-	-	-	
	Maximum	6		14,446	133,172	160,793	15,446	70,108	105,477	-34.88	-53.02	-50.37	-27.51	-42.16	-38.89	
Average age of new drinker	Minimum	-		-	-	-	-	-	-	-	-	-	-	-	-	Lifetime drinker
	Base-case	19	26	24,297	293,140	338,472	29,180	194,066	232,486	-	-	-	-	-	-	
	Maximum	20	27	23,664	291,706	334,776	28,610	192,887	229,385	-2.60	-0.49	-1.09	-1.96	-0.61	-1.33	
	Minimum	-		-	-	-	-	-	-	-	-	-	-	-	-	Quitted at age of 25(male) / 30 (female)
	Base-case	19	26	2,709	29,781	68,313	2,730	22,668	53,870	-	-	-	-	-		
	Maximum	20	27	2,078	28,265	64,486	2,161	21,447	50,701	-23.28	-5.09	-5.60	-20.86	-5.39	-5.88	
	Minimum	-		-	-	-	-	-	-	-	-	-	-	-	-	Quitted at age of 35
	Base-case	19	26	14,347	167,028	226,709	8,406	26,866	68,691	-	-	-	-	-	-	
	Maximum	20	27	13,715	165,554	222,959	7,837	25,643	65,524	-4.40	-0.88	-1.65	-6.77	-4.55	-4.61	
	Minimum	-		-	-	-	-	-	-	-	-	-	-	-	-	Quitted at age of 45
	Base-case	19	26	22,182	283,491	323,960	21,307	121,220	172,610	-	-	-	-	-	-	
	Maximum	20	27	21,550	282,054	320,257	20,737	120,022	169,485	-2.85	-0.51	-1.14	-2.68	-0.99	-1.81	

Res*=Responsible, HZ**=Hazardous, HM***=Harmful

Result of sensitivity analysis classified by drinking category, gender, and duration of drinking (continue)

Parameter	Value	Gender		Total indirect cost (baht)						Percent changing of total cost						Scenario
		Male	Female	Male			Female			Male			Female			
				Res*	HZ**	HM***	Res*	HZ**	HM***	Res*	HZ**	HM***	Res*	HZ**	HM***	
Probability of quitting	Minimum	0.50	0.63	23,672	294,885	341,096	29,008	194,575	233,259	-2.57	0.60	0.78	-0.59	0.26	0.33	Lifetime drinker
	Base-case	0.56	0.70	24,297	293,140	338,472	29,180	194,066	232,486	-	-	-	-	-	-	
	Maximum	0.62	0.77	24,864	291,553	336,083	29,334	193,612	231,796	2.33	-0.54	-0.71	0.53	-0.23	-0.30	
	Minimum	0.50	0.63	2,619	30,084	68,772	2,694	22,792	54,059	-3.30	1.02	0.67	-1.34	0.55	0.35	Quitted at age of 25(male) / 30 (female)
	Base-case	0.56	0.70	2,709	29,781	68,313	2,730	22,668	53,870	-	-	-	-	-	-	
	Maximum	0.62	0.77	2,791	29,504	67,892	2,764	22,554	53,697	3.03	-0.93	-0.62	1.23	-0.50	-0.32	
	Minimum	0.50	0.63	14,033	168,015	228,188	8,338	27,096	69,038	-2.19	0.59	0.65	-0.81	0.85	0.50	Quitted at age of 35
	Base-case	0.56	0.70	14,347	167,028	226,709	8,406	26,866	68,691	-	-	-	-	-	-	
	Maximum	0.62	0.77	14,632	166,130	225,364	8,467	26,660	68,379	1.99	-0.54	-0.59	0.72	-0.77	-0.45	
	Minimum	0.50	0.63	21,742	284,760	325,886	21,194	121,580	173,151	-1.98	0.45	0.59	-0.53	0.30	0.31	Quitted at age of 45
	Base-case	0.56	0.70	22,182	283,491	323,960	21,307	121,220	172,610	-	-	-	-	-	-	
	Maximum	0.62	0.77	22,581	282,338	322,209	21,408	120,898	172,126	1.80	-0.41	-0.54	0.47	-0.27	-0.28	
Probability of relapsing	Minimum	0.59	0.42	24,902	291,446	335,919	29,342	193,593	231,766	2.49	-0.58	-0.75	0.55	-0.24	-0.31	Lifetime drinker
	Base-case	0.66	0.47	24,297	293,140	338,472	29,180	194,066	232,486	-	-	-	-	-	-	
	Maximum	0.73	0.52	23,756	294,651	340,746	29,032	194,502	233,149	-2.23	0.52	0.67	-0.51	0.22	0.29	
	Minimum	0.59	0.42	2,780	29,542	67,949	2,749	22,604	53,773	2.61	-0.80	-0.53	0.69	-0.28	-0.18	Quitted at age of 25(male) / 30 (female)
	Base-case	0.66	0.47	2,709	29,781	68,313	2,730	22,668	53,870	-	-	-	-	-	-	
	Maximum	0.73	0.52	2,645	29,998	68,642	2,712	22,728	53,962	-2.36	0.73	0.48	-0.65	0.27	0.17	
	Minimum	0.59	0.42	14,642	166,099	225,316	8,457	26,691	68,427	2.06	-0.56	-0.61	0.61	-0.65	-0.38	Quitted at age of 35
	Base-case	0.66	0.47	14,347	167,028	226,709	8,406	26,866	68,691	-	-	-	-	-	-	
	Maximum	0.73	0.52	14,083	167,859	227,955	8,358	27,029	68,937	-1.84	0.50	0.55	-0.57	0.61	0.36	
	Minimum	0.59	0.42	22,602	282,276	322,114	21,406	120,905	172,136	1.89	-0.43	-0.57	0.46	-0.26	-0.27	Quitted at age of 45
	Base-case	0.66	0.47	22,182	283,491	323,960	21,307	121,220	172,610	-	-	-	-	-	-	
	Maximum	0.73	0.52	21,806	284,576	325,608	21,216	121,511	173,047	-1.69	0.38	0.51	-0.43	0.24	0.25	

Res*=Responsible, HZ**=Hazardous, HM***=Harmful

Result of sensitivity analysis classified by drinking category, gender, and duration of drinking (continue)

Parameter	Value	Gender		Total indirect cost (baht)						Percent changing of total cost						Scenario
		Male	Female	Male			Female			Male			Female			
				Res*	HZ**	HM***	Res*	HZ**	HM***	Res*	HZ**	HM***	Res*	HZ**	HM***	
Relative risk	Minimum	0.90(Res)/1.22(HZ)/1.35(HM)		18,740	288,908	334,844	27,909	193,184	231,699	-22.87	-1.44	-1.07	-4.36	-0.45	-0.34	Lifetime drinker
	Base-case	0.93(Res)/1.24(HZ)/1.37(HM)		24,297	293,140	338,472	29,180	194,066	232,486	-	-	-	-	-	-	
	Maximum	0.96(Res)/1.27(HZ)/1.49(HM)		29,700	298,588	355,216	30,429	195,240	236,604	22.24	1.86	4.95	4.28	0.61	1.77	
	Minimum	0.90(Res)/1.22(HZ)/1.35(HM)		1,857	29,331	67,800	2,416	22,496	53,699	-31.45	-1.51	-0.75	-11.51	-0.76	-0.32	Quitted at age of 25(male) /30(female)
	Base-case	0.93(Res)/1.24(HZ)/1.37(HM)		2,709	29,781	68,313	2,730	22,668	53,870	-	-	-	-	-	-	
	Maximum	0.96(Res)/1.27(HZ)/1.49(HM)		3,537	30,438	71,295	3,039	22,932	55,002	30.59	2.21	4.37	11.30	1.17	2.10	
	Minimum	0.90(Res)/1.22(HZ)/1.35(HM)		11,514	164,890	224,700	7,875	26,593	68,438	-19.74	-1.28	-0.89	-6.32	-1.02	-0.37	Quitted at age of 35
	Base-case	0.93(Res)/1.24(HZ)/1.37(HM)		14,347	167,028	226,709	8,406	26,866	68,691	-	-	-	-	-	-	
	Maximum	0.96(Res)/1.27(HZ)/1.49(HM)		17,101	169,832	236,191	8,927	27,298	70,561	19.19	1.68	4.18	6.20	1.61	2.72	
	Minimum	0.90(Res)/1.22(HZ)/1.35(HM)		18,235	279,855	320,804	20,458	120,660	172,086	-17.79	-1.28	-0.97	-3.98	-0.46	-0.30	Quitted at age of 45
	Base-case	0.93(Res)/1.24(HZ)/1.37(HM)		22,182	283,491	323,960	21,307	121,220	172,610	-	-	-	-	-	-	
	Maximum	0.96(Res)/1.27(HZ)/1.49(HM)		26,018	288,025	336,800	22,141	122,000	175,528	17.29	1.60	3.96	3.91	0.64	1.69	

Res*=Responsible, HZ**=Hazardous, HM***=Harmful

APPENDIX C

Results of sensitivity analysis

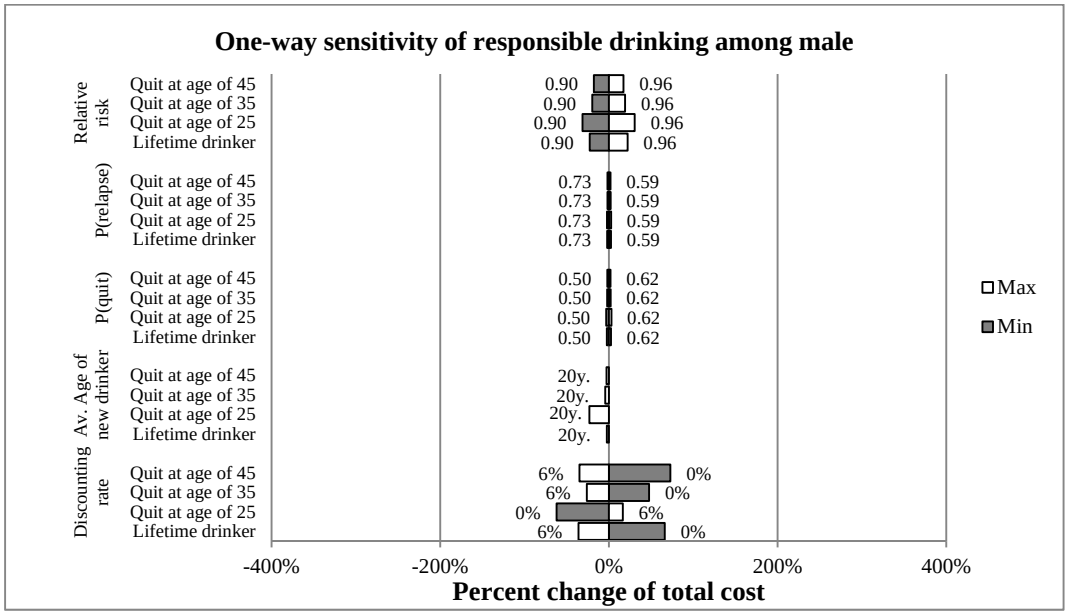

Figure C-1 A tornado diagram of responsible drinking among male which presented by percent changing of total lifetime cost

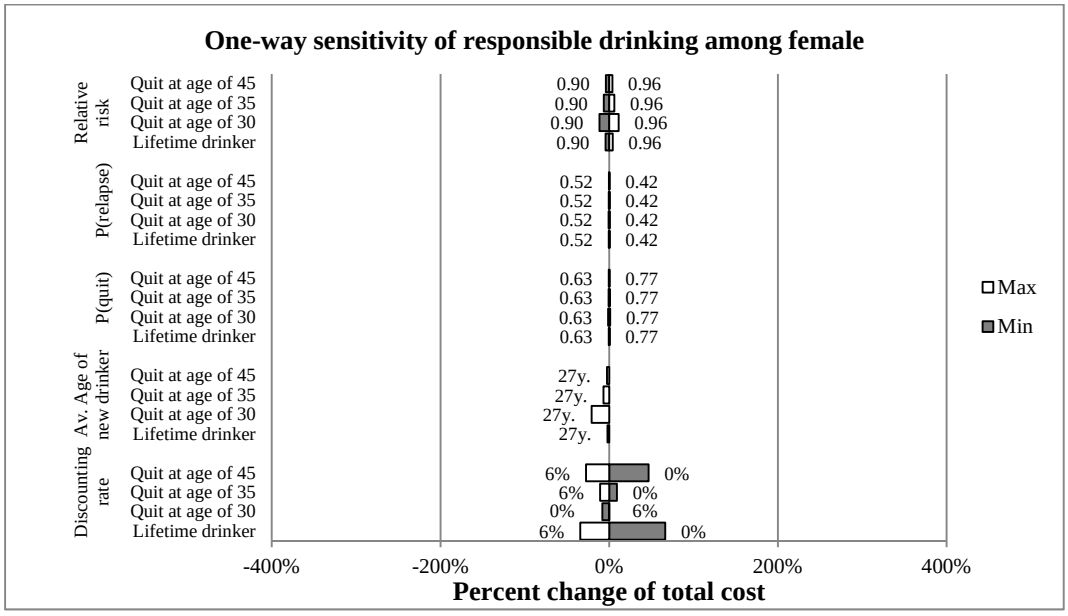

Figure C-2 A tornado diagram of responsible drinking among female which presented by percent changing of total lifetime cost

Results of sensitivity analysis (continue)

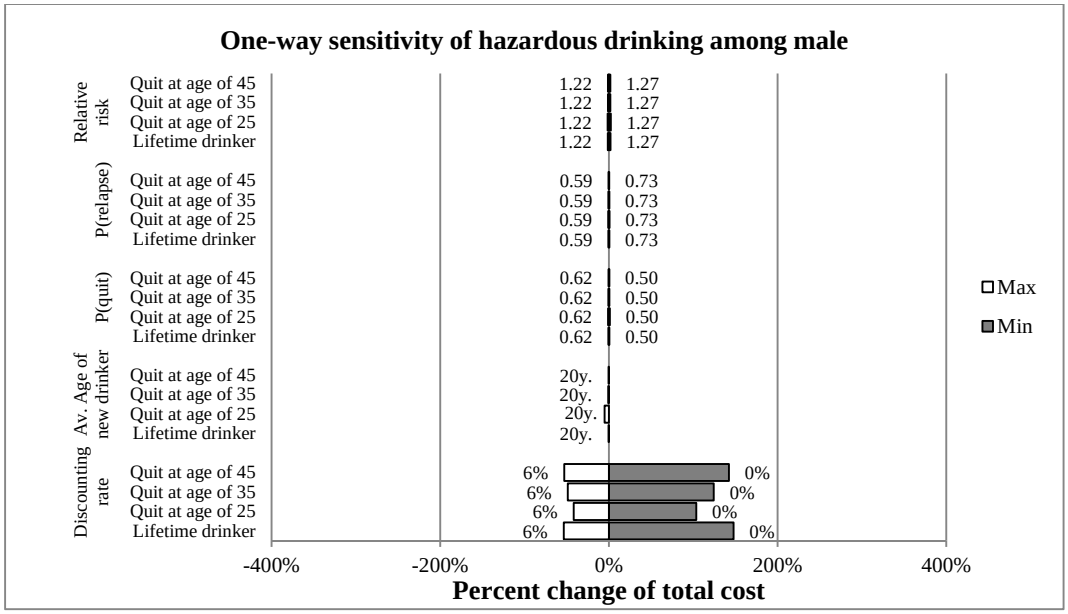

Figure C-3 A tornado diagram of hazardous drinking among male which presented by percent changing of total lifetime cost

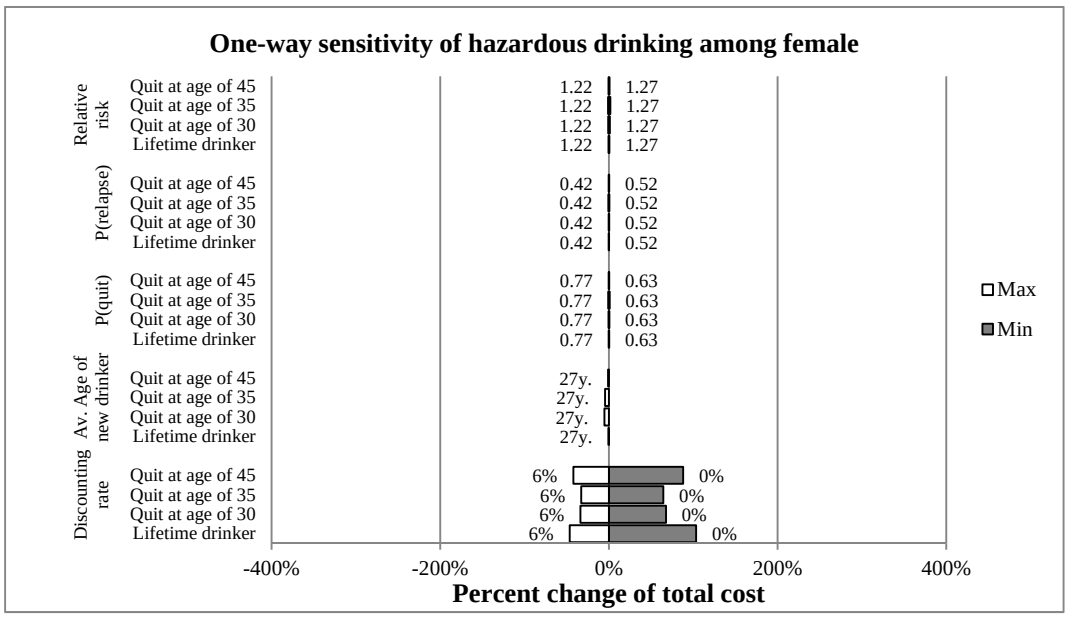

Figure C-4 A tornado diagram of hazardous drinking among female which presented by percent changing of total lifetime cost

Results of sensitivity analysis (continue)

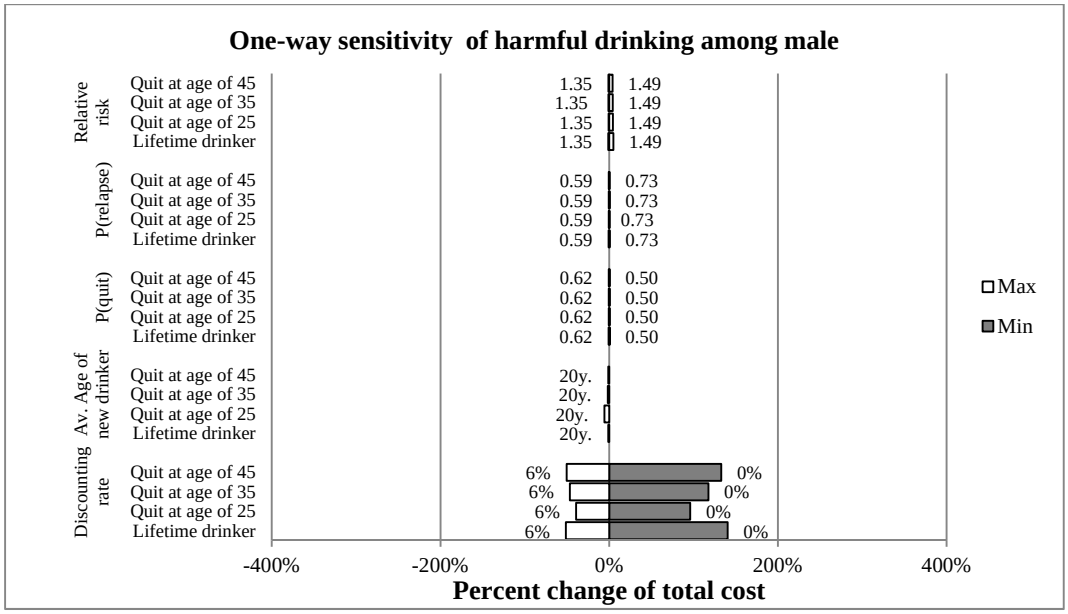

Figure C-5 A tornado diagram of harmful drinking among male which presented by percent changing of total lifetime cost

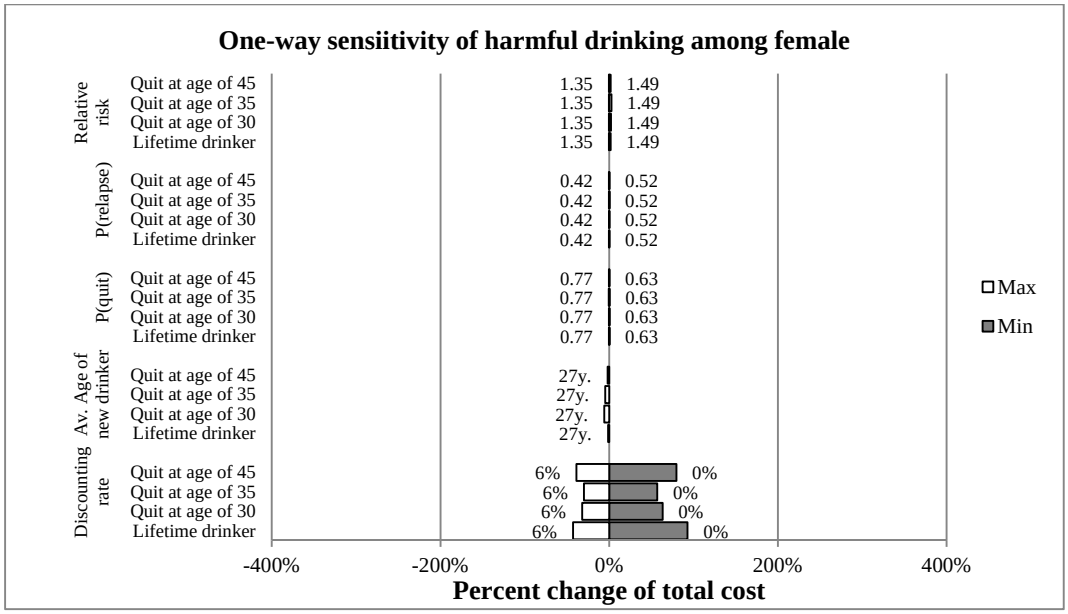

Figure C-6 A tornado diagram of harmful drinking among female which presented by percent changing of total lifetime cost

BIOGRAPHY

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