IMPACT OF OBESITY ON HEALTHCARE COST AND COST OF PRODUCTIVITY LOSS DUE TO PREMATURE MORTALITY IN THAILAND

PAIBOON PITAYATIENANAN

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Paiboon Pitayatienanan
.....
Mr. Paiboon Pitayatienanan
Candidate

.....
Assist. Prof. Montarat Thavorncharoensap,
Ph.D. (Social and Administrative
Pharmacy)
Major advisor

.....
Mr. Yot Teerawattananon,
M.D., Ph.D. (Health Economics)
Co-advisor

.....
Assoc. Prof. Naeti Suksomboon,
Ph.D. (Clinical Pharmacy)
Co-advisor

.....
Prof. Banchong Mahaisavariya,
M.D., Dip Thai Board of Orthopedics
Dean
Faculty of Graduate Studies
Mahidol University

.....
Assoc. Prof. Arthorn Riewpaiboon,
Ph.D. (Pharmacology)
Program Director
Master of Science in Pharmacy
Program in Pharmacy Administration
Mahidol University

Thesis
entitled

IMPACT OF OBESITY ON HEALTH CARE COST AND COST OF PRODUCTIVITY LOSS DUE TO PREMATURE MORTALITY IN THAI LAND

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(Pharmacy Administration)
on
May 2, 2011

Paiboon Pitayatienanan
.....
Mr. Paiboon Pitayatienanan
Candidate

.....
Assist. Prof. Montarat
Thavorncharoensap,
Ph.D. (Social and Administrative
Pharmacy)
Member

.....
Lect. Nattiya Kapol,
Ph.D. (Social and Administrative
Pharmacy)
Chair

.....
Mr. Yot Teerawattananon,
M.D., Ph.D. (Health Economics)
Member

.....
Assoc. Prof. Naeti Suksomboon,
Ph.D. (Clinical Pharmacy)
Member

.....
Prof. Banchong Mahaisavariya,
M.D., Dip Thai Board of Orthopedics
Dean
Faculty of Graduate Studies
Mahidol University

.....
Assoc. Prof. Chuthamanee Suthisisang,
Ph.D. (Pharmacology)
Dean
Faculty of Pharmacy
Mahidol University

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Paiboon Pitayatienanan

IMPACT OF OBESITY ON HEALTH CARE COST AND COST OF PRODUCTIVITY LOSS DUE TO PREMATURE MORTALITY IN THAILAND

PAIBOON PITAYATIENANAN 5236114 PYPA/M

M.Sc. in Pharm.(PHARMACY ADMINISTRATION)

THESIS ADVISORY COMMITTEE: MONTARAT THAVORNCHAROENSAP,Ph.D (SOCIAL ADMINISTRATIVE PHARMACY), NAETI SUKSOMBOON, Ph.D (CLINICAL PHARMACY), YOT TEERAWATTANANON, Ph.D (HEALTH ECONOMICS)

ABSTRACT

Obesity is regarded as a disease that requires appropriate treatment. At the global level, obesity is ranked the 6th among factors that cause diseases. The economic impact of obesity is substantial. The objective of this study was to estimate the healthcare cost and cost of productivity loss due to premature mortality attributable to obesity in Thailand, in 2009. This was a prevalence-based cost-of-illness study. The obesity–attributable fractions (OAFs), proportion of disease in a population which is attributable to obesity, were calculated for each disease associated with obesity. OAFs can be calculated using information on the prevalence of obesity and relative risk for each disease. The number of patients in each disease category attributable to obesity was then calculated as the product of OAFs, as well as the total number of patients with that disease in 2009. The health care costs of obesity were further estimated by multiplying the number of patients in each disease category attributable to obesity by the unit cost of treatment. The cost of productivity loss due to premature mortality was calculated using the human capital approach.

Health care costs attributable to obesity in this study were estimated at 5,581 million baht (i.e., out-patient department = 848 million baht and in-patient department = 4,733 million baht), which accounted for about 2.01% of national health expenditures. Premature mortality costs attributable to overweight and obesity was estimated at 9,328 million baht. The total cost of obesity was then estimated at 14,909 million baht, accounting for 0.19% of the gross domestic product (GDP). The results of this study indicated that the economic impact of obesity in Thailand is substantial. Related organizations should pay attention in implementing more effective policies/ interventions aimed at increasing awareness of the negative economic impact of obesity, as well as reducing the prevalence of obesity.

KEY WORDS: HEALTH CARE COSTS/ PREMATURE MORTALITY/ OVERWEIGHT/ OBESITY/ ECONOMIC

57 pages

ผลกระทบของโรคอ้วนต่อค่าใช้จ่ายด้านสุขภาพและผลิตภาพในการทำงานจากการเสียชีวิตก่อนวัยอันควรในประเทศไทย

IMPACT OF OBEESITY ON HEALTH CARE COST AND COST OF PRODUCTIVITY LOSS DUE TO PREMATURE MORTALITY IN THAILAND

ไพบูลย์ พิทยาเธียรอนันต์ 5236114 PYPA/M

ภ.ม. (บริหารเภสัชกิจ)

คณะกรรมการที่ปรึกษาวิทยานิพนธ์ : มนทรัตม์ ถาวรเจริญทรัพย์, Ph.D (SOCIAL ADMINISTRATIVE PHARMACY), เนติ สุขสมบูรณ์, Ph.D (CLINICAL PHARMACY), ยศ ตีระวัฒนานนท์, Ph.D (HEALTH ECONOMICS)

บทคัดย่อ

โรคอ้วน (Obesity) ถูกจัดเป็นโรคประเภทหนึ่งซึ่งต้องได้รับการรักษาและดูแลอย่างเหมาะสม ทั้งนี้ข้อมูลจากการศึกษาภาระโรคพบว่า ภาวะอ้วนหรือน้ำหนักเกินจัดเป็นปัจจัยเสี่ยงที่สำคัญลำดับที่ 6 ที่มีผลต่อภาระโรคในระดับโลก ผลกระทบของโรคอ้วนในทางเศรษฐกิจมีมูลค่าสูง การศึกษาในครั้งนี้มีวัตถุประสงค์ของการศึกษาเพื่อ (1) ประเมินผลกระทบด้านค่าใช้จ่ายในการรักษาพยาบาลจากภาวะน้ำหนักเกินและโรคอ้วนในประเทศไทยในปี พ.ศ.2552 (2) ประเมินผลกระทบด้านค่าใช้จ่ายในการรักษาพยาบาลจากการตายก่อนวัยอันควรเนื่องจากภาวะน้ำหนักเกินและโรคอ้วนในประเทศไทยในปี พ.ศ.2552 การศึกษาครั้งนี้เป็นการศึกษาต้นทุนความเจ็บป่วยแบบวิธีความชุก โดยเริ่มต้นจากการคำนวณสัดส่วนของการเกิดโรคต่างๆจากภาวะน้ำหนักเกินและโรคอ้วน (Obesity attributable fractions, OAFs) ซึ่งต้องใช้ข้อมูลความชุกของภาวะน้ำหนักเกินและโรคอ้วนในประชากรไทย และค่าความเสี่ยงสัมพัทธ์ (Relative Risk)ของการเกิดโรคต่างๆ ทั้งนี้ในแต่ละโรค จำนวนผู้ป่วยที่เป็นโรคโดยมีสาเหตุจากภาวะน้ำหนักเกินและโรคอ้วนสามารถคำนวณได้จากผลคูณของสัดส่วนของการเกิดโรคจากภาวะน้ำหนักเกินและโรคอ้วนกับจำนวนผู้ป่วยโรคดังกล่าวทั้งหมดในประเทศไทยในปีดังกล่าว จากนั้นจึงคำนวณค่าใช้จ่ายทางด้านสุขภาพเนื่องจากภาวะน้ำหนักเกินและโรคอ้วนโดยนำจำนวนผู้ป่วยที่เป็นโรคต่างๆ ซึ่งมีสาเหตุจากภาวะน้ำหนักเกินและโรคอ้วนคูณด้วยต้นทุนต่อหน่วยของการรักษา ส่วนค่าใช้จ่ายในการรักษาพยาบาลจากการตายก่อนวัยอันควรใช้วิธีต้นทุนมนุษย์ ผลการศึกษาพบว่าค่าใช้จ่ายด้านสุขภาพ ที่เกิดขึ้นจากภาวะน้ำหนักเกินและโรคอ้วน ใน พ.ศ. 2552 มีมูลค่าสูงถึง 5,581 ล้านบาท โดยจำแนกเป็นค่าใช้จ่ายที่เกิดจากการรักษาในแผนกผู้ป่วยนอก 848 ล้านบาท และผู้ป่วยใน 4,733 ล้านบาท ทั้งนี้ค่าใช้จ่ายด้านสุขภาพที่เกิดขึ้นคิดเป็นร้อยละ 2.01 ของค่าใช้จ่ายด้านสุขภาพทั้งหมดของประเทศ ค่าใช้จ่ายในการรักษาพยาบาลจากการตายก่อนวัยอันควรเนื่องจากภาวะน้ำหนักเกินและโรคอ้วน ใน พ.ศ. 2552 มีมูลค่า 9,328 ล้านบาท ทั้งนี้ค่าใช้จ่ายที่เกิดขึ้นทั้งหมดคิดเป็นมูลค่า 14,909 ล้านบาทหรือคิดเป็นประมาณร้อยละ 0.19 ของผลผลิตมวลรวมประชาชาติ จากผลการศึกษาแสดงให้เห็นว่าภาวะน้ำหนักเกินและโรคอ้วนส่งผลกระทบทางเศรษฐกิจอย่างชัดเจน ทั้งนี้หน่วยงานที่เกี่ยวข้องควรให้ความสำคัญในการวางแผนนโยบายหรือกำหนดมาตรการแทรกแซงเพื่อสร้างความตระหนักถึงผลกระทบทางเศรษฐศาสตร์จากโรคอ้วนตลอดจนเพื่อลดความชุกของโรคอ้วนให้มีประสิทธิภาพมากขึ้นต่อไป

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LIST OF ABBREVIATIONS

(A-Z)

OAFs	=	Overweight and obesity-Attributable Fractions
BOD	=	Burden of Disease Project
CHEM	=	Center of Health Equity Monitoring
CSMBS	=	Civil Servant Medical Benefit Scheme
DALYs	=	Disability-Adjusted Life Years
GDP	=	Gross Domestic Product
GNP	=	Gross National Product
HSRI	=	Health System Research Institute
ICD-10	=	International Classification of Diseases, 10th Revision
IPD	=	Inpatient Department
MOPH	=	Ministry of Public Health
NHSO	=	National Health Security Office
NSO	=	National Statistical Office
OPD	=	Outpatient Department
OAF	=	Obesity Attributable Fraction
RR	=	Relative Risks
SSS	=	Social Security Scheme
UC	=	Universal Coverage Scheme
WHO	=	World Health Organization

CHAPTER I
INTRODUCTION

Obesity is regarded as a disease that requires appropriate treatment(1). World Health Organization (WHO) includes obesity in the International Classification of Disease (ICD). In the global level (2), obesity is ranked 6th among factors that cause diseases. The most common indicator of obesity is the Body Mass Index or BMI, which is the body weight in kilogram divided by a square of body height in meter. A reading of 25-29.9 indicates an overweight condition. A reading of 30 and higher indicates obesity (3). Studies also found a direct relationship between the BMI and risk of diseases. A reading of 25-29.9 indicates increased risk. A reading of 30-34.9 indicates moderate risk. A reading of 35-39.9 indicates that risk is severe. And a reading of 40 or higher indicates that risk is very severe (4). And a reading of 40 or higher indicates that risk is very severe. According to the US Preventive Task Force, BMI has a J-shaped or U-shaped relationship with mortality rate (5-7). It also suggests that doctors should screen patients for obesity (8).

Obesity is a cause of several chronic diseases. Obesity-induced diseases include Diabetes, Hypertension, Gall bladder diseases, Osteoarthritis, Hyperlipidemia, Stroke, Myocardial infarction, Pulmonary embolism, Angina pectoris, Depression, Sleep apnea, Endometrial cancer, Uterus cancer, Breast cancer, Colon cancer and Colorectal Cancer (9-12). As the result, Obesity has substantial negative impact on health and health care cost.

There is evidence that the adverse consequences of obesity impose a substantial economic burden on societies worldwide. From the review of literatures in 13 studies conducted in 10 European countries, economic losses caused by obesity was found to range from 0.09 to 0.61% of GDP (13). Meanwhile, a study found that economic loss caused by obesity in the US in 1995 was around 100 billion US dollar (14). Obesity and related diseases were found to be responsible for 5.5-7% of total

healthcare expense in the US and 2.0-3.5% in other countries (15). The figure was found to be 8.2-9.8% for Hong Kong (16) and 3.7% for China (17).

Apart from treatment charges, which are direct costs, obesity is also a cause of indirect costs. Since it is a cause for several diseases, obesity is also an important cause of productivity loss (18). Productivity loss may also take a form of premature mortality (which means people die before they should) or absenteeism (which mean a person is absent from work because of sickness) or presenteeism (which means the person shows up but is not as productive as he or she could be). Such productivity losses are examples of indirect costs caused by obesity (19). The recent review of indirect costs of obesity (18) revealed that indirect costs of obesity are substantial. Apart from economic losses, obesity is also a cause of psychosocial problems. It is found to destroy self-efficacy (20-22) and reduce the quality of life (23-28).

Recent years, obesity is recognized as a major healthcare problem for many countries, not only the developed countries (29). There has been a rapid increase worldwide in the prevalence of overweight and obesity. WHO estimates that there are over 1 billion overweight adults worldwide. And at least 3 million have obesity. Obesity is also a problem in the Asia-Pacific region. The prevalence of obesity in 14 countries in the region was found to range from below 5% in India to 60% in Australia (30). The prevalence of obesity, both in adult and in children, has been increasing in the 10-20 years (29-30).

Like other countries, the prevalence of obesity in Thailand is also increasing rapidly. The forth National Health Examination Survey conducted in Thailand 2008-9 (29) found that, 28.4% of male and 40.7% of female in working-age and elder population had BMI of 25 or higher as compared to the figures in the first survey (in the year 2000) which found 13% and 23.2% for male and female, respectively. To our knowledge, no study examining economic cost of obesity was conducted in Thailand before. Although such studies were conducted in several countries worldwide it should be noted that the generalizability of study results across settings is limited due to several reasons including differences in prevalence of obesity, effect of obesity on health, socioeconomic and health care structure. This, together with growing prevalence of obesity in the country, has led to the need of such

study in Thailand. Therefore, this study aimed to estimate the economic cost attributable to obesity in Thailand, 2009.

Objectives

This study aims to estimate the economic costs of obesity, in Thailand, 2009. The specific objectives are;

1. To estimate health care costs attributable to obesity in Thai population, 2009
2. To estimate costs of productivity loss due to premature mortality attributable to obesity in Thai population, 2009.

Expected benefits and applications

The findings of this study are useful for policy makers, public health planners, and researchers. The estimations can be used in facilitating the formulation of obesity-related policies or intervention aimed at reducing the prevalence of obesity. It also can be used to draw the public awareness to the negative economic impact of obesity.

Definition of terms

Attributable fraction

The proportion of cases of a disorder (cause of diseases or death) that can be causally attributed to particular risk factor.

Obesity

A widely used indicator of obesity is the Body Mass Index (BMI) which is the body weight in kilogram divided by a square of body height in meter. Therefore, the unit if the BMI is kilogram/meter^2. In this study, patients with a BMI of 25

kilogram/meter^2 or higher will be defined as having obesity. As compared to the definition used by WHO, this definition would include both overweight and obesity.

CHAPTER II
LITERATURE REVIEW

Classification of Obesity

A widely used indicator of obesity is the Body Mass Index (BMI) which is the body weight in kilogram divided by a square of body height in meter. Therefore, the unit if the BMI is kilogram/meter^2 [3]. The table below demonstrates the international classification of obesity patients according to BMI by the World Health Organization (WHO) As shown in table 2.1, WHO proposed BMI cut-off points of 25.0- 29.9 kg/m^2 for overweight and ≥30 kg/m^2 for obese.

Table 2.1. WHO classification of adult underweight, overweight and obesity according to BMI (31).

Classification	BMI (kg/m^2)	Risk of co-morbidity
Underweight	< 18.50	Low (but risk of other clinical problems increased)
Normal range	18.50 – 24.99	Average
Overweight	≥ 25.00	Increased
Pre –Obese	25.0-29.99	Increased
Obese Class 1	30.00 - 34.99	Moderate
Obese Class 2	35.00 – 39.99	Severe
Obese Class 3	≥ 40.00	Very severe

As risks of cardiovascular diseases in Asians increases below the cut-off points of 25.00 kg/m^2, alternative cut-off for Asian people was proposed as shown in

Table 2.2. It has been proposed that the normal range for Asians should be 18.50-22.99 kg/m^2 instead of 18.50-24.99 kg/m^2, as shown in table 2.2. Meanwhile, the cut-off points to identify patients as having obesity in Asian countries vary from 22-25 kg/m^2 (31). In addition, it is suggested that the cut-off points for BMI 27 kg/m^2 and 25 kg/m^2 should be used in Thai male and female population, respectively (32). However, WHO expert consultation addressed this issue and insisted that BMI cut-off points as shown in Table 2.1 should be retained as international classifications (33).

Table 2.2. Alternative classification of adult underweight, overweight and obesity according to BMI proposed for Asian People [40].

Classification	BMI (kg/m^2)	Risk of co-morbidity
Underweight	< 18.50	Low (but risk of other clinical problems increased)
Normal range	18.50 – 22.99	Average
Overweight	≥ 23.00	Increased
At risk	23.0-24.99	Increased
Obese Class 1	25.00 – 29.99	Moderate
Obese Class 2	≥ 30.00	Severe

In addition, a child or an adolescent is classified as overweigh if his or her BMI is above the 85th percentile and as obese if the BMI is above the 95th percentile (34-36).

Prevalence of obesity

WHO estimates that currently 1 billion people are overweight, of these 300 million are defined as obese (37). For Asia-Pacific region, prevalence of overweight and obesity ranging from less than 5% in India to 60% in Australia. (30). In addition, the prevalence of obesity in children has been increasing in the 10-20 years (29-30).

As shown in table 2.3, the prevalence of obesity in Thailand by gender also has been rising rapidly (38).

Table 2.3. Prevalence of obesity in Thailand by gender (38).

	Prevalence of Obesity (BMI ≥25.0 (kg/m^2)	
	Male	**Female**
1st NHES (2000)	13%	23.2%
3rd NHES (2003-2004)	22.5%	34.4%
4th NHES (2008-2009)	28.4%	40.7%

Note; NHES= National Health Examination Survey

The Third National Health Examination Survey conducted in 2009 (39) found that, 28.4% of male and 40.7% of female in working-age and elder population had BMI of 25 or higher as compared to the figures in the first survey (in the year 2000) which found 13% and 23.2% for male and female, respectively.

Table 2.4 displayed the prevalence of overweight and obesity by age and gender. For both male and female, it was found that the prevalence was highest among those with age between 45-59 followed by 30-44 years old, respectively.

Table 2.4 Prevalence of overweight and obesity classified by age and gender.

Age (year)	BMI (kg/m^2)			
	Male (%)		Female (%)	
	25-<30	≥30	25-<30	≥30
15-29	12.0	6.5	13.6	7.0
30-44	25.7	6.5	31.6	12.6
45-59	27.4	6.3	36.0	14.7
60-69	22.1	4.3	31.9	11.1
70-79	16.1	2.4	25.4	5.9
80+	10.0	1.3	9.8	4.1
Total	22.3	6.0	29.1	11.6

The prevalence of obesity in Thai children also has been rising. The prevalence in children aged 2-5 years increased from 5.8% in 1997 to 7.9% in 2005 and increased from 7.9% in 2005 to 8.5% in 2009. The prevalence in children aged 6-12 years also increased from 5.8% in 1997 to 6.7% in 2005 and increased from 6.7% in 2005 to 9.7% in 2009.

Disease burdens attributable to overweight and obesity

Obesity is an independent risk factor for many chronic diseases. Obesity-induced diseases include Diabetes, Hypertension, Gall bladder diseases, Osteoarthritis, Stroke, Pulmonary embolism, Ischaemic heart disease, Depression, Endometrial cancer, Breast cancer, Colon and colorectal Cancer. Table 2.5 displays the disease associated with obesity classified by relative risk.

Data from the Global Burden of Disease study suggested that excess body weight is the most important risk factor contributing to the worldwide disease burden (2). According to the ‘Burden of Disease and Injuries in Thailand’ report, obesity is ranked the fifth most important risk factors contributing to disease burden in Thailand (40).

Table 2.5 Health risk of obesity(41).

Greatly increased risk (RR >9) • Diabetes • Hypertension • Dyslipidemia • Breathlessness • Sleep apnoea • Gall baldder disease
Moderately increased risk (RR about 2-3) • Coronary heart disease or heart failure • Osteoarthritis (knee) • Hyperuricaemia and gout • Complications of pregnancy
Increased risk (RR about 1-2) • Cancer • Impaired fertility/ polycystic ovary syndrome • Low back pain • Increased risk due to anaesthesia • Fetal defects arising from maternal obesity

Health care costs of obesity

From the review of literature, we found that, in 13 studies conducted in 10 European countries, economic losses caused by obesity was found to range from 0.09 to 0.61% of GDP (ใส่ references). Meanwhile, a study found that economic loss caused by obesity in the US in 1995 was around 100 billion US dollar. Obesity and related diseases were found to be responsible for 5.5-7% of total healthcare expense in the US and 2-3.5% in other countries. In Asia, health cost of obesity and its co-morbidities ranges from 3.7% and 8.2-9.8% of National health care expenditure for China and Hong Kong, respectively.

Recent systematic review of the direct costs of obesity found that obesity is responsible to approximately 0.7% and 2.8% of a country total health care expenditure(42).

Indirect costs of obesity

Apart from treatment charges, which are direct costs, obesity is also a cause of indirect costs. Since it is a cause for several diseases, obesity is also an important cause of productivity loss (18) Productivity loss may take a form of premature mortality (which means people die before they should) or absenteeism (which mean a person is absent from work because of sickness) or presenteeism (which means the person shows up but is not as productive as he or she could be). Such productivity losses are examples of indirect costs caused by obesity (19). The recent review of indirect costs of obesity (18) revealed that indirect costs of obesity are substantial.

Reviews of the studies on economic costs of obesity

The estimation of economic losses caused by obesity has been conducted in many countries, which are Sweden (41, 43-44), The United Kingdom (45), France (46-47), Germany (48-49), Switzerland (50-51), Italy (52), the Netherland (53), USA (14, 54-55), Australia (56), Canada (57), New Zealand (58), Portuguese(59), and the European Union (60). Studies conducted in Asia include those of China (16) and Hong Kong (17).

The result of the review are shown in table 2.6-2.8 below,

Table 2.6. Characteristics of reviewed studies

Country/Year	Method (Prevalence VS Incidence)	BMI cut point(kg/m^2)	Total costs (as shown in the study)
USA 1986 (54)	Prevalence	≥ 29	$39.3 billion
Australia 1989-90 (56)	Prevalence	≥ 30	AUS$395 billion
USA 1990 (61)	Prevalence	≥ 29	$45.8 billion
New Zealand 1991 (58)	Prevalence	≥ 30	NZ$135.11 million
France 1992 (47)	Prevalence	≥ 27	FF 11.89billion
USA 1993 (55)	Prevalence	≥ 30	$22.90 billion
United Kingdom 1995(62)	Prevalence	≥ 30	£3.8 million
USA 1995 (63)	Prevalence	≥ 29	$55.56 billion
USA 1995 (64)	Prevalence	≥ 30	$70 billion
Portugal 1996 (59)	Prevalence	≥ 30	PTE46.2 billion
Canada 1997 (57)	Prevalence	≥ 27	$1.8 billion
Nationally representative samples from china 2000 (65)	Incidence	> 30	$49.41 billion
Germany 2001 (48)	Prevalence	≥ 30	€661 million
Switzerland 2001 (53)	Incidence	≥ 30	$895.88 billion
Hong Kong 2002 (17)	Prevalence	≥ 25	$0.43 billion
Mainland China 2003 (16)	Prevalence	≥ 28	$2.74 billion

Table 2.7. Cost of obesity

Country/year of study	Direct health care cost	Type of indirect costs				Direct cost (%)
		Premature mortality	Absenteeism	Presenteeism	Others	
USA 1986 (54)	$39.3 billion	NA	NA	NA	NA	100
Australia 1989-1990 (56)	AUS$395 billion	NA	NA	NA	NA	100
USA 1990 (61)	$45.8 billion	$23 billion	NA	NA	NA	49.9
New Zealand 1991 (58)	NZ$135 million	NA	NA	NA	NA	100
France 1992 (47)	FF 11.89 billion	FF 0.6 billion	NA	NA	NA	90.8
USA 1993 (55)	$22.6 billion	NA	$0.03 billon	$0.18 billon	$0.07 billon	98.8
United Kingdom 1995 (62)	€3.8 million	NA	NA	NA	NA	100
USA 1995 (63)	$51.64 billion	$3.92 billon	NA	NA	$43.66 billon	52.0
USA 1995 (64)	$24 billion	NA	$46 billion	NA	NA	34.3
Portugal 1996 (59)	PTE46.2 billion	NA	NA	NA	NA	100
Canada 1997 (57)	$1.8 billion	NA	NA	NA	NA	100
Nationally representative samples from china 2000 (65)	$5.86 billion	$0.34 billion	$37.28 billion	NA	$5.93 billion	11.9
Germany 2001 (48)	€332 million	€67 million	€150 million	NA	€112 million	50.2
Switzerland 2001 (53)	$61 billion	NA	NA	NA	$56 billion	52.1
Hong Kong 2002 (17)	$0.43 billion	NA	NA	NA	NA	100
Mainland China 2003 (16)	$2.74 billion	NA	NA	NA	NA	100

Psychosocial impact of obesity

Apart from economic losses, obesity is also a cause of psychosocial problems. It is found to destroy self-efficacy (20-22) and reduce the quality of life (23-

24, 26-28, 66). Therefore, obesity is a major healthcare problem for many countries, not only the developed countries (29).

Table 2.8. Classified diseases from reviewed studies

Country/year of study	Diseases																					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
USA 1986 (54)			√		√		√						√			√							√
Australia 1989-90(56)			√				√		√				√			√							√
USA 1990 (61)			√				√						√			√	√						√
NewZealand 1991 (58)			√				√		√				√			√							√
France 1992 (47)			√				√				√		√	√	√	√		√	√				
USA 1993 (55)									√				√			√							√
United Kingdom 1995 (62)	√			√		√		√			√		√			√		√	√				√
USA 1995 (63)			√				√		√			√	√			√			√				√
USA 1995 (64)			√				√	√	√				√			√							√
Portugal 1996 (59)		√	√		√		√				√	√	√			√			√				√
Canada 1997 (57)			√					√	√		√	√	√			√				√		√	√
Nationally representativesamples from china 2000 (65)											√					√							√
Germany 2001 (48)																√		√				√	√
Switzerland 2001 (53)			√					√	√	√	√		√		√	√			√		√	√	√
Hong Kong 2002 (17)											√					√							√
Mainland China 2003 (16)									√							√						√	√

*A = Angina, B = Arthropaties, C = Breast cancer, D = Cancer of the uterus, E = Cardiovascular disease, F = Cerebrovascular disease, G = Colon cancer, H = Colorectal cancer, I = Coronary heart disease, J = Depression, K = Dyslipidaemias, L = Endometrial cancer, M = Gallbladder disease, N = Genitourinary cancer, O = Gout, P = Hypertension, Q = Musculoskeletal disease, R = Myocardial infraction, S = Osteoarthritis, T = Pulmonary embolism, U = Sleep apnea, V = Stroke, W = Type 2 Diabetes Mellitus

CHAPTER III
MATERIALS AND METHOD

This chapter is consisted of 5 parts as follow;

3.1 Study design and perspective

3.2 Data material/ sources of data

- 3.2.1 Prevalence of obesity
- 3.2.2 Relative risks of morbidity associated with obesity
- 3.2.3 Costs of treatment

3.3 Data analysis

- 3.3.1 Steps of calculating health care cost attributable to obesity
- 3.3.2 Steps of calculating cost of premature mortality attributable to obesity
- 3.3.3 Computing obesity attributable fractions (OAFs)
- 3.3.4 Estimation of health care cost attributable to obesity
  - 3.3.4.1 Computing costs of obesity in outpatient department
  - 3.3.4.2 Computing costs of obesity in inpatient department
- 3.3.5 Estimation of cost of productivity loss due to premature mortality attributable to obesity
- 3.3.6 Computing the total cost of obesity in Thailand Population, 2009
- 3.3.7 Sensitivity analysis

3.1. Study design and perspective

This is a prevalence-based, cost-of-illness study. The prevalence-based design differs from the incidence-based design which includes only patients diagnosed as having obesity during a given year. A prevalence-based study helps estimating costs of illness caused by obesity each year. Therefore, it helps governments or responsible organizations quantify the economic impact of obesity each year and also plan for the

appropriate budgets. On the other hand, incidence-based study provides useful results that policy makers can use for resource allocation or for the identification of cost-effective measures aim at reducing the incident of obesity. However, incidence-based study requires complex data such as length of diseases, survival rates, which are difficult to obtain at current state. Due to the availability of data and the urgent need for information regarding annual economic impact attributable to obesity in the country, prevalence-based design will be employed in this study. In addition, as most of earlier studies on costs of obesity were prevalence-based studies then comparison of this study results with previous studies can be made.

This study employed Government perspective. Both direct cost (health care cost) and indirect cost (cost of premature mortality) were taken into account in this study, as shown in table 3.1. Based on the literature review, these 2 costs were found to be the most important costs and were included in most of the studies. (16-17, 47-48, 53-59, 61-65) Intangible costs, although they are important, were not included due to problems in translating them into monetary costs.

Table 3.1. Costs included in this study

Direct cost	Indirect cost
Healthcare costs	Costs of productivity loss due to premature mortality

3.2. Data material / Sources of data

3.2.1 Prevalence of obesity

The prevalence of obesity among Thai Population was obtained from the 4th National Health Examination Survey conducted during 2008-2009.

3.2.2 Relative risks of morbidity associated with obesity

For each selected disease, relative risk associated with obesity classified by level of BMI and gender was derived from related meta-analysis or study involved in Asia.

3.2.3 Costs of treatment

3.2.3.1 For outpatient service, average costs of OPD treatment per visit and average number of OPD visit per person per year in 2009 for each selected disease were derived from the 2007 outpatient database obtained from Center of Health Equity Monitoring (CHEM), Faculty of Medicine, Naresuan University.

3.2.3.2 For inpatient service, average costs of IPD treatment per visit and average number of IPD visit per person per year in 2009 for each selected disease was derived from the 2007 inpatient database obtained from the Center Office of Healthcare Information's database.

3.2.3.3 The expected lifespan

The expected lifespan is obtained from Burden of disease project (BOD),2004 Thailand.

3.2.3.4 The average wage

The average wage per year by age and gender as well as workforce participation rate in Thailand in 2009 was obtained from the National Economic and Social Survey 2009 by the National Statistic Office.

3.2.3.5 Number of patients in each selected disease by gender in Thailand in 2009

The number of OPD patients in each selected disease in Thailand 2009 was estimated from the 2007 database of the Center of Health Equity Monitoring (CHEM), Faculty of Medicine, Naresuan University. On the other hand, the number of IPD patients in each selected disease in Thailand 2009 was obtained from the Bureau of Policy and Strategy, Ministry of Public Health, 2009.

3.2.3.6 Number of mortality by age and gender in each selected disease in Thailand in 2009

The number of mortality by age and gender in each selected disease in Thailand 2009 was obtained from Burden of disease and injuries project (BOD), Thailand,

Summary of required data and their sources is presented in table 3.2.

Table 3.2. Data and sources of data

Data	Resource of Data
The prevalence of obesity	The 4th National Health Examination Survey
Relative risk	Meta-analysis or study involved in Asia
Number of OPD patients for each selected disease in 2009	Center of Health Equity Monitoring (CHEM), Faculty of Medicine, Naresuan University, 2007
Number of IPD patients for each selected disease in 2009	Bureau of Policy and Strategy, 2009
Number of mortality by age and gender in each disease in 2009	Burden of disease (BOD) project, Thailand, 2004
Average annual costs for each disease from Out Patient Department	Center of Health Equity Monitoring (CHEM), Faculty of Medicine, Naresuan University, 2007
Average annual costs for each disease from In Patient Department	Center Office of Healthcare Information's database 2007
The expected lifespan	Burden of disease (BOD) project, Thailand 2004
The average wages per year by age and gender	National Economic and Social Survey 2009 by the National Statistic Office

3.3. Data analysis

3.3.1 Steps of calculating health care cost attributable to obesity

Steps of calculating health care cost attributable to obesity are presented in figure 3.1. After the list of diseases/conditions attributable to obesity is identified by literature review, obesity attributable fraction (OAFs) will be calculated for each disease/conditions. Then, the number of patients in each disease/condition attributable to obesity is calculated by multiplying the OAF with the total number of patients suffering from the corresponding disease in Thailand, 2009. Generally, for each

disease attributable to obesity, the costs associated with obesity were estimated by multiplying the number of patients suffering from a disease attributable to obesity by the average annual cost of the corresponding disease.

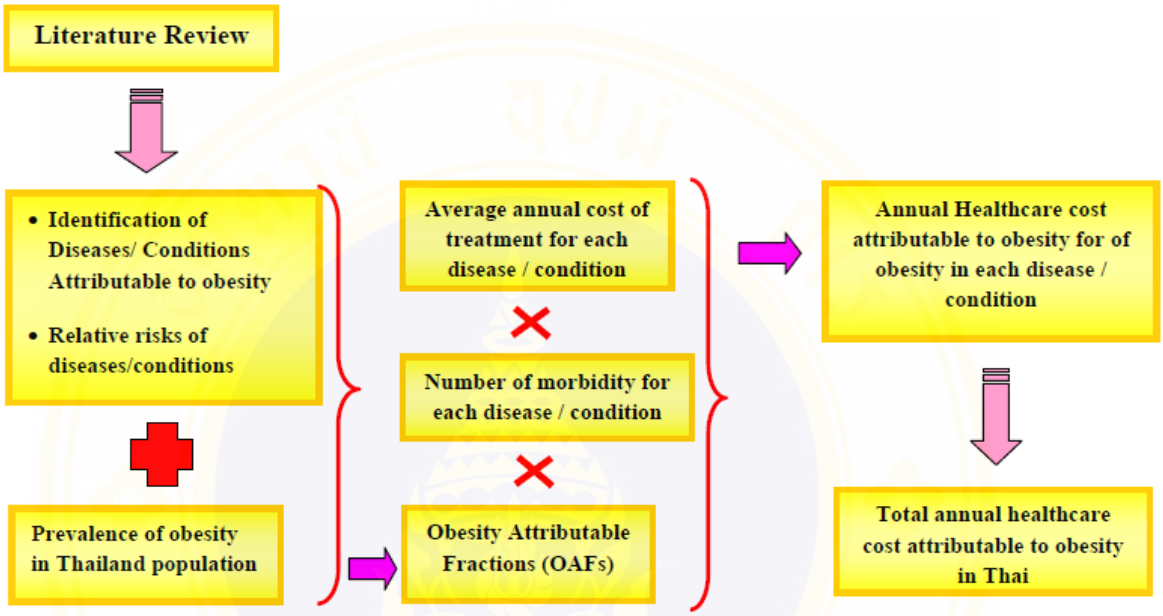

Figure 3.1. Steps of calculating health care cost attributable to obesity

3.3.2 Steps of calculating cost of premature mortality attributable to obesity

Steps of calculating cost of premature mortality attributable to obesity are presented in figure 3.2. After the list of diseases/conditions attributable to obesity is identified by literature review, obesity attributable fraction (OAFs) will be calculated for each disease/conditions. Then, the number of death in each disease/condition attributable to obesity is calculated by multiplying the AF with the total number of patients died from the corresponding disease in Thailand, 2009. Generally, for each disease attributable to obesity, the costs associated with obesity were estimated by multiplying the number of patients died from a disease attributable to obesity by the present value of age and gender adjusted future earning.

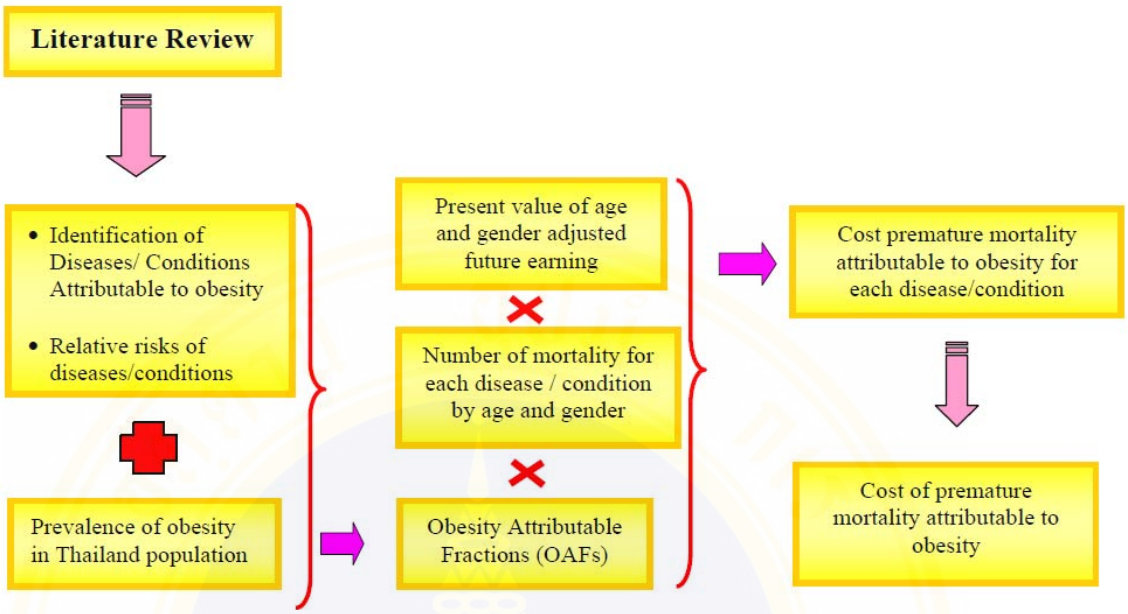

Figure 3.2. Steps of calculating cost of premature mortality attributable to obesity

3.3.3 Computing obesity – attributable fractions (OAFs)

The proportion of patients with obesity-induced disease to total patients with disease j (OAF_j) can range from 0-1. An OAF_j of 1 means obesity is the cause of all cases. The OAF_j is calculated as follows:

$$OAF_j = \frac{\sum_{i=1}^{2} P_i(RR_{ij} - 1)}{\sum_{i=1}^{2} P_i(RR_{ij} - 1) + 1}$$

Where

I = Body Mass Index (BMI) level (i = 1 mean BMI ≥ 25.0-29.9 kg/m^2 and i = 2 mean BMI ≥ 30 kg/m^2)

j = Diseases attributable to obesity were classified into 1-12 (as shown in table 10)

P_i = Prevalence of obesity

RR_{ij} = Relative risk of disease j associated with obesity level i compared with non-obese population

The prevalence of obesity (P_i) will be obtained from the results of the 4th National Health Examination Survey conducted in 2008-2009. The relative risk (RR_{jj}) will be derived from meta-analysis or study involved in Asia.

3.3.4 Estimation of health care cost attributable to obesity

To estimate the health care cost attributable to obesity, the first step is to identify diseases that will be included in the calculation. Based on the literature review, previous studies included 6-10 of the following 18 diseases in their estimations: obesity, diabetes, hypertension, gall bladder diseases, gout, osteoarthritis, hyperlipidemia, stroke, myocardial infarction, pulmonary embolism, angina pectoris, depression, sleep apnea, endometrial cancer, uterus cancer, breast cancer, colon cancer, and colorectal cancer.

In this study, the lists of diseases included in the estimation were determined based on the degree of association with obesity, the availability of existing information and its importance in Thai's context. The lists of 12 diseases included in the estimation was shown in table 3.3.

Table 3.3. List of diseases included in the estimation

ICD10	Disease
C18-21	Colon and colorectal cancer
C50	Breast cancer
C54-55	Endometrial cancer
E10-14	Diabetes Mellitus
E66	Obesity
F32-33	Depression
I 10-15	Hypertension
I20-22	Ischaemic heart disease
I26	Pulmonary embolism
I60-69	Stroke
K80	Gall bladder
M15-19	Osteoarthritis

Costs of treating both in-patients and out-patients will be included in this study. The number of patients with obesity-induced disease j (N_Obese_j) will be calculated by multiplying the obesity attributable fraction (OAF_j) with total number of patients with disease j in 2009 ($T\_patient_j$), as follows:

$$N\_Obese_j = OAF_j * T\_patient_j$$

Where

N_0bese_j = Number of patients with obesity-induced disease j

$T\_patient_j$ = Number of patients with disease j in 2009

OAF_j = The proportion of patients with obesity-induced disease to total patients with disease j

3.3.4.1 Computing costs of obesity in outpatient department

Treatment costs of out-patients with obesity-induced disease j ($OPD\_N\_Obese_j$) will be calculated by multiplying the number of patients with obesity-induced disease j ($OPD\_N\_Obese_j$), with the average number of OPD visits of patient with disease j per year ($frenquency_j$) and the average cost per OPD visit of patient with disease j (OPD_cost_j), as follow:

$$EX\_OPD = \sum_{j=1}^{12} (OPD\_N\_Obese_j * frequency_j * OPD\_cost_j)$$

Where,

$$OPD\_N\_Obese_j = OAF_j * T\_OPD\_patient_j$$

$OPD\_N\_Obese_j$ = Total number of out-patients with obesity- induced disease j in 2009

$Frenquency_j$ = Average number of OPD visits by patient with disease j per year

OPD_cost_j = Average cost per OPD visit of patients with disease j

$T\_OPD\_Patient_j$ = Total number of outpatients with disease j in 2009

The total number of patients with disease j ($T\_OPD\_Patient_j$), average number of OPD visit of patients with disease j per year ($frenquency_j$) and the average cost per OPD visit of patient with disease j (OPD_cost_j) were obtained from the 2007 database of the Center for Health Equity Monitoring (CHEM), Faculty of Medicine, Naresuan University. This database includes outpatient information covered by National Health Security Office and Civil Medical Service Scheme in 675 hospitals from 75 provinces. Therefore, it is assumed that these patients account for 80% of total outpatient from these two health insurance schemes. Also, it is assumed that the total number of patients covered by these two schemes is accounted for 80% of the total number of patients in the country. By using these assumptions,, the total number of outpatients in Thailand in 2009 ($T\_OPD\_Patient_j$), can be further estimated.

3.3.4.2 Computing costs of obesity in inpatient department

Treatment costs of in- patients with obesity-induced disease j will be calculated by multiplying the number of patients with obesity-induced disease j ($IPD\_N\_Obese_j$) by the average number of admissions of patient with disease j per year ($N\_Admission_j$) and the average cost per admission (IPD_cost_j), as follows:

$$EX\_IPD = \sum_{j=1}^{12} (IPD\_N\_Obese_j * N\_Admission_j * IPD\_cost_j)$$

Where;

$$IPD\_N\_Obese_j = OAF_j * T\_IPD\_patient_j$$

$IPD\_N\_Obese_j$ = Total number of in-patients with obesity-induced disease j

$N\_Admission_j$ = Average number of admission by patient with disease j per year

IPD_cost_j = Average cost per admission of in-patients with disease j

$T\_IPD\_patient_j$ = Total number of in-patients with disease j in 2009

The number of patients with obesity-induced disease j ($IPD\_N\_Obese_j$) will be calculated by multiplying the number of patients with disease j during the year with attributable fraction of obesity (OAFj) and the proportion of patients. Average number of admissions by patients with disease j ($N\_Admission_j$) was calculated by

dividing total number of admission of in-patients with disease j with the total number of in-patients with disease j during the year.

Average number of admissions by patients with disease j ($N\_Admission_j$) and average cost per admission of in-patients with disease j (IPD_cost_j) was obtained from the Central Office for Healthcare Information's 2007 database. This database includes in-patient information covered by National Health Security Office and Civil Medical Service Scheme through out the country. Therefore, it is assumed that these patients accounted for 70% of total admissions in Thailand. By using this assumption, the total number of in-patients with disease j in 2009 ($T\_IPD\_patient_j$) can be further estimated.

3.3.5 Estimation of cost of productivity loss due to premature mortality attributable to obesity

To estimating cost of premature mortality, human capital approach is employed.

The costs will be calculated by multiplying the number of deaths associated with obesity in 2009, by age and gender, with average wage each person would receive if he or she lived through his or her lifespan. Workforce participation rates by age and gender will also be taken into account. The result then will be subject to a discount rate of 3%, as suggested by the Handbook for Health Technology Assessment in Thailand (67).

$$C\_premature = \sum_{j=1}^{8} N\_Obese_j * Inc\_life$$

Where,

N_Obese_j = The number of deaths caused by obesity-induced disease j

Inc_life = The average earning the patients would receive if they live through their lifespan

$$Inc\_life = \sum_{t=1}^{8} \frac{av\_cost * Emp}{(1+dis)^t}$$

Where

av_cost_t = The average earning a person would receive if he or she lives for another t year

Emp = Workforce participation rate by gender and age

dis = Discount rate

t = The number of years from death to expected lifespan

The expected lifespan was obtained from Thai Burden of disease project 2004. Workforce participation rate (Emp) and average earning a person would receive if he or she lived for another t year(av_cost_t) by gender and age was calculated by the National Statistic Office using National Economic and Social Survey 2009, as shown below in table 3.4.

Table 3.4. Average earning per year, workforce participation rate and average earning the patients would receive if they live through their lifespan by age and gender

Age (years)/ Sex	Annual income		Work force participation rate		Average earning through lifespan*		Average earning through lifespan**		Average earning through lifespan***	
	Male (Baht)	Female (Baht)	Male (%)	Female (%)	Male (Baht)	Female (Baht)	Male (Baht)	Female (Baht)	Male (Baht)	Female (Baht)
15 – 29	70,933	78,144	69.3	54	4,985,419	3,546,339	2,494,592	1,903,773	1,444,918	1,156,832
30 – 44	106,252	103,190	96.5	85	3,968,629	2,597,339	2,555,422	1,799,117	1,788,582	1,326,524
45 - 59	153,767	142,193	93.7	76	2,214,899	1,140,462	1,720,160	962,550	1,397,933	834,130
60 - 69	107,745	51,485	68.1	43	818,106	189,937	677,489	164,345	576,767	145,202
70 - 79	87,989	29,069	35.2	17	325,867	41,183	278,626	36,180	242,359	32,271
More than 80	135,664	32,036	12.5	4	194,000	12,814	168,078	11,259	147,441	9,997

* discount rate 0%

** discount rate 3%

***discount rate 6%

Source: The National Statistic Office's National Economic and Social Survey 2009

3.3.6 Computing the total cost of obesity in Thailand Population

Summation of cost of obesity in inpatient department and outpatient department are the total health care cost of obesity. The summation of total health care cost and cost of premature mortality is the total cost of obesity in Thailand.

3.3.7 Sensitivity analysis

Univariate sensitivity analyses were conducted to investigate the influence of various factors on the calculated costs, such as the discount rates, definitions of obesity and prevalence of obesity. (Table 3.5).

Table 3.5. Sensitivity analysis

Variable / method
1) Discount rate
None
3% (Base case)
6%
2) Premature mortality
Exclude value for non-labour worker (Base case)
Include value for non-labour worker
3) Premature mortality
No effect of retirement age (Base case)
Effect of introducing a retirement age of 60
4) Prevalence of obesity
4^{th} National Health Examination Survey (Base case)
Increase 10%
Decrease 1%
5) BMI cut off point
BMI $\geq$ 25 kg/m^2 (Base case)
BMI $\geq$ 30 kg/m^2

CHAPTER IV
RESULTS

The results were divided into 5 parts as follows.

4.1 Obesity – attributable fractions (OAFs) of selected diseases

4.2 Number of patients in each disease attributable to obesity

4.3 Average treatment cost of each disease in inpatients and outpatients departments

4.4 Cost of overweight and obesity in outpatient department

4.5 Cost of overweight and obesity in inpatient department

4.6 Total health care cost of obesity

4.7 Cost of productivity loss due to premature mortality attributable to obesity

4.8 Total cost of obesity in Thai Population, 2009

4.9 Sensitivity analysis

4.1 Obesity – attributable fractions (OAFs) of selected diseases

The OAFs of 12 selected diseases indicating the proportion of cases attributable to obesity are shown in table 4.1.

Table 4.1. Relative risk and Obesity Attributable Fractions (OAFs)

Disease	Relative Risk				OAFs (%)	
	Male		Female		Male	Female
	BMI ≥ 25.0-29.9 kg/m^2	BMI ≥ 30 kg/m^2	BMI 25.0-29.9 kg/m^2	BMI ≥ 30 kg/m^2		
Breast Cancer (68)	-	-	1.08	1.13	-	2
Colon and rectal Cancer(68)	1.51	1.95	1.45	1.66	8	9
Depression(69)	1.30	1.31	0.98	1.67	4	3
Diabetes Mellitus(68)	2.40	6.47	3.92	12.41	24	52
Endometrial Cancer (68)	-	-	1.53	3.22	-	17
Gall Bladder (68)	1.09	1.43	1.44	2.32	2	12
Hypertension(68)	1.28	1.84	1.65	2.42	5	15
Ischaemic heart disease (70)	3.02	4.37	3.02	4.37	25	33
Obesity(68)	1.00	1.00	1.00	1.00	100	100
Osteoarthritis(68)	2.76	4.20	1.80	1.96	23	15
Pulmonary Embolism(68)	1.91	3.51	1.91	3.51	15	22
Stroke(68)	1.23	1.51	1.15	1.49	4	5

4.2Number of patients in each disease attributable to obesity

In estimating health care cost associated with obesity in 2009, the total number of patients in each disease attributable to obesity in that year must be firstly identified**.** This number was calculated as the product of the OAFs and the total number of patients with that disease in Thailand 2009, classified by gender**.** The number of out-patients in each disease attributable to obesity in Thailand, 2009 are shown in table 4.2.

Table 4.2. The number of morbidity attributable to obesity in outpatient department in 2009, classified by types of disease and gender (ranked by maximum to minimum)

No.	Disease Conditions	Number of patients attributable to obesity (person)		Total (person)
		Male	Female	
1	Diabetes Mellitus	63,376	274,451	337,827
2	Hypertension	20,537	92,211	112,748
3	Osteoarthritis	16,296	29,578	45,874
4	Ischaemic heart disease	6,743	6,537	13,280
5	Obesity	2,761	6,736	9,497
6	Stroke	3,218	3,016	6,235
7	Gall Bladder	218	2,180	2,398
8	Colon and rectal Cancer	951	1,050	1,965
9	Depression	430	817	1,247
10	Breast Cancer	-	649	649
11	Endometrial Cancer	-	504	504
12	Pulmonary Embolism	22	36	58
	Total	114,516	417,765	532,281

Table 4.3. The number of morbidity attributable to obesity in inpatient department in 2009, classified by types of disease and gender (ranked by maximum to minimum)

No.	Disease Conditions	Number of patients attributable to overweight and obesity (persons)		Total (persons)
		Male	Female	
1	Diabetes Mellitus	10,361	41,945	52,306
2	Ischaemic heart disease	17,251	18,177	35,428
3	Hypertension	1,044	5,325	6,369
4	Stroke	2,510	2,534	5,044
5	Colon and rectal Cancer	2,160	2,171	4,331
6	Gall Bladder	433	3,797	4,230
7	Osteoarthritis	788	2,057	2,845
8	Endometrial Cancer	-	897	897
9	Breast Cancer	-	712	712
10	Obesity	160	145	305
11	Pulmonary Embolism	38	128	166
12	Depression	47	104	151
	Total	34,792	77,992	112,784

From table 4.2, 531,128 patients received treatment at outpatient department in Thailand, 2009 as the result from obesity (i.e., 114,516 male and 417,765 female). When looking at the number of in-patient department, 112,784 patients were hospitalized in 2009 as the result from obesity (34,792 male and 77,992 females, as shown in table 4.3)

For outpatient department, the top three diseases that lead to the highest number of patients in out-patient department are diabetes mellitus (337,827 people), hypertension (112,748 people), osteoarthritis (45,874 people), respectively (as shown in table 4.2). On the other hand, the top three diseases that lead to the highest number of patients in in-patients department are diabetes mellitus (52,306 people), ischaemic heart disease (35,428 people), hypertension (6,368 people) (as shown in table 4.3)

Table 4.4. Number of morbidity attributable to obesity in 2009 classified by types of service and gender

Type of service	Number of patients (person)		Total (person)
	Male	female	
Outpatient	114,516	417,765	532,281
Inpatient	34,792	77,992	112,784

As shown in table 4.4, the total number patients received treatment at outpatient and inpatient department in Thailand, 2009 was 532,281 and 112,784, respectively. The number of female patients is higher than male patients in both OPD department and IPD department.

4.3 Average treatment cost of each disease in Inpatients and Outpatients department

Average annual treatment cost of each disease in outpatient department could be derived from the 2007 outpatient database obtained from Center of Health

Equity Monitoring (CHEM), Faculty of Medicine, Naresuan University. The average cost of each disease was then adjusted with inflation rate to 2009 prices.

Average annual treatment cost of each disease in inpatient department was derived from the 2007 inpatient database of Central Office for Healthcare Information (COHI). The average cost of each disease was then adjusted with inflation rate to 2009 prices.

Average treatment cost of each disease in Inpatients and Outpatients department were shown in table 4.5 and 4.6.

Table 4.5. Average annual treatment costs in out-patient department (ranked by alphabetical)

No.	Disease Conditions	Average cost per visit (baht)	Average visit/year (times)	Average annual treatment cost (baht)
1	Breast Cancer	714	2.51	1,792
2	Colon and rectal Cancer	944	2.41	2,266
3	Depression	325	2.51	813
4	Diabetes Mellitus	352	5.60	1,961
5	Endometrial Cancer	219	1.91	418
6	Gall Bladder	215	1.36	292
7	Hypertension	241	4.61	1,103
8	Ischaemic heart disease	400	1.57	624
9	Obesity	166	1.65	276
10	Osteoarthritis	295	1.85	543
11	Pulmonary Embolism	112	1.77	197
12	Stroke	473	2.20	1,031
	Total	354	2.50	874

Average cost per visit in outpatient department ranged between 112 and 944 baht for treatment of pulmonary embolism and colon and rectal cancer, respectively. The average annual cost of treatment in OPD department ranged between 197 and 2,266 baht for treatment of pulmonary embolism and colon and rectal cancer, respectively.

Table 4.6. Average annual treatment costs in in-patient department (ranked by alphabetical)

No.	Disease	Average cost per admission (baht/admission)	Average admission/year (times)	Average annual Treatment cost (baht)
1	Breast Cancer	25,277	1.84	46,510
2	Colon and rectal Cancer	22,376	1.17	26,180
3	Depression	19,148	2.58	49,402
4	Diabetes Mellitus	10,613	4.85	51,473
5	Endometrial Cancer	17,660	1.05	18,543
6	Gall Bladder	40,631	1.14	46,319
7	Hypertension	24,375	1.22	29,738
8	Ischaemic heart disease	34,826	1.08	37,612
9	Obesity	7,547	1.07	8,075
10	Osteoarthritis	33,090	2.58	85,372
11	Pulmonary Embolism	9,973	1.11	11,070
12	Stroke	44,733	1.05	46,970
	Total	22,808	1.68	38,317

As shown in the table, average cost per admission ranged between 7,547 and 44,733 baht for obesity and stroke, respectively. Average annual treatment cost ranged between 8,075 and 85,372 baht for obesity and osteoarthritis, respectively.

4.4 Health care cost of obesity in outpatient department

The top three leading causes of health care cost in out-patient department are diabetes mellitus (670.8 million baht), hypertension (126.1 million baht), and osteoarthritis (25.1 million baht), respectively. (Table 4.7) Cost incurred by female was higher than male in all diseases except ischaemic heart disease and stroke.

Table 4.7. Health care costs attributable to overweight and obesity in outpatient department classified by gender (ranked by maximum to minimum)

No.	Disease Conditions	Number of patients attributable to obesity (Person)		Cost associated with OPD service (Baht)		Total cost (Baht)
		Male	Female	Male	Female	
1	Diabetes Mellitus	63,376	274,451	125,858,774	545,036,272	670,895,046
2	Hypertension	20,537	92,211	22,982,492	103,188,263	126,170,755
3	Osteoarthritis	16,296	29,578	8,950,320	16,245,801	25,196,121
4	Ischaemic heart disease	6,743	6,537	4,267,138	4,136,264	8,403,402
5	Stroke	3,218	3,016	3,368,921	3,157,306	6,526,227
6	Colon and rectal Cancer	951	1,050	2,101,953	2,411,003	4,512,956
7	Obesity	2,761	6,736	762,378	1,859,995	2,622,373
8	Breast Cancer	-	649	-	1,172,690	1,172,690
9	Depression	430	817	352,989	670,774	1,023,763
10	Gall Bladder	218	2,180	64,186	642,415	706,601
11	Endometrial Cancer	-	504	-	212,854	212,854
12	Pulmonary Embolism	22	36	4,341	7,233	11,574
	Total	114,552	417,765	168,713,493	678,740,871	847,454,364

4.5 Health care cost of obesity in inpatient department

The top three leading causes of health care cost incurred in inpatient department are diabetes mellitus (2,715.8 million baht), ischaemic heart disease (1,062.1 million baht), and colon and rectal cancer (372.7 million baht), respectively. (Table 4.8)

Table 4.8. Health care costs attributable to obesity in inpatient department classified by gender (ranked by maximum to minimum)

No.	Disease Conditions	Number of patients attributable to obesity (person)		Cost associated with IPD service (baht)		Total cost (baht)
		Male	Female	Male	Female	
1	Diabetes Mellitus	10,361	41,945	537,951,441	2,177,808,483	2,715,759,924
2	Ischaemic heart disease	17,251	18,177	517,209,424	544,962,973	1,062,172397
3	Colon and rectal Cancer	2,160	2,171	185,895,269	186,872,472	372,767,741
4	Stroke	2,510	2,534	95,496,805	96,417,512	191,914,317
5	Osteoarthritis	788	2,057	37,319,875	97,381,103	134,700,987
6	Gall Bladder	433	3,797	11,433,242	100,331,349	111,764,591
7	Hypertension	1,044	5,325	8,462,766	43,181,839	51,644,605
8	Endometrial Cancer	-	897	-	42,118,355	42,118,355
9	Breast Cancer	-	712	-	35,411,664	35,411,664
10	Pulmonary Embolism	38	128	1,771,880	5,927,890	7,699,770
11	Obesity	160	145	2,996,288	2,715,386	5,711,674
12	Depression	47	104	527,213	1,165,618	1,692,832
	Total	34,792	77,992	1,399,064,203	3,344,294,644	4,733,358,857

4.6 Total health care cost of obesity in Thai Population in 2009

The total health care cost attributable to obesity was the summation of cost of obesity in inpatient department and outpatient department. The total health care cost attributable to obesity classified by types of disease and gender was displayed in table 4.9.

The top three leading causes of health care cost are diabetes mellitus (3,387 million baht), ischaemic heart disease (1,071 million baht), and colon and rectal cancer (377 million baht), respectively. (Table 4.9 and figure 4.1)

Table 4.10 summarized the total health care costs attributable to obesity classified by types of service and gender. As shown in table 4.10, health care costs attributable to obesity in Thailand, 2009 was 5,580,813,211 baht. Health care cost incurred in inpatient department (4,733,358,847 baht) was higher than that of out-patient department (847,454,364 baht). In addition, total health care cost incurred by female was approximately two point five times higher than that of male.

Table 4.9. Total health care cost attributable to obesity classified by types of disease and gender (ranked by maximum to minimum)

No.	Disease Conditions	Cost associated with OPD& IPD service (baht)		Total health care cost (baht)
		Male	Female	
1	Diabetes Mellitus	663,810,215	2,722,844,755	3,386,654,970
2	Ischaemic heart disease	521,456,562	549,099,237	1,070,575,799
3	Colon and rectal Cancer	187,997,222	189,283,475	377,280,697
4	Stroke	98,845,726	99,574,818	198,440,544
5	Hypertension	31,445,258	146,370,102	177,815,360
6	Osteoarthritis	46,270,194	113,626,905	159,897,099
7	Gall Bladder	11,497,428	100,973,764	112,471,192
8	Endometrial Cancer	-	42,331,209	42,331,209
9	Breast Cancer	-	36,584,354	36,584,354
10	Obesity	3,758,666	4,575,382	8,334,048
11	Pulmonary Embolism	1,776,221	5,935,123	7,711,344
12	Depression	880,202	1,836,393	2,716,595
	Total	1,567,777,694	4,013,035,517	5,580,813,211

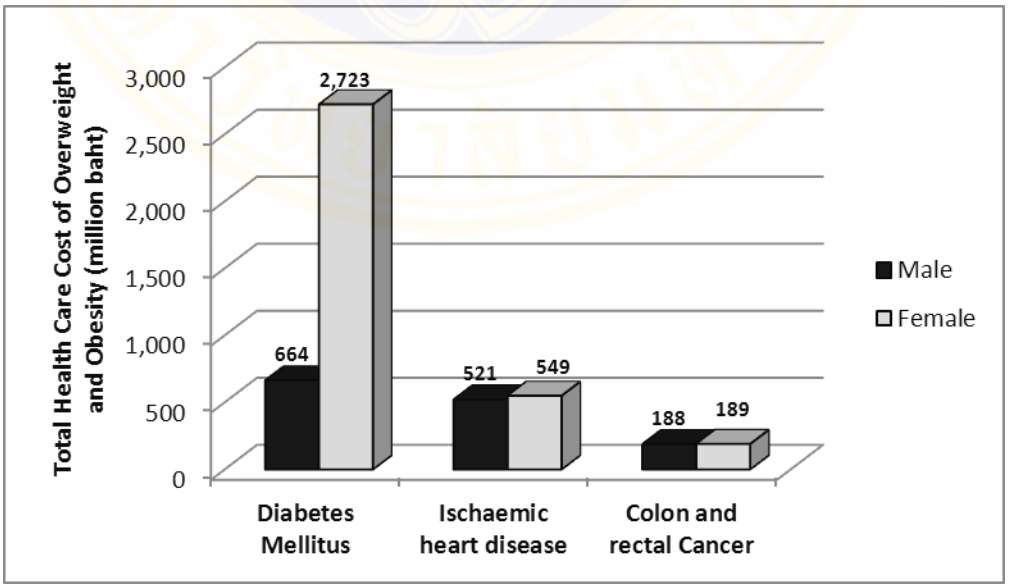

Figure 4.1. The top three leading causes of health care cost attributable of obesity

Table 4.10. Total health care costs attributable to obesity classified by types of service and gender

Type of service	Number of patients (persons)		Health care cost (baht)		Total health care cost (baht)
	Male	Female	Male	female	
Out-patient	114,552	417,765	168,713,493	678,740,871	847,454,364
In-patient	34,792	77,992	1,399,064,203	3,334,294,644	4,733,358,847
Total	149,308	495,756	1,567,777,694	4,013,035,517	5,580,813,211

4.7 Cost of productivity loss due to premature mortality attributable to obesity

To estimate cost of productivity loss due to premature mortality, human capital approach will be employed in this study. The cost will be calculated by multiplying the number of deaths attributable to obesity in 2009, by age and gender, with average wage each person would receive if he or she lived through his or her lifespan. Workforce participation rates by age and gender will also be taken into account. A discount rate of 3% was applied as suggested by the Handbook for Health Technology Assessment in Thailand. The expected lifespan is obtained from Thai Burden of disease project 2004. The average wages per year by age and gender was calculated by the National Statistic Office based on the National Economic and Social Survey 2009

Table 4.11. Years to life throughout the lifespan of the average wage and, if alive by sex and age

Age (years)	Male				Female			
	Number of years expected to live (years)	Average wages in 2009* (baht/year)	Workforce participation rate	Average wages throughout the life span (baht)	Number of years expected to live (years)	Average wages of in 2009* (baht/year)	Workforce participation rate	Average wages throughout the life span (baht)
15-29	52	70,933	69	2,494,592	58	78,144	54	1,903,773
30-44	40	106,252	97	2,555,422	45	103,190	85	1,799,117
45-59	28	153,767	94	1,720,160	31	142,193	76	962,550
60-69	19	107,745	68	677,489	21	51,485	43	164,345
70-79	13	87,989	35	278,626	14	29,069	17	36,180
80+	9	135,664	13	168,078	9	32,036	4	11,259

* discount rate 3%

Table 4.12 displays the total number of mortality attributable to obesity in 2009. It was found that the top three leading causes of mortality attributable to obesity were are diabetes mellitus (9,330 people), ischaemic heart disease (7,039 people), and stroke (2,160 people), respectively.

The total cost of premature mortality attributable to obesity in 2009 was estimated at 9,328,564,863 Baht. The cost incurred in male is higher than male. The top three leading causes of premature mortality cost attributable to obesity were diabetes mellitus (approximately 4,000 Million baht), ischaemic heart disease (approximately 3,700 Million baht), and stroke (approximately 1,000 Million baht), respectively.

The total number of year loss due to premature mortality attributable to obesity in 2009 was estimated at 366,370 years. The number of year loss in female was higher than male. The top three leading causes of year of life loss attributable to obesity were diabetes mellitus (approximately 180,000 years), ischaemic heart disease (approximately 130,000 years), and stroke (approximately 37,000 years), respectively.

The top three leading causes of productivity loss and total number of year loss due to premature mortality are diabetes mellitus (4,031 million baht and 180,211 years), ischaemic heart disease (3,714 million baht and 127,271 years), and stroke (1,001 million baht and 36,383 years), respectively (as shown in table 4.12-4.14 and figure 4.2).

Table 4.12. Number of mortality attributable to obesity in 2009, classified by types of disease and gender (ranked by maxium to minimum)

No.	Disease	Number of mortality attributable to obesity (person)		Total (person)
		Male	Female	
1	Diabetes Mellitus	2,021	7,309	9,330
2	Ischaemic heart disease	3,237	3,802	7,039
3	Stroke	922	1,238	2,160
4	Colon and rectal Cancer	254	292	546
5	Hypertensive heart disease	58	391	449
6	Breast Cancer	-	89	89
7	Endometrial Cancer	-	45	45
8	Osteoarthritis	18	23	41
	Total	6,510	13,189	19,699

Table 4.13. Total cost of productivity loss due to premature mortality attributable to obesity classified by types of disease and gender (ranked by maximum to minimum)

No.	Disease Conditions	Cost of productivity loss due to premature mortality attributable to obesity (baht)		Total cost of productivity loss (baht)
		Male	Female	
1	Diabetes Mellitus	1,652,084,807	2,378,429,378	4,030,514,185
2	Ischaemic heart disease	2,812,437,698	901,203,589	3,713,641,287
3	Stroke	729,718,178	271,014,592	1,000,732,770
4	Colon and rectal Cancer	246,372,247	119,354,582	365,726,829
5	Hypertensive heart disease	41,243,684	75,655,050	116,898,734
6	Breast Cancer	-	76,542,583	76,542,583
7	Endometrial Cancer	-	18,260,660	18,260,660
8	Osteoarthritis	4,558,083	1,689,732	6,247,815
	Total	5,486,414,697	3,842,150,166	9,328,564,863

Table 4.14. Total number of year loss due to premature mortality attributable to obesity classified by types of disease and gender (ranked by maxium to minimum)

No.	Disease Conditions	Number of year loss due to premature mortality attributable to overweight and obesity (years)		Number of year loss (years)
		Male	Female	
1	Diabetes Mellitus	37,523	142,688	180,211
2	Ischaemic heart disease	62,477	64,794	127,271
3	Stroke	16,702	19,681	36,383
4	Colon and rectal Cancer	5,201	6,017	11,218
5	Hypertensive heart disease	1,015	6,212	7,227
6	Breast Cancer	-	2,593	2,593
7	Endometrial Cancer	-	993	993
8	Osteoarthritis	197	277	474
	Total	123,115	243,255	366,370

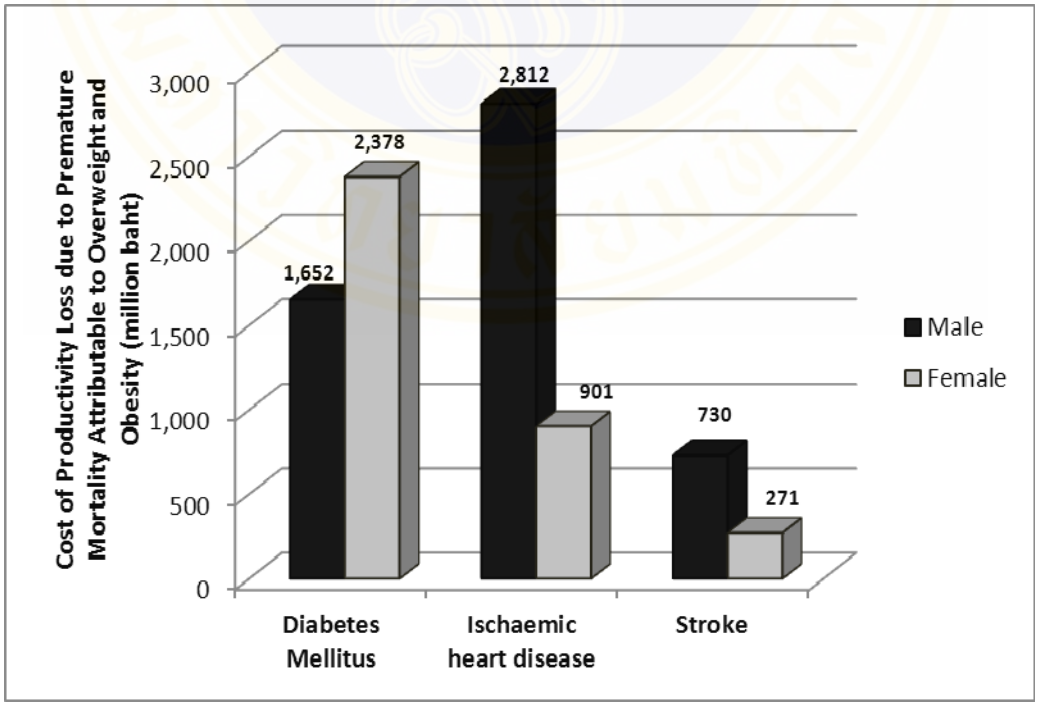

Figure 4.2. The top three leading causes of premature mortality cost attributable to obesity

4.8 Computing the total cost of obesity in Thai Population, 2009

The economic cost attributable to obesity in Thailand in 2009 was estimated at 14,904 Million baht, as shown in table 4.15. This represents 0.19 % of the national GDP. Indirect cost outweighed the direct cost, representing approximately 63% of the total cost.

Health care costs were estimated at 5,581 million baht. The cost incurred in IPD was significantly higher than that incurred in OPD. Health care cost attributable to obesity accounted for 2.18% of national health expenditure in 2009. Cost of premature mortality was estimated at 9,328 Million Baht.

Table 4.15. Estimates of the economic cost of obesity in Thailand 2009.

	Million baht (2009)
Direct cost	
Health care cost	5,581
OPD cost	848
IPD cost	4,733
Indirect cost	
Cost of premature mortality	9,328
Total costs in million baht	14,909
Total cost as % of GDP	0.19
Total Health care cost as % of National Health expenditure	2.18

4.9 Sensitivity analysis

A number of sensitivity analyses were conducted to examine whether the results were sensitive to the changes of important assumptions or parameters. As shown in table 4.16, the total estimates range from 11,023 million baht to 26,080 million baht.

Table 4.16. Results from sensitivity analyses

Parameters/ Methods		Total estimated (Million baht)
Discounting rate		
	0%	17,813
	3% (Base case)	14,909
	6%	13,113
Premature mortality		
	Exclude value for non-labour worker (Base case)	14,909
	Include value for non-labour worker	26,080
Premature mortality		
	No effect of a retirement age (Base case)	14,909
	Effect of introducing a retirement age of 60	11,023
Prevalence of obesity		
	4th Nation Health Examination Survey (Base case)	14,909
	Increase 10%	15,848
	Decrease 1%	14,813
BMI cut off point (kg/m^2)	≥ 25 (Base case)	14,909
	≥ 30	13,853

CHAPTER V
DISCUSSION

Similar to the developed countries, economic impact of obesity in Thailand was substantial. Health care cost attributable to obesity in Thailand, in 2009 was estimated at 5,581 million baht, or 2.18% of the total health expenditure in the country. Cost of productivity loss due to premature mortality was responsible for approximately 9,328 million baht. Total cost attributable to obesity was 14,909 million baht, accounted for 0.19 % of gross domestic product (GDP).

In term of total cost, this estimate is consistent, although at the lower end, with the recent review in Europe (13), which indicated that the economic burden attributable form obesity ranged between 0.09% to 0.61% of GDP. Nevertheless, this estimate may be lower than the actual cost since indirect cost due to absenteeism, presenteeism, disabilities, and loss employment were not taken into account in this study.

For health care cost, the findings from this study was in line with the recent review(42), which found that health care cost attributable to obesity ranged between 0.7% to 2.8% of a country's total health expenditure. However, these figures were lower than those in the US (15) and Hong Kong (17) which found that obesity accounted for 5.5-7.0% and 8.2-9.8%, respectively.

It is worth noting that, health care cost attributable to obesity was as comparable to those of important risk factors such tobacco and alcohol. In the US, excess health care cost attributable to obesity has been found to equal or exceed those of smoking (71-72).

In Thailand, health care cost attributable to obesity is similar although slightly higher than health care cost attributable to alcohol, which was estimated at approximately 5,500 million baht (2006 value).

Concerning the total cost, cost of premature mortality was slightly outweighed health care cost, representing about 60% of the total cost. This is

consistent with several studies that included both health care cost and premature mortality cost in their estimates, which found that indirect cost range between 25% to 63% of the total cost(41). However, when the total cost was compared, economic cost due to obesity was lower from those of alcohol. This can be explained by the fact that premature mortality associated with alcohol is higher than those of obesity since consequences of obesity on health are chronic diseases, which occurs at the older age as the long term consequence of fat accumulation. The most common diseases attributable to obesity identified in this study are similar to those of previous studies, which included diabetes, ischaemic stroke and hypertension. In line with previous study, which indicated that obesity accounted for 60-90% of causes of diabetes in Asia(73). This study found that obesity accounted for about 52% of diabetes patients. In addition, this study found that costs of diabetes treatment were found to be the largest healthcare costs as well as cost of premature mortality associated with obesity. Weight reduction was recommended as an efficient mean to prevent diabetes(73).

According to the sensitivity analysis, if the prevalence of obesity in the country increased by 10% the total cost will increase about 1,100 million baht. On the other hand if the prevalence of obesity decreased by 1%, the total cost will decrease about 100 million baht. As the prevalence of obesity is likely to rise in Thailand including obesity in children (30, 38, 74-75), more attention is required to attenuate the impact of the obesity on economic, especially health care cost. However, policies or interventions aimed at reducing health care consequences due to obesity received less support as compared to those related to alcohol or other risk factors. Therefore, raising social awareness about harmful of obesity should be the first step in building support in policy formulation in the country.

The limitation for this study lies in the validity of secondary data it used. Costs per visit of outpatients were collected only from outpatient database of Center of Health Equity Monitoring (CHEM), Faculty of Medicine, Naresuan University. Although it may not represent the Thai population as a whole, this database is the largest in Thailand. It collects data from 675 hospitals in 75 provinces across the country. Therefore, the data is reliable to some extent. For inpatients, the data was from the database of Center Office of Healthcare Information’s database, which included only patients covered by government healthcare schemes and the universal

healthcare scheme. These patients were assumed to account for 80% of all patients. This assumption need to be proven further.

In addition, the relative risk used in this study was taken from earlier studies done abroad. Even so, the figure was inferred after a careful review of literature. The estimated figure could have been more accurate if figures regarding diabetes and cardiovascular diseases in Thailand are more available. In addition, RRs can be classified into two categories namely RRs for incidence or RRs for mortality for the health consequences related to obesity. In this study, RRs for incidence were used to calculate both health care cost and cost of premature mortality. Therefore, the cost of premature mortality may be slightly overestimated since obesity is more related to incidence of disease more than mortality.

In this study, BMI was used as a measure of obesity in this study since it can correctly predict the risk of obesity on health conditions as well as mortality. In addition, it is inexpensive, fast, easy, and widely use anthropometric method, however, it cannot distinguish between fat and fat-free components. The usefulness of using other anthropometric methods to calculate cost of obesity, such as waist-hip-ratio deserved further investigation.

Compared with previous studies, of which cost attributable to obesity were estimated from 6-12 diseases, this study estimated healthcare costs associated with 12 diseases. However, some diseases, such as sleep apnea and asthma, were not included due to unavailability of information. Cost of productivity loss due to premature mortality associated with only 8 diseases. Nevertheless, most diseases believed to be associated with obesity and important in Thais' context was included in this study, the estimated should be minimally underestimated.

As mentioned, earlier, this study did not take into account other costs related to obesity such as absenteeism or productivity losses. Therefore, to understand the real magnitude impact of obesity on the society these cost should be further investigated, In addition, the psychosocial impact of obesity especially on quality of life should be further investigated.

CHAPTER VI
CONCLUSION

Economic cost of obesity in Thailand is substantial. The results of this study could be used as concrete evidence to promote the awareness among Thai people of the economic impact of obesity. They can also be used to support the campaign aims at reducing unhealthy behavior such as consumption of less sweet, fat, salt, carbonated drinks, coffee and sugar-added fruit juice while promoting healthy behavior such as consumption of more fruit and vegetable as well as regular exercise.

The result of this study can also be used to craft an appropriate healthcare policy to reduce the prevalence of obesity. For example, food and drinks likely to increase consumer weight might be taxed more. The amount of sugar of added to food and drinks might be regulated. While tax measures have long been applied to liquor and cigarettes, such measure have not been applied seriously to high-fat and high-sugar food.

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APPENDICES

APPENDIX A

SOURCE OF CATEGORY OF ESTABLISHMENT USING FOR CALCULATED COST IN OUTPATIENT DEPARTMENT

No.	Classification of Hospital	Number of hospital (places)
1.	Center Hospital	25
2.	General Hospital	64
3.	Hospital Community	578
4.	Hospital without National Health Security office controlled	2
5.	Hospital without Ministry of Public health controlled	6
	Total	675

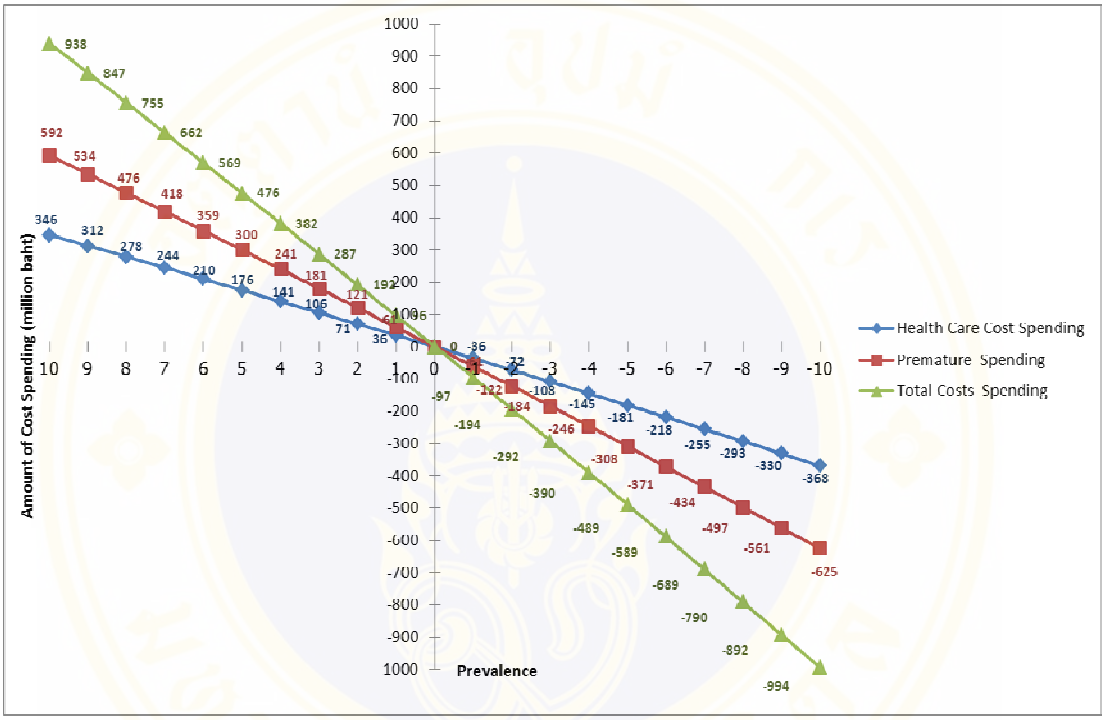
APPENDIX B

COST OF PRODUCTIVITY LOSS DUE TO PREMATURE MORTALITY ATTRIBUTABLE TO OBESITY

no.	Diseases / Conditions	Age	Number of pass away		OAFs		Number of pass away by obesity		Cost of lossing (baht)		Number of year loss	
			Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1	Diabetes Mellitus	0-4	1	-	0.24	0.52	0	-	-	-	-	-
		5-14	1	-	0.24	0.52	0	-	-	-	-	-
		15-29	56	53	0.24	0.52	14	28	33,882,015	52,544,742	709	1,613
		30-44	590	675	0.24	0.52	143	352	365,675,802	632,413,961	5,666	15,650
		45-59	1,656	2,527	0.24	0.52	402	1,316	690,892,930	1,266,679,656	11,109	40,849
		60-69	2,040	3,912	0.24	0.52	495	2,037	335,207,784	334,805,562	9,218	42,404
		70-79	2,380	3,985	0.24	0.52	577	2,075	160,834,745	75,081,919	7,309	28,738
		80+	1,609	2,883	0.24	0.52	390	1,501	65,591,529	16,903,540	3,513	13,433
		total	8,333	14,035	-	-	2,021	7,309	1,652,084,807	2,378,429,378	37,523	142,688
2	Ischaemic heart disease	0-4	-	1	0.25	0.33	-	0	-	-	-	-
		5-14	10	-	0.25	0.33	2	-	-	-	-	-
		15-29	157	40	0.25	0.33	39	13	96,361,747	25,021,305	2,016	768
		30-44	1,125	468	0.25	0.33	277	154	707,327,499	276,656,010	10,959	6,846
		45-59	2,627	1,310	0.25	0.33	646	430	1,111,819,529	414,313,830	17,877	13,361
		60-69	3,309	2,367	0.25	0.33	814	778	551,574,912	127,817,011	15,168	16,189
		70-79	3,666	3,672	0.25	0.33	902	1,207	251,315,449	43,652,216	11,420	16,708
		80+	2,274	3,715	0.25	0.33	559	1,221	94,038,563	13,743,217	5,036	10,922
		total	13,168	11,573	-	-	3,237	3,802	2,812,437,698	901,203,589	62,477	64,794
3	stroke	0-4	-	1	0.04	0.05	-	0	-	-	-	-
		5-14	4	1	0.04	0.05	0	0	-	-	-	-
		15-29	128	164	0.04	0.05	5	8	12,559,798	14,936,929	263	459
		30-44	1,803	933	0.04	0.05	71	45	181,230,559	80,305,148	2,808	1,987
		45-59	4,335	2,813	0.04	0.05	171	135	293,312,797	129,537,453	4,716	4,177
		60-69	5,059	3,564	0.04	0.05	199	171	134,815,585	28,021,771	3,707	3,549
		70-79	6,356	6,964	0.04	0.05	250	333	69,659,171	12,053,963	3,165	4,614
		80+	5,769	11,435	0.04	0.05	227	547	38,140,268	6,159,327	2,043	4,895
		total	23,454	25,875	-	-	922	1,238	729,718,178	271,014,592	16,702	19,681
4	Colon and rectal Cancer	0-4	2	3	0.08	0.09	0	0	-	-	-	-
		5-14	1	5	0.08	0.09	0	0	-	-	-	-
		15-29	45	38	0.08	0.09	4	4	8,829,094	6,800,411	185	209
		30-44	312	259	0.08	0.09	25	24	62,707,753	43,802,170	972	1,084
		45-59	805	611	0.08	0.09	63	57	108,910,244	55,284,191	1,751	1,783
		60-69	787	641	0.08	0.09	62	60	41,935,429	9,902,618	1,153	1,254
		70-79	813	818	0.08	0.09	64	77	17,816,233	2,782,009	810	1,065
		80+	467	740	0.08	0.09	37	70	6,173,494	783,182	331	622
		total	3,232	3,115	-	-	254	292	246,372,247	119,354,582	5,201	6,017
5	Hypertensive heart disease	0-4	12	4	0.05	0.15	1	1	-	-	-	-
		5-14	-	-	0.05	0.15	-	-	-	-	-	-
		15-29	15	1	0.05	0.15	1	0	1,998,423	286,205	42	9
		30-44	51	64	0.05	0.15	3	10	6,960,321	17,310,147	108	428
		45-59	160	281	0.05	0.15	9	42	14,698,915	40,662,211	236	1,311
		60-69	291	453	0.05	0.15	16	68	10,529,113	11,192,192	290	1,418
		70-79	318	841	0.05	0.15	17	126	4,732,002	4,574,316	215	1,751
		80+	259	963	0.05	0.15	14	145	2,324,911	1,629,981	125	1,295
		total	1,106	2,607	-	-	58	391	41,243,684	75,655,050	1,015	6,212
6	Breast Cancer	0-4	-	-	NA	0.03	NA	-	-	-	-	-
		5-14	-	-	NA	0.03	NA	-	-	-	-	-
		15-29	-	34	NA	0.03	NA	1		1,758,740		54
		30-44	4	742	NA	0.03	NA	20		36,271,943		898
		45-59	4	1,368	NA	0.03	NA	37		35,778,068		1,154
		60-69	9	513	NA	0.03	NA	14		2,290,764		290
		70-79	10	381	NA	0.03	NA	10		374,543		143
		80+	-	224	NA	0.03	NA	6		68,525		54
		total	27	3,262	-	-	-	89		76,542,583		2,593

no.	Diseases / Conditions	Age	Number of pass away		OAFs		Number of pass away by obesity		Cost of lossing (baht)		Number of year loss	
			Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
7	Endometrial Cancer	0-4	-	-	NA	0.17	NA	-	-	-	-	-
		5-14	-	-	NA	0.17	NA	-	-	-	-	-
		15-29	-	2	NA	0.17	NA	0		650,050		20
		30-44	-	17	NA	0.17	NA	3		5,221,674		129
		45-59	-	57	NA	0.17	NA	10		9,366,980		302
		60-69	-	87	NA	0.17	NA	15		2,441,048		309
		70-79	-	90	NA	0.17	NA	15		555,921		213
		80+	-	13	NA	0.17	NA	2		24,988		20
		total	-	266	-	-	-	45		18,260,660		993
8	Osteoarthritis	0-4	-	-	0.23	0.15	-	-	-	-	-	-
		5-14	-	-	0.23	0.15	-	-	-	-	-	-
		15-29	-	-	0.23	0.15	-	-	-	-	-	-
		30-44	-	-	0.23	0.15	-	-	-	-	-	-
		45-59	2	7	0.23	0.15	0	1	778,028	989,224	13	32
		60-69	1	15	0.23	0.15	0	2	153,214	361,926	4	46
		70-79	28	32	0.23	0.15	6	5	1,764,314	169,978	80	65
		80+	49	102	0.23	0.15	11	15	1,862,527	168,604	100	134
		total	80	156	-	-	18	23	4,558,083	1,689,732	197	277

APPENDIX C



BIOGRAPHY

NAME	Mr. Paiboon Pitayatienanan
DATE OF BIRTH	September 29, 1980
PLACE OF BIRTH	Bangkok, Thailand
INSTITUTIONS ATTENDED	Mahidol University, 1998 – 2004: Bachelor of Pharmacy Ramkhamhaeng University, 2001 – 2004: Bachelor of Political Science (Public Administration) Ramkhamhaeng University, 2006 – 2008: Master of Business Administration (Marketing) Mahidol University, 2011: Master of Science in Pharmacy (Pharmacy Administration)
POSITION&OFFICE	Rajavithi Hospital, 2 Phaya Thai Rd, Ratchathewi Bangkok, Thailand Position : Pharmacist Tel. 02-354-8108-37 E-mail: paiboon89@hotmail.com
HOME ADDRESS	42 Soi.Taksin 22,Taksin Rd., Bukkalao Thonburi Bangkok, Thailand 10600.