GAINS IN LIFE EXPECTANCY DUE TO ELIMINATING MAJOR CAUSES OF DEATH IN THAI OLDER PERSONS

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ABSTRACT:

Background: The age structure of the population of Thailand has been rapidly changing. The proportion of older persons aged 60 years and over is significantly increasing as a result of a range of declining mortality and, most importantly, decrease in fertility. Burden of disease measured by non-communicable diseases in older persons is at the most elevated key factor when compared with other population groups. This study estimated the gains of life expectancy from elimination of three major causes of death including cerebrovascular disease, heart disease and cancer in older Thai people by gender.

Methods: Based on data on causes of death in 2007 from the Bureau of Policy and Strategy, Ministry of Public Health, Thailand, the multiple decrement and cause eliminated life tables were carried out for life expectancy estimates. By eliminating certain causes of death, a more accurate life expectancy, that is capable of predicting gender difference in life expectancy at age 60, is obtained.

Results: This study showed that the net gain in life expectancy at age 60 would be 1.2, 1.5 and 4.8 years from heart disease, cerebrovascular disease and cancer, respectively. Men are expected to gain longer life expectancy than women subsequent to elimination of cerebrovascular disease. Women are expected to gain longer life expectancy as a result of elimination of cancer.

Conclusion: This study outlined how each of three diseases could affect the life expectancy of Thai older persons. Gains in life expectancy depend on particular causes of death and sex. Therefore, the findings provide potentially relevant evidence for the Thai government to provide improvement of public health policies for older persons to reduce their loss of life, particularly as caused by cerebrovascular disease and cancer.

Keywords: Cause elimination, Life expectancy, Thai older persons, Thailand

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INTRODUCTION

The world's population is growing older; population aging is occurring in both developed and developing countries. The aged society results from decreasing mortality, and, most importantly, declining fertility. The world's total fertility rate (TFR) fell from 5 children per women in 1950 to roughly 2.5 today, and is projected to drop further to about 2.2 by 2050 [1]. The standard definition of the old age population commonly used by the Thai government is those who are 60 and older. In indicator of elders is commonly measured as the proportion of the population age 60 and older. Thailand has entered into the aged society since 2005 when this proportion reached 10%. Thailand will become a completed aged society in 2021, when the proportion of those ages is 20% [2]. Comparing with developed countries, population aging in Thailand is occurring faster than the Western countries in the past. The speed of the Thai aging population is the same as that of South Korea [3]. In the 1980s, Thailand experienced a remarkable revolution in reproductive behavior, resulting in a rapidly declining fertility rate [4]. TFR dropped from the average of more than 6 in 1960, to only 2 in 1990. Now, a Thai woman has only 1.6 children on the average, which can be classified into a very low level of fertility. As families have fewer children, the elderly share of the total population

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naturally increases.

In most parts of the world, people are living significantly longer lives than in previous decades. For the world as a whole, life expectancy increased by two decades since 1950 (from 48 years in 1950–55 to 68 years in 2005-10). During the current half century, the UN Population Division projects global life expectancy to rise further to 76 years [5]. However, some scholars report we cannot continue to reduce mortality at the oldest ages without better health system and making medical advances against such major causes of death such as cardiovascular diseases and cancer.

Since the late 1980s, the economic structure has shifted from agriculture to industry [6]. Then in 1985, life expectancy at birth of Thai population has dramatically increased from 61.8 in men and 67.5 in women to 70 and 77.7 in men and women respectively, in 2006, and the major causes of death have changed. Thailand is undergoing epidemiological transition from communicable to non-communicable diseases, which brought about a decline in crude death rate and a surge in life expectancy. The leading causes of death are the same for different age-sex groups, but their ranking order varies. In 21st century, 2000 the leading causes of death among older persons aged 60 years and older are cerebrovascular diseases, heart disease, and neoplasm. Heart disease has remained the leading cause of death for most of the groups until 1998. Then the first ranked cause of death was changed to cancer instead and the third leading cause of death is most often cerebrovascular disease (see Appendix). Cancer is the most common not only the younger age groups but also ranking the third among women age 85 years and older [7].

The Global Burden of Disease [8] study have reported the risk of death by non-communicable disease rises rapidly among older persons age 60 and over in all regions of the world. Globally, 60 years olds could expect to live longer 20 years on average in 2013 [9]. The strong evidence of analysis in burden of disease and life expectancy [10] showed the physical inactivity would increase the risk of major non-communicable diseases such as coronary heart disease, type 2 diabetes, and breast and colon cancers, and shortens life expectancy. Recently, the Burden of Disease Study [9, 11] provided results of the estimated of burden of diseases and injuries in Thailand. Stroke, followed by cancer and ischemic heart disease have been the top five leading causes of DALY loss among the elderly. The size of the total burden in older Thai people was slightly greater in women than in men. The amount of burden attributable to ischemic heart disease was quite similar in both men and women. Cardiovascular diseases cause nearly a quarter of the total burden both in men and women, followed by cancer. However, recent studies have investigated life expectancy in term of estimating healthy life expectancies (HLE) in Thailand [12-14] to study and express trend in health status at older ages in multidimensional health domains such as disability-free life expectancies (DFLE) or cognitive-free life expectancy (CFLE). Healthy life expectancy is the number of remaining years, at a given age, which an individual can expect to live in a healthy state. One study [11] compared their findings with the 1990 and 2010 Global Burden of Disease studies' results. Using HLE based on disease prevalence, the GBD found that Thailand experienced small longevity improvement and morbidity compression. But the studies' findings suggest those results should be treated with caution, as, since 2000, Thailand has introduced universal health care which both men and women aged 60 to 80 still gains in their life expectancy, and trends in healthy life expectancy varied by health indicators measured. Two other studies [13, 14] examined gender differences in these health expectancies. The study found that women had a longer total life expectancy, but had shorter when considering on multiple domains of health, and both genders, years lived with cognitive impairment, depression and ADL disability were almost constant with increasing age.

Most of the studies on gains in life expectancy due to eliminating major causes of death have been conducted in the Western countries [15-17], some focused on older people [18, 19]. Only a limited number of studies have estimated especially on the major cause of death in non-Western countries including Thailand [20]. One study in Thailand explored cause of death that focusing on pattern and differences on longevity. The study concluded that different age-sex groups which have the same cause of death there are different year and life gained or lost depend on cause of death [21]. Another study examined the patterns of health status and quality of life of the Thai elderly in terms of active life expectancy by eliminating specific diseases in six regions of Thailand [22]. The third one estimated cause of death and life expectancy at birth in both genders in Thai population after applying appropriate demographic adjustments in incompleteness' death registration data to provide a primary evidence for global burden of disease assessments and cost-effectiveness evaluation of intervention options in Thailand [23]. Yet we still do not know completely about the gains in life expectancy due to eliminating major causes of death

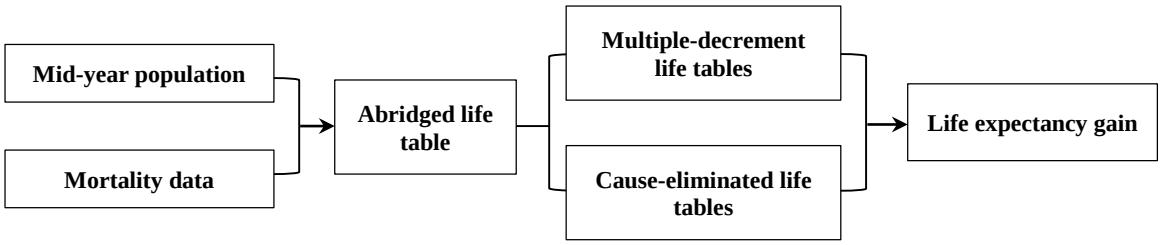

Figure 1 Framework for estimating live expectancy gained by elimination of specific causes of death

among Thai older persons particularly. Thus there is the gap of knowledge in Thai older persons who suffer more from the chronic degenerative diseases compared to younger age groups. Estimation of life expectancy gained by elimination of specific causes of death using mortality analysis will suggest the future increase in life expectancy and will be helpful for future proper health services programmes. This study aims to estimate life expectancy gained by elimination of three major causes of death; cerebrovascular disease, heart disease and cancer of Thai older persons.

METHODOLOGY

Data for this study was drawn from compulsory death registration system collected by the Bureau of Policy and Strategy, the Ministry of Public Health, Thailand. Since 1916, all deaths have been required by law to be registered. The Ministry of Public Health has conducted a retest survey by using verbal autopsy to improve the quality of data and to ascertain the true cause of death. The classification of 'causes of death' in the present study was based on Ministry of Public Health's classification. More specifically, ICD-10 classification were grouped by Ministry of Public Health, into cerebrovascular disease (I60-I69), heart diseases (I05-I09, I20-I25, I26-I28, I30-I52), and cancer (malignant and neoplasm C00-D48) by age group in 2007. However, the report of cause of death from this source was still incomplete. This study did the adjustment on unknown cases for further analysis. The adjusted deaths were employed to construct the life tables in function estimated the age-sex specific death rates. The mortality analysis technique was used to find the gain in life expectancy after elimination of deaths due to three major causes of death shown in framework (Figure 1).

The gain in life expectancies were calculated according to the following steps: Firstly, a conventional abridged life table was constructed and calculated based on the age-specific death rates. The life tables are routinely used to study mortality experience of a cohort. The expectation of life at birth reflects the number of years a person is expected to live under existing conditions while expectation of life at various ages indicates the average number of years of life remaining at attainment of the given age. Secondly, multiple decrement life tables were constructed after ${}_nd_x$ and ${}_nq_x$ were obtained from abridged life table. In multiple decrement tables, the number or proportion dying at each age is distributed into categories according to the cause of death; ${}_nd_{x,j}$ and ${}_nq_{x,j}$. Multiple decrement life tables used similar principles to those in the construction of abridged life table but allow the possibility of other decrements such as different cause of death based on mortality ratio of each cause of death calculation; ${}_nD_{x,j}/{}_nD_x$. Finally, causes-eliminated life tables by Greville's method were obtained by constructing a life table devoid of mortality due to cerebrovascular disease, heart disease and cancer. The constructions of this kind of life table the same method of abridged life table, except for the concept of the probability of dying (${}_nq_{x,-j}$); the function ${}_nq_x$ in the cause-eliminated life table, could be obtained from following equation:

${}_nq_{x,-j} = 1-{}_nP_{x,-j}$ if we then substitute ${}_nP_{x,-j} = {}_nP_x{}^{(1-nDx,j/nDx)}$, we get

$$ {}_nq_{x,-j} = 1- {}_nP_x{}^{(1-nDx,j/nDx)} $$

This expression was introduced by Greville in 1948 [24]. When ${}_nP_{x,-j}$ is probability of surviving after eliminate cause of death j, ${}_nP_x$ is probability of surviving between age x to x+n (from the abridged life table; $1-{}_nq_x$), ${}_nD_{x,j}$ is number of death by cause j between age x to x+n, and ${}_nD_x$ is total number of death between age x to x+n. Expectation of life at various ages was computed for the hypothetical question of what a life table cohort's mortality experience would be if those three causes of death were eliminated. So gain in life expectancy obtains from the difference value of life expectancy that getting from multiple life tables and from cause-eliminated life table. These life tables were constructed by using Microsoft Excel version 2010.

Table 1 Life expectancy of cerebrovascular disease, heart disease and cancer calculated by using the abridged life table (e_x), multiple-decrement life tables ($e_{x,j}$) and cause-eliminated life table ($e_{x,-j}$).

Age (yrs)	Cerebrovascular disease								
	All			Male			Female		
	e_x	$e_{x,CVA}$	$e_{x,-CVA}$	e_x	$e_{x,CVA}$	$e_{x,-CVA}$	e_x	$e_{x,CVA}$	$e_{x,-CVA}$
0	77.1	76.6	77.4	73.2	72.8	73.6	81.1	80.6	81.3
60-64	24.3	22.9	24.4	22.3	20.7	22.4	26.1	25.1	26.2
65-69	20.8	20.2	20.9	19.1	18.3	19.2	22.4	21.9	22.5
Age (yrs)	**Heart disease**								
	All			Male			Female		
	e_x	$e_{x,Heart}$	$e_{x,-Heart}$	e_x	$e_{x,Heart}$	$e_{x,-Heart}$	e_x	$e_{x,Heart}$	$e_{x,-Heart}$
0	77.1	78.3	77.5	73.2	75.2	73.7	81.1	81.4	81.4
60-64	24.3	23.3	24.5	22.3	21.3	22.5	26.1	25.1	26.3
65-69	20.8	20.2	21.0	19.1	18.5	19.2	22.4	21.7	22.5
Age (yrs)	**Cancer**								
	All			Male			Female		
	e_x	$e_{x,CA}$	$e_{x,-CA}$	e_x	$e_{x,CA}$	$e_{x,-CA}$	e_x	$e_{x,CA}$	$e_{x,-CA}$
0	77.1	72.4	78.7	73.2	71.7	74.9	81.1	72.8	82.5
60-64	24.3	20.2	25.0	22.3	18.9	23.1	26.1	21.4	26.7
65-69	20.8	18.5	21.2	19.1	17.1	19.5	22.4	19.8	22.7
Age (yrs)	**Other causes**								
	All			Male			Female		
	e_x	$e_{x,other}$	$e_{x,-other}$	e_x	$e_{x,other}$	$e_{x,-other}$	e_x	$e_{x,other}$	$e_{x,-other}$
0	77.1	77.7	84.9	73.2	73.3	82.8	81.1	82.0	86.7
60-64	24.3	24.9	26.6	22.3	22.9	24.8	26.1	26.7	28.1
65-69	20.8	21.2	22.2	19.1	19.4	20.5	22.4	22.7	23.6

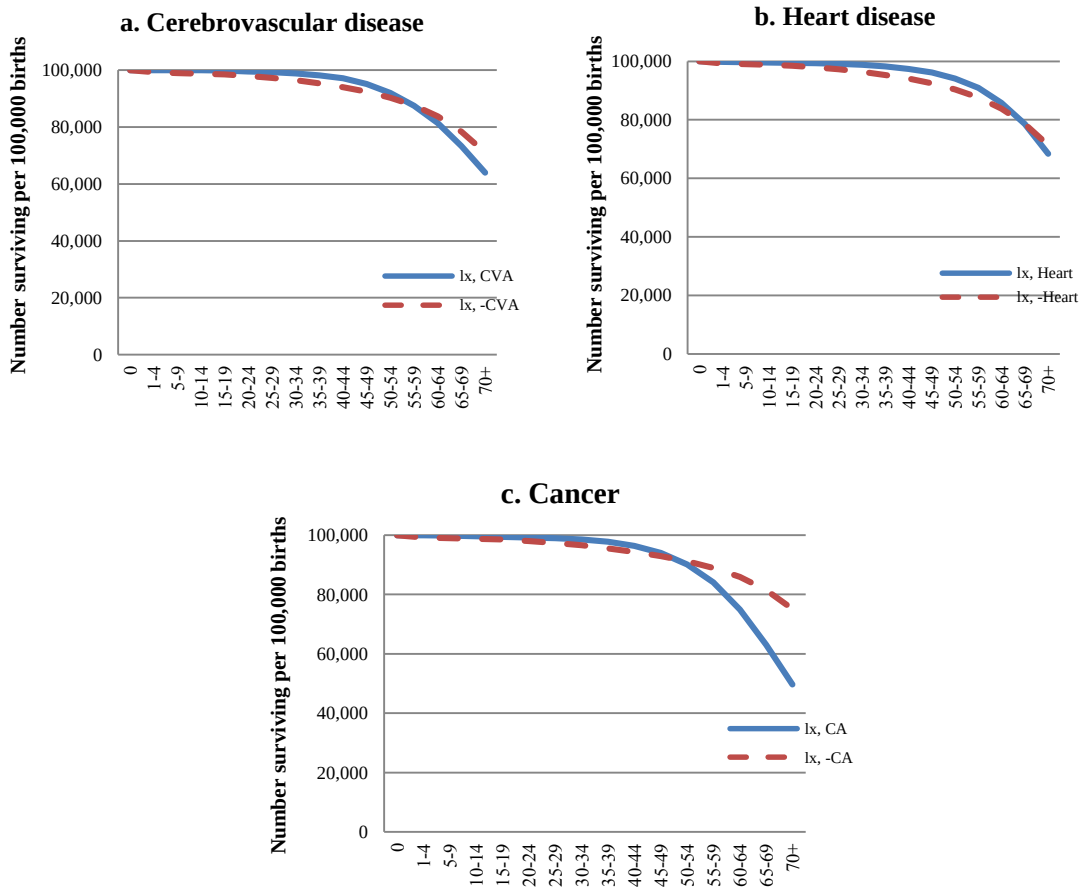

Figure 2 Thailand, 20007 multiple decrement life tables and caused-eliminated life tables for (a) cerebrovascular disease; CVA, (b) heart disease, and (c) cancer; CA

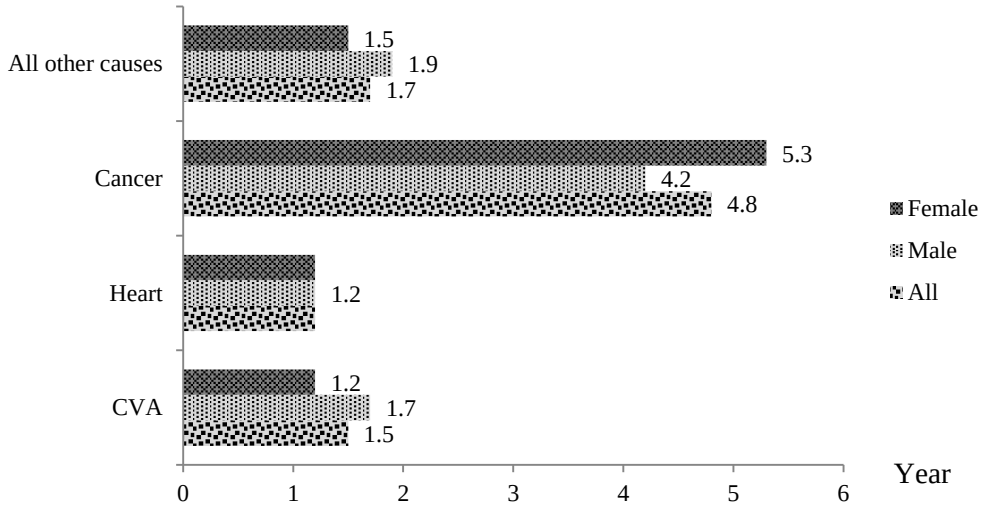

Figure 3 Gains in life expectancy due to eliminating cause of death from cerebrovascular disease (CVA), heart disease and cancer, including other diseases in Thai older persons, in 2007.

RESULTS

In 2007, Thai older persons age 60 years and older died from all three major causes of death was about one-fifth of all deaths (48,104/236,107). The majority of deaths were caused by cancer (11.9%), heart disease (5.2%) and cerebrovascular disease (3.3%). All three causes of death were higher among males compared to female counterpart. It is important to note that the total number of persons who died by cancer was dramatically increased after the age of 30 years (see Appendix).

There were a slightly difference of life expectancy gained after we eliminated cause of death, the values of life expectancy eliminated by causes of death were similar compared to life expectancy from the abridged life table. While life expectancy in cause-eliminated life table was higher than in abridged life table, it implies those causes of death was mostly impact on life gain that the government should be concerned. The data of life expectancy at birth, at aged 60 and aged 65 by sex assigned by four causes of diseases were shown in Table 1.

Compare number of surviving (l_x –j) when eliminate causes of death for each age group to number of surviving from multiple decrement life tables (l_x, j).

Cause-eliminated and multiple decrement l_x distributions were graphed in Figure 2. In general, for all three causes the survival patterns are similar, since at most age's mortality was low and the adjustment for competing risk in the cause-eliminated tables was small. The gap compared between two line graphs displays the effect of each cause of death. Focusing on heart disease, the gap is smallest, which means, heart disease is less effect of cause of death, although heart disease ranks the second as the cause of death of the Thai older persons in 2007. It implies that heart disease was less severity when compared to cerebrovascular disease and cancer. However, cerebrovascular disease and heart disease show nearly the same trend; it just only gap is started in different age group. Number of survival experience of persons who eventually dying by cerebrovascular disease ($l_{x,CVA}$) and heart disease ($l_{x,heart}$) dropped after the age of 35 to 40 years whilst cancer started to drop after age 30 years and sharply dropped after age 50 years.

Elimination of cancer would increase life expectancy at age 60 years by almost 4.8 years, and elimination of cerebrovascular disease and heart disease by 1.5 and 1.2 years, respectively. It means cancer cause over 3 times the loss of life years, higher than heart disease and cerebrovascular disease. It implied that severity of cancer was the highest. Gain in life expectancy obtains from the difference value of life expectancy that getting from multiple decrement life tables and from cause-eliminated life table shown in Figure 3. Males gained more year of life expectancy than female after eliminating cerebrovascular disease (1.7 years for male and 1.5 years for female), whilst female gained more life year by elimination of cancer (4.2 years for male and more than 5 years for female), except for heart disease there was no different among males and females.

DISCUSSION

The trend of number of deaths by heart disease

is a small increasing in the 21st century. Even heart disease ranks second as the cause of death of the aging population, followed by cerebrovascular disease in Thailand, 2007. Elimination of heart disease would increase life expectancy at age 60 only 1.2 years, which have a much smaller impact compared to cerebrovascular disease and cancer. It implied that persons who had heart disease could live longer than those two diseases. In other words heart disease was less severity compared to the other two diseases nowadays. According to the epidemiological transition or health transition theory [25], deaths from cerebrovascular and cardiovascular diseases, cancers, and other non-communicable diseases increasingly become leading causes after mortality due to infectious diseases reaches a low level. Third stage, the era of degenerative and man-made disease was characterized by life expectancy at birth rose to at least 70 years because of declining in death rates among those surviving to the middle and older ages. The stage was driven by "socially determined" factors in developed countries like lifestyle changes and better public health as well as modern medical technology in the developing countries. Degenerative diseases associated with aging (such as cancer and cardiovascular diseases) have become the leading cause of death while infectious and parasitic diseases receded. Fourth stage, era of delayed degenerative diseases, in the late 20th century, death rates from these chronic degenerative diseases began to decline rapidly. For instant, circulatory disease including heart disease and cerebrovascular death rate declined. From 1990 to 2002 in United States, heart disease death rates for persons age 65 and older decline about 24 percent. Stroke death rates for the same age group declined about 12 percent [26]. Major degenerative causes of death were present, but life expectancy is lengthened due to medical advances and the continuation of standards of living permitting individuals with diseases such as cardiovascular disease and cancer to survive until older age. So this study expects that Thailand is entering the fourth stage of health transition that is characterized by declining cardiovascular mortality, ageing, lifestyle and behavioral modification.

Cancer is the most severity and seems to be the first cause of death among people not only in older age but also working age, especially among Thai women. From the result of this study the number of people who died from cancer is double from age before and after 30 years. In United States, since 1990, there has been a downward trend in cancer death rates among men, but not women. For women aged 75 years and older, death rate from cancer still increased by 3 to 4 percent. Between 2000 and 2002, cancer death rate decreased 2 percent among older women and 4 percent among older men [26]. The cancer mortality varied greatly by type of cancer. In Thailand, now liver and intrahepatic bile ducts and lung cancer are first and second rank fatal diseases that affect Thai people premature death both men and women and as well as in older peoples. Breast and cervical cancers are increasing affect Thai women premature. Classified by age, females with ages 35 or higher have a greater incidence rate of cervical and breast cancers than those aged lower than 35 [27]. In comparison with cancer patients in the United States, 76.8 percent of which were females with ages higher than 50, this study confirm Thai cancer patients were detected at lower ages, approximately under 30 years old. Focusing on older person in Thailand, colorectal cancer is the third rank and more increase in 2003 to 2010 after liver cancer and lung cancer [28].The previous study also reported about the incident of colorectal cancer in Thailand which is increasing [29, 30]. There is evidence that the behavioral consumption change such as a diet high in calories, poor in vegetables, alcohol intake and smoking is associated with an increased risk of colorectal cancer among Thai older persons.

This study reveals that reductions in mortality due to cancer and cerebrovascular disease added 4.8 years and 1.5 years respectively. But, how long that Thailand can gain life expectancy such as result? This question has led to an important consideration. The previous study reported that Japanese, Republic of Korea and Singapore took time 30 years to gain life expectancy at age 65 by 1 to 2 years from both cerebrovascular disease and heart disease. Yet changes in mortality due to cancer contributed to only 0.1to 0.6 years in Japan and Singapore but in Republic of Korea, about 0.4 of loss in life expectancy at age 65. This was a small gain in considering that Japan is one of the countries with the longest life expectancy in the world today [31].

Therefore, the nation has to embrace various policy options to improve the robustness of health, long-term care, and welfare systems in Thailand to help people to stay healthy and active in the later life. These policy options include prevention and health promotion in order to reduce their probability of dying by three major causes of death. Especially, cancer which this study confirmed that people should concern about the screening test for detecting cancer cell at least before 30 years old. The programs have to sponsored by local hospitals, community health promotion center, and considered

trendy by the media should be designed to promote health awareness and screening in older adults. Much of the chronic illness experienced by older persons is related to social, environmental, and behavioral factors, especially poor health habits. Health promotion involves changing individual health behaviors through regular exercise, good nutrition, elimination of poor health habits such as high fat diets. Other important factors are the proper use of prescription and nonprescription medication, and annually medical check-ups. Moreover, the finding also confirmed a need for increasing medical and health personnel particularly cancer physicians and rehabilitative personnel which Thailand is a high disparity in the distribution of medical personnel between Bangkok Metropolis and other provinces.

Some limitations of this study have to be addressed. The study used secondary data for mortality analysis by routine death registration without verbal autopsy procedures, so it is limited by the quality of data. Furthermore, the cause-eliminated life table analysis was a tool for analyzing which might be overestimated because these estimates fail to take into account the fact that those who are saved from one cause are likely to have another conditions, which may increase their risks of dying. However, in general, it is likely that the low prevalence of competing causes among persons dying from cancer. Competing causes will only reduce the number of life years to be gained, if the intervention does not eliminate the competing causes with the underlying cause. Because associations between competing and underlying causes depend on common risk factors, the effect of competing causes of death is likely to be smaller with interventions targeted at risk factors than with interventions targeted at more advanced steps in the disease process.

CONCLUSION

The present study was conducted to estimate the potential gain in life expectancy when mortality due to cerebrovascular disease, heart disease and cancer are eliminated. This study found that the net gain in life expectancy at age 60 would be 1.2, 1.5 and 4.8 years from heart disease, cerebrovascular disease and cancer, respectively. Such the results of the study outlined a picture of how each three diseases could affect the life expectancy in old age in Thailand. Therefore, the findings somehow showing some evidences for Thailand government to provide a proper public health improvements for older persons in order to reduce their probability of dying due to cerebrovascular disease, heart diseases and cancer, but also provide useful information for future research and disease control programs to extend longevity of older adults.

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APPENDIX

Table A1 Number of deaths for cerebrovascular disease, heart disease and cancer by age group and gender, Thailand 2007

Age group (yrs)	Cerebrovascular disease			Heart disease		
	Male	Female	Total	Male	Female	Total
0	2	3	5	51	37	88
1-4	1	1	2	24	22	46
5-9	5	3	8	18	15	33
10-14	20	16	36	13	20	33
15-19	70	19	89	50	18	68
20-24	69	22	91	69	45	114
25-29	118	38	156	119	48	167
30-34	161	62	223	207	103	310
35-39	295	109	404	324	158	482
40-44	516	211	727	468	221	689
45-49	696	326	1,022	705	356	1,061
50-54	809	409	1,218	886	439	1,325
55-59	836	469	1,305	1,089	612	1,701
60-64	793	508	1,301	1,055	708	1,763
65-69	792	606	1,398	1,246	1,073	2,319
70+	2,300	2,699	4,999	3,866	4,359	8,225
Total	7,483	5,501	12,984	10,190	8,234	18,424
Total 60+	**3,885**	**3,813**	**7,698**	**6,167**	**6,140**	**12,307**

Table A1 Number of deaths for cerebrovascular disease, heart disease and cancer by age group and gender, Thailand 2007 (Cont.)

Age group (yrs)	Cancer			Other		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**
0	22	17	39	3,194	2,455	5,649
1-4	82	58	140	1,168	847	2,015
5-9	86	93	179	1,077	688	1,765
10-14	116	80	196	1,353	827	2,180
15-19	136	93	229	4,315	1,107	5,422
20-24	177	117	294	4,818	1,359	6,177
25-29	298	255	553	6,288	2,273	8,561
30-34	531	523	1,054	8,265	3,064	11,329
35-39	928	908	1,836	9,650	3,503	13,153
40-44	1,680	1,467	3,147	10,671	3,966	14,637
45-49	2,544	1,982	4,526	11,131	4,485	15,616
50-54	3,393	2,588	5,981	10,648	5,419	16,067
55-59	4,211	2,929	7,140	10,751	6,469	17,220
60-64	4,217	2,663	6,880	10,723	7,693	18,416
65-69	4,374	2,808	7,182	13,445	10,738	24,183
70+	8,292	5,745	14,037	65,676	79,728	145,404
Total	31,087	22,326	53,413	173,173	134,621	307,794
Total 60+	**16,883**	**11,216**	**28,099**	**89,844**	**98,159**	**188,003**