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Longevity of the Thai Population: Reflecting the Analytical Methodology of Causes of Death Elimination

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ABSTRACT

This investigation on "The Longevity of the Thai Population: Reflecting of the Analytical Methodology of Causes of Death Elimination" employed the secondary data on causes of death collected from death certificates throughout Thailand by the Ministry of Interior. And the causes of death were coded according to the international list of disease between 1996 to 2000, using the demography tool of the cause elimination life table. The objective of the study was to find the years of life gained by setting an assumption that Thailand was able to eliminate the primary causes of death in 2000. As the said tools were very difficult to comprehend by interested parties who had no basic knowledge in formal demography, the use of this tool was therefore somewhat limited. The researcher therefore briefly explained the conceptual framework of the analytical methodology and the various formulas used in the hope that it could be put to more beneficial used that at present. From the study it was found that the average life expectancy of the Thai population would increase from large to small respectively. If the causes of death from neoplasm, heart disease, AIDS, and transports accident were eliminated respectively, with males gaining more benefit as a result of the cause of death elimination than females, and the younger age groups gaining more benefit as a result of the cause of death elimination than the older age groups. The benefit obtained from this study could be used for public health planning. It was an option to eliminate the cause of death from certain causes when considering its role of importance and other related factors. Moreover, the methodology could be applied to various study tools and be made to conform with the situation in Thailand, so that it could be used as a guideline in solving problems affecting health, the end-result being that the Thai population would continue to gain greater life expectancy.

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ความยืนยาวชีวิตของประชากรไทย: ผลสะท้อนจากการวิเคราะห์ด้วยวิธีการขจัดสาเหตุการตาย

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บทคัดย่อ

บทความเรื่อง "ความยืนยาวชีวิตของประชากรไทย: ผลสะท้อนจากการวิเคราะห์ด้วยวิธีการขจัดสาเหตุการตาย (Longevity of the Thai Population: Reflecting the Analytical Methodology of Causes of Death Elimination)" นี้ใช้แหล่งข้อมูลทุติยภูมิของสาเหตุการตายที่รวบรวมจากใบมรณบัตรทั่วประเทศโดยกระทรวงมหาดไทย และนำมาลงรหัสสาเหตุการตายตามบัญชีจำแนกโรคระหว่างประเทศ ระหว่างปี 1996-2000 โดยใช้เครื่องมือด้านประชากรศาสตร์คือ cause elimination life table โดยมีวัตถุประสงค์เพื่อคำนวณหาจำนวนปีที่เพิ่มขึ้นจากการตั้งเงื่อนไขว่าถ้าประเทศไทยสามารถขจัดสาเหตุการตายที่สำคัญในปี 2000 ได้ เนื่องจากเครื่องมือดังกล่าวนี้มีความยากในการเข้าใจสำหรับผู้ที่สนใจแต่ไม่มีความรู้พื้นฐานด้านประชากรศาสตร์พิสุทธิ์ (Formal Demography) เครื่องมือนี้จึงมีการใช้ค่อนข้างจำกัดเฉพาะแต่ในวงแคบ ๆ ผู้วิจัยจึงได้อธิบายถึงแนวความคิดที่มาของวิธีการวิเคราะห์และสูตรต่าง ๆ พอสังเขป ด้วยหวังว่าจะเป็นส่วนหนึ่งให้มีผู้ที่จะสนใจนำไปใช้ประโยชน์ให้มากกว่าที่เป็นอยู่ ผลการศึกษาค้นพบว่า อายุขัยเฉลี่ยของประชากรไทยจะเพิ่มขึ้นจากมากไปหาน้อยตามลำดับ ถ้าสามารถขจัดสาเหตุการตายด้วยโรคมะเร็ง โรคหัวใจ เอดส์ และอุบัติเหตุจากการโดยสาร ตามลำดับ โดยเพศชายได้รับประโยชน์จากการขจัดสาเหตุการตายมากกว่าเพศหญิง และประชากรในกลุ่มอายุน้อยกว่าจะได้รับประโยชน์จากการขจัดสาเหตุการตายมากกว่ากลุ่มประชากรที่มีอายุมากกว่า ประโยชน์ที่ได้จากผลการศึกษาสามารถนำไปใช้ในการวางแผนงานด้านสาธารณสุข เป็นทางเลือกที่จะขจัดสาเหตุการตายบางสาเหตุ เมื่อต้องพิจารณาลำดับความสำคัญและปัจจัยแวดล้อมอื่น ๆ นอกจากนั้นยังสามารถประยุกต์เทคนิควิธีการให้เหมาะสมกับวัตถุการศึกษาที่หลากหลาย และให้สอดคล้องกับสถานการณ์ของประเทศไทย เพื่อให้สามารถใช้เป็นแนวทางในการแก้ไขปัญหาผลกระทบด้านสุขภาพ และในที่สุดแล้วประชากรไทยจะมีอายุขัยเฉลี่ยที่ยืนยาวมากขึ้นเรื่อย ๆ

Introduction

The Eighth National Economics and Social Development Plan (1997-2001), could be regarded as a turning point from the previous policy of focusing mostly on acceleration of economic growth and reduction of population growth. It identified human activity as the dominant figure and placed importance on population and social developments. During that period Thailand has developed at a tremendous pace, with very rapid growth in the economy. Infrastructure was expanded in order to pave way for economic expansion and the export industry. Thailand has therefore changed in several ways, such as the construction and expansion of interstate highways from 4 lanes into 6 lanes throughout the Kingdom (MOPH, 1997). Moreover, it was found that Thais have changed consumption preferences to fast food due to their hurried lifestyle, which required speed. At the same time it was found that the Thai death rates from specific causes had increased until it could be said that the causes of death could be linked to the nation's developmental processes. For example, death from HIV/AIDS, heart disease, and transportation accidents have now become important issues. Furthermore, studies on longevity have shown conflicting points of view, opening the issue that in the future, the human life span may become shortened. It was speculated that in the very near future, humans may be confronted with an unexpected crisis in longevity - the first in the history of mankind during the age of very advanced industrial and manufacturing technology development. A clear example is found in the shortened life span of the Russian population following the breaking up of the Soviet Union. As for Thailand, it was ascertained that the population's life expectancy at birth would be reduced by approximately 3-5 years, mostly due to the widespread incidence of HIV/AIDS (Chen, et al., 1996; USAID, 2002: 1-2).

At present, Thailand's population is being threatened with increasing death tolls among the teenaged population, which may affect the life expectancy of said population group. Moreover, infant mortality rates have a tendency to increase due to an important cause, namely infectious disease. It is expected that this would affect the life expectancy at birth of the country's whole population (e0) in the future. This event is becoming a recurring event of developed countries, that is to say, the life expectancy at birth (eo) has a tendency to slowly increase. Data collected by the United Nations indicated that during the period between 1950 to 1995 the life expectancy at birth of the Japanese population (eo) increased by only 0.39 years, or approximately 4.7 months per annum. Similarly, life expectancy at birth of the Singaporeans increased by 0.37 years, or approximately 4.3 months per annum, while for the Thais the increase was by 0.55 year or 6.4 month per annum. Moreover, the United Nations also indicated that in the future, the average life expectancy at birth of the population of the three-mentioned countries would be increasing at a diminishing rate, or there would be a slowdown in the increase. The most notable aspect of that increase in the longevity of the population of developed countries would be that it is at a much slower rate than the population of developing countries. This is due to the fact that the death rate of these developed countries are at a low level and/or are rather constant. Therefore, if this fact is not resolved by reducing the number of deaths through the study of each significant cause of death, the human longevity crisis may not be solved (UN, 2001). Moreover, a concerned issue for Thailand, one of the developing countries which is stepping up to a fully-developed industrialized country, is that it has been estimated that Thai life expectancy at birth (eo) could be reduced. Thus, although this may be a rather pessimistic point of view, this tendency could actually become a reality if preventative measures in the right direction are not taken. On the other hand, it could be said that this is a very useful prediction, as it would ignite an interest in problems that could occur in the future. For this reason it is necessary to seek a way to increase the longevity of the country's population in order to avoid the stated crisis.

For the above reason, it is seen as appropriate to give greater importance to the life expectancy issue. Therefore, we sought out ways and means to use demographic knowledge to make an empirical study which would create a new body of knowledge. Our hope is to use rectification measures to creat guidelines for future population health problem. We therefore selected a mathematical method called the "cause elimination life table", in order to ascertain whether the death rate from major causes could be reduced. Also give a reduction, we wondered whether there be a gain in the longevity of the Thai population. And if so, what would be the direction of this longevity? The answer could be applied to deal with the said crisis that could potentially occur in the future. A brief history of this method follows:

In the middle of the seventeenth century, the study of longevity was taken up in a manner that may be regarded as the precursor to modern methods. It was based on the basis of mortality at the time. The first life table was claimed to have been constructed by John Graunt in 1532. (Dublin, et al., 1949: 32-34). Subsequently, the first life table developed in a logical way was by Halley. The first scientifically correct life table was published in 1693, and it was based on birth and death registration data. Since that period, the life table method was continually developed, until the beginning of modern demography. In 1925, Lotka constructed the first modern life table. He developed the mathematics model in order to study fertility. Afterwards official life tables were prepared in the United States during 1900-1902 in connection with the decennial censuses of population. The United States life tables constructed from death statistics were separated into several life tables for whites, blacks, males, and females, etc.

Arriaga prepared new life tables for the countries of Latin America, principally employing census data and stable population and techniques. In 1966, a set of model life tables, which were developed by Coale and Demeny, called "Regional Model Table", were published by the United Nations. These sets of tables corresponded to the stable population theory. They are useful (for estimating life table function in developing countries, where data are under-reported, incomplete and unavailable (Dublin, et al., 1949: 32-34; Shryock, et al., 1971: 251; Shryock, et al., In Bogue, et al., Eds., 1993: 780-781). The life tables (for a large number of countries spanning a wide range of time) have been published by Keyfitz and Flieger since 1968. From the empirical studies, the life table is used for several purposes; the gradual evolution and development in method are due to the objectives of the study. Although a life table was first designed to measure mortality, it is employed by a variety of specialists. It is used in studies of longevity, fertility, migration, and population growth as well as in making projections of population size and characteristic. Also the resulting values are used to measure mortality, survivorship, and life expectancy. In other applications, the mortality rates in the life table can be used to study the causes of death by cohort and cause elimination, etc. We will focus the study on cause elimination.

Karn (1933: 91-92) claimed to have developed a method of calculating death rates for the purpose of measuring the effect of death rates from cancer and other diseases on the expectation of life as given by the English Life Table. Thereafter, Dublin, et al. (1949) calculated the years of life gained by the elimination of the specific causes of death with a life table prepared on the basis of the data for the United States in 1939-1941. They also discussed potential years of life gained by simultaneous elimination of several causes of death. The other study by Greville (1948) calculated the mortality table by causes of death for the United States. Afterwards the United Nations (1968) calculated and published the United States life table by causes of death between 1959-1961. Nevertheless, this method remains imperfect because of certain limitations and a lack of data quality during that period. Consequently, when Reed & Merrel (1939) and Greville (1943) presented short-cut methods for constructing an abridged life table, they also commented that it was possible to divide the abridged life table into several causes of death. Thus, the probability of survival in the population must be increased by elimination. From these concepts, a year of life that would be gained if the causes were completely eliminated would obviously affect the life expectancy. Therefore, the life expectancy must be increased as well (Dublin, et al., 1949: 94-95; Vacharangkul, R., 1975: 3-4). The example of several related previous studies in the cause of death and longevity were conducted in more than three decades, as follows.

In 1959-1961, the United States National Center for Health Statistics examined the causes of death on the assumption that when death from malignant neoplasm are eliminated. Manton, et al.,(1976: 541-564) examined multiple cause mortality for the state of North Carolina in 1969 and focused on chronic diseases such as for example cardiovascular diseases, neoplasm, hypertension were eliminated. In 1980 they studied cause elimination of the United States' population classified by race and gender. White (1999) examined the cardiovascular and tuberculosis diseases by using multiple decrement and cause elimination life tables of the United States from 1900 to 2000. In Thailand, mortality information is claimed to be incomplete in causes of death.

The only available study using elimination technique was conducted about 3 decades ago by Vacharangkul, R. in 1975. The purpose of the study was to calculate the years of life that would be gained after accidents, respiratory tuberculosis, and neoplasm were eliminated from 1971 and 1972. After there was no interested in this technique because of imperfect data of cause of death. This technique may be known in only a narrow field, for example, population study, demography, health science, etc. It was such a difficult method for other fields of study. After that no more studies were conducted. In sum, there were no progress in this method by empirical studies. At that time we had no need to increase life expectancy, because it has been increasing. But, some studies warning about decrease in life expectancy in Thais due to AIDS, which inspired me to use this technique and apply it in order to get rid of the weak point. Details concerning the research methodology and data analysis are, as follows:

Research Methodology and Data Sources

This research utilizes the Formal Demography analytical methodology which employed secondary data and evaluation by the life table developed by Greville (1948). This is a method of calculation which allows the conversion of the observed central death rates into mortality rates. Its leading characteristics are: (1) it uses a formula which is easily understood and calculable, (2) it uses a formula which is used in analysis of the true population without having to make comparisons with previously calculated models, such as the model life table, and (3) the formula's conceptual framework corresponds to the death rate data of the Thai population, where there is a lot of infant and old age mortality, corresponding to the West model in the Model Life Table. The formula has the following equation in commencing the calculation of its mortality rate:

$$ {}_nq_x = \frac{{}_nM_x}{\frac{1}{n} + {}_nM_x\left[\frac{1}{2} + \frac{n}{12}\ ({}_nM_x - \log c)\right]} $$

From the equation, the c value is obtained from the assumption that the observed central death rates ($_nM_x$) will be in the form of an exponential curve. Death will increase faster, the older one gets, this being similar to Gompertz' Law of Mortality (1825), which states that the number of deaths will increase by geometric progression. Moreover, Makeham (1938) also sets another assumption that the said pattern must be constant throughout life. Therefore, the basis for calculation starts from consideration of the mortality ratio per cause of death for each age group, based on the Secondary Data on Causes of Death from the Ministry of Public Health. This method is believed to be more accurate and reliable than in the past as the death reporting system has been revised in cooperation with the Ministry of Interior (MOPH, 2001b). The base population which were analysed came from the population registration of the Ministry of Interior in July 1 or mid-year population. This is the population at risk. Thereafter the Causes of Death were coded according to the International Classification of Disease Revision 10th (ICD-10), with the said data having been amended, revised and displayed on the Electronic Data Base of the MOPH. The selected causes of death data were primarily classified into 3 very broad etiologic groupings: infectious disease (A00-B99), Non-infectious Diseases (D50-D89, I00-I99, J00-J99, K00-K99, M00-M99), and External Cause (V01-Y89). The three broad groupings were divided into categories. Each cause of death category was then seperated into sub-categories.

The improvement of death registration system affect to number cause of death and number of death in each cause. At that time the MOPH had trained and revised the procedure of true diagnosis of cause of death. Through revision of the medical manual or operation under ICD-10. First we grouped cause of death into broad categories and selected only significant causes. For example in the criterion of people and policy makers concerns such as AIDS, a large number of death such as neoplasm, etc. The other benefit was to cumulate error in miss-diagnosis, for example, hypertensive heart disease and ischemic heart disease were grouped into cerebrovascular disease.

This analysis utilized the 2000 data as the causes of death data had been checked and revised with the main assumption that the population used for the analysis should be a "stationary population", which would mean stationary in age and gender, with a stationary pattern of age-specific death throughout the study period (Dublin, et al.,1949). Therefore, the data used for analysis were prepared according to the following stages:

First Stage. The first step is one of the most important aspect of preparation of a life table. It invloved the testing of data for possible biases and other errors. It is important to adjust data on deaths and population in order to be fully accurate. The number of deaths may be adjusted for completeness of under registration by using the results of the "The Survey of the Population Change (SPC), conducted by the National Statistic Office (NSO) which classified by gender and age group. For example, the completeness of death registration in male age group of 1-9 year was 80.0%, female was 76.2%. We also checked the number by cause, gender and data accuracy. For example, death causes by old age was used in people aged under 1 year, so it was redistributed to people aged 65 and over, ect. The number of people or deaths at unknown ages were distributed to the known age categories in proportion to the total number at those ages. The adjusted number were then rounded up to integer quantities in such a way as to retain the correct total population and number of deaths.

This stage is considered very essential to the reliability of the study, being the stage where the accuracy of the age and gender were checked. Thereafter, adjustments were made to the number of age-specific deaths from all causes of death and classified into the true causes of death. The check started from utilizing the result on the completeness of the death registration classified by gender and age groups, based on data collected from the latest survey -the Survey of Population Change 1966/1997. Thereafter, a standard life table from all causes of death was constructed. At this stage, the probability of survivor - ${}_{n}p_{x,j}$ and life expectancy at age x (e_x) were obtained to be used in the cause elimination life table analysis.

Second Stage. This is the stage where life expectancy at age x (e_x) derived from the standard life table is compared with the life expectancy calculated from the cause elimination life table. At this stage the differential in life expectancy at age x (ex) could be derived, being the years of life gained after elimination of the causes of death. For mutual understanding, the operational definition of the study has been defined as "years of life gained by cause elimination, i.e. the life expectancy at age x (e_x) of the population which will be gained if death from that particular cause were eliminated". Therefore, life expectancy gained, derived from the life expectancy without death from cause j (j being a symbol representing the cause of death) shall have a greater value than the life expectancy from all causes, or represented by $(e_{x,j} - e_{x,\ all\ cause})$.

To make this demonstration more authentic, 4 major causes of death were selected for the study, heart disease, neoplasm, AIDS, and transportation accidents. The main reason for selecting these four causes was due to the fact that these were major causes that have taken the lives of a large number of the Thai population during the past year (see Appendix). It is therefore ascertained that if these causes could be eliminated, the longevity of the Thai population would reduced to the point of it would not become a crisis, as was predicted by the United Nations. Besides, in order to avoid the problem of competing risks, an assumption has been made in the calculation that "each cause of death shall not be related", since in actual fact, if a population does not die from heart disease, it would probably die from neoplasm or from other diseases, which could have a similar probability of occurring (Smith,1994).

Calculation Method and Formula used for Evaluation

At the beginning, the observed central death rate from each cause of death or particular cause (j) in age group x and $x + n$ would have to be calculated using formula.

$$ {}_nM_{x,j} = \frac{{}_nD_{x,j}}{{}_nN_x} \qquad \text{-----------------------(1)} $$

After that, the value ${}_nM_{x,j}$ derived will be converted into the probability of survivor by using exponential, using the formula:

$$ {}_np_{x,j,exp} = e^{-n\,{}_nM_{xj}} \qquad \text{-----------------------(2)} $$

Generally, ${}_nM_{x,j}$ is replaced by ${}_nM_x \left[\frac{{}_nD_{x,j}}{{}_nD_x}\right]$ and finally, the probability of survivor can be re-written as follows:

$${}_np_{x,j,exp} \quad = \quad e^{-n_nM_{xj}}\left[\frac{{}_nD_{x,j}}{{}_nD_x}\right] \qquad \text{-----------------------(3)}$$

if $e^{-n_nM_x}$ is assigned the value of ${}_np_x$, we shall get

$${}_np_{x,j,Greville} = \begin{cases} 1 & \Big| {}_nD_x = 0 \\ {}_np_x^{\frac{{}_nD_{x,j}}{{}_nD_x}} & \Big| {}_nD_x > 0 \end{cases} \qquad \text{-----------------------(4)}$$

Since the probability of survivor is a probability value, it would lie between 0 and 1, where the value will be equal to 0 when there is no probability of survival in the population. On the other hand, it will be equal to 1 when there is total population survival. Therefore, after elimination of the cause j, the ${}_np_x$ value of the remaining causes of death would have the following new ${}_np_x$ and ${}_np_x$, $-j$ values:

$${}_np_{x,-1} = \prod_{i \neq j} {}_np_{x,j} = \frac{{}_np_x}{{}_np_{x,j}}$$

Under a set condition that cause j shall have to be eliminated, the third equation will be converted as follows:

$${}_np_{x,-j,Greville} = {}_np_x^{1-\left[\frac{{}_nD_{x,j}}{{}_nD_x}\right]} \qquad \text{-----------------------(5)}$$

Moreover, the following formula will be used to calculate life expectancy gains when the eliminated target has been determined:

$${}_np_{x,-j,(1-\alpha)j} = \frac{{}_np_x}{({}_np_{x,j})^{\alpha}} \qquad \text{-----------------------(6)}$$

the value α will be substituted for the portion of cause j which needs to be eliminated, namely, heart disease and the symbols j and j^* will be used. In a comparative analysis between different methodologies, the probability of survival at age x and $x + n$ will change to

$${}_np_x \quad = ({}_np_{x,j})({}_np_{x,-j})$$

and

$$ {}_np_{x,\,-j^*(1-\alpha)j} = ({}_np_{x,\,j^*})\,({}_np_{x,\,-j}) = {}_np_x\left(\frac{{}_np_{x,\,j^*}}{{}_np_{x,j}}\right) \qquad \text{------------------------(7)} $$

and the values of ${}_np_{x,\,j}$, ${}_np_{x,\,-j}$, ${}_np_{x,\,-j}$, $(1-\alpha)j$ or ${}_np_{x,\,-j,\,j^*}$ are substituted for the value of ${}_np_x$ in the life table, in order to consider the change in the l_x , ${}_nL_x$ value and the average life span at age x where the population in the standard life table starts with radix (100,000 population). If there is no death through cause j, the population will be equal to $\omega - {}_fL_{f,-j} = \omega - {}_fL_f$. Thereafter the life expectancy of the last age group will be calculated using the formula:

$$ {}_{j-x}e_x = \sum_{\alpha-x}^{f-n}\frac{{}_nL_\alpha}{l_x} \qquad \text{------------------------(8)} $$

The probability of survivor from each cause of death in age group x and $x+n$ would have to be calculated, and the resulting value would be applied to the cause elimination life table, the probability of surviving all causes shall have the following formula:

$$ {}_np_x = ({}_np_{x\,hd})\,({}_np_{x,\,neop})\,({}_np_{x,\,AIDS})\,({}_np_{x,\,ta})\,({}_np_{x,\,other}) \textit{ or represented by } \prod_j {}_np_{x,\,i} \qquad \text{------------------------(9)} $$

From the above formula, in order to obtain a clear result of the underlying cause of mortality that will affect the life expectancy when age x is increased (or in some cases there would be no change) (Manton, et al.,1976; Manton and Stallard, 1984; Manton and Myers,1987; Prentice, et al.,1978;) an initial assumption must be made that each cause of death shall not be related. Therefore, if there is no death from heart disease, the probability of survivor of the remaining causes shall remain constant, i.e. control of change in one factor, while other factors remain constant. In this, the minus sign indicates that there is no death from heart disease.

Notation

${}_nM_{x,j}$	=	observed central death rate through cause *j* in age x
${}_nD_{x,j}$	=	number of deaths through cause *j* in age x
${}_nN_x$	=	number of population of age x
${}_np_x$	=	the probability of survivor of all cause of death in age x
${}_np_{x,j}$	=	the probability of survivor in particular cause (*j*) in age x
${}_np_{x,-j}$	=	the probability of survivor after eliminating cause (*j*)
l_x	=	Number of Survivor at age x
${}_nL_x$	=	Number of Population age x to x+n
e_x	=	the average life expectancy at age *x*

Additional symbols below, represented in

(f, ω)	=	the last age group			
j	=	particular cause of death			
*j**	=	particular cause of death j in another source or alternate tables			
hd	=	heart disease	*neop*	=	neoplasm
AIDS	=	AIDS	*ta*	=	transport accidents
other	=	other cause of death			

Result of Study

From data analysis it was found that between 1996 to 2000 life expectancy at birth (e_0) was approximately 69 years for males and 76 years for females. This issue showed great differential in gender's life expectancy at birth (e_0) of the Thai population. However, when considering the population at age group 75 which constitute the old age group, it was found that the number of years of life remaining for the average life expectancy (e_{75}) of both gender equal to 12 years, although males will have a slightly lesser number of years remaining than females, as is shown in the following Table 1:

Table 1

The life expectancy at age 0, 1, and 75 years, 1996-2000

Year	e_0 (Year)			e_1 (Year)			e_{75} (Year)		
	Male	Female	Different	Male	Female	Different	Male	Female	Different
1996	67.55	75.90	8.35	67.56	76.06	8.50	11.37	12.25	0.88
1997	70.78	78.57	7.79	70.67	78.51	7.84	13.40	14.17	0.77
1998	70.85	76.97	6.12	70.63	77.00	6.37	12.34	12.61	0.27
1999	67.92	74.96	7.05	67.24	75.37	8.13	10.94	11.43	0.49
2000	68.38	75.42	7.04	68.55	75.47	6.92	11.09	11.41	0.32
1996-2000	69.10	76.36	7.26	68.93	76.48	7.55	11.83	12.37	0.54

From calculations made when the major causes of death e.g., heart disease, neoplasm, transport accidents, and AIDS, have been eliminated. It is found that the life expectancy at age x (e_x) of the population will increase differently according to age groups and according to each cause of death, as is shown in Table 2.

Table 2

The years of life gained by heart disease, neoplasm, AIDS, and transport accident, 2000

Age Group	Years of life gained by elimination							
	Heart Diseases		Neoplasms		AIDS		Transport Accidents	
	M	F	M	F	M	F	M	F
< 1	1.64	1.40	1.88	1.50	0.45	0.25	0.86	0.26
1-4	1.65	1.40	1.91	1.51	0.45	0.24	0.88	0.26
5-9	1.64	1.38	1.90	1.50	0.45	0.23	0.85	0.24
10-14	1.64	1.37	1.89	1.49	0.43	0.22	0.83	0.23
15-19	1.64	1.37	1.88	1.48	0.43	0.22	0.80	0.21
20-24	1.63	1.36	1.88	1.48	0.44	0.22	0.67	0.18
25-29	1.62	1.35	1.89	1.46	0.42	0.19	0.54	0.16
30-34	1.62	1.33	1.88	1.42	0.32	0.12	0.44	0.14
35-39	1.59	1.32	1.85	1.37	0.18	0.07	0.35	0.12
40-44	1.56	1.29	1.80	1.30	0.10	0.04	0.28	0.10
45-49	1.50	1.26	1.74	1.21	0.05	0.02	0.22	0.08
50-54	1.42	1.20	1.62	1.08	0.03	0.01	0.17	0.07
55-59	1.32	1.13	1.44	0.91	0.01	0.01	0.13	0.05
60-64	1.20	1.06	1.20	0.73	0.01	0.00	0.10	0.04
65-69	1.07	0.97	0.96	0.56	0.01	0.00	0.07	0.03
70-74	0.94	0.86	0.73	0.41	0.00	0.00	0.05	0.03
75+	0.85	0.76	0.57	0.31	0.00	0.00	0.04	0.02

From Table 2 it could be seen that the Thai population life expectancy would increase the most through elimination of death from neoplasm, with the life expectancy at birth (e_0) of males increasing by approximately 1.9 year, while females by approximately 1.5 year. For heart diseases, it is found that when this cause has been eliminated, male life expectancy would increase by 1.6 year and female by 1.4 year. With regard to AIDS, it could be seen that if this cause were eliminated, the life expectancy would increase by only approximately 6 months for males and approximately 4 months for females, which is rather a small number when compared with the other major causes of death. For transport accidents, male life expectancy would increase by approximately 0.9 year, female by about 0.3 years. It is noted that life expectancy for males will increase at a higher rate than females in all causes of death and in all age groups, the main reason being that the male death rate from each cause used for calculation is mostly higher than the female. Therefore if these causes were eliminated, males would have a higher number of years gained than females.

When considering only age groups with a high probability of dying from each cause, it is found that with death from heart disease in males aged over 70 years and females aged over 65 years, the years of life gained is less than 1 years, which upon comparison with younger age groups such as age groups 55-59, 60-64, it is found that the younger age groups would gain greater life expectancy. When considering death from neoplasm, it is found that males at age groups 1-4 and 5-9 gained the greatest life expectancy, but the group gaining life expectancy of less than 1 year are the male population aged over 65 years and females aged over 55 years.

At present it is well known that AIDS is an infectious disease affecting the greatest number of deaths. However, under the assumption that this disease has been eliminated, it is found that the life expectancy for both males and females shall increase by less than one year. It is also of interest that the population of age group less than 30 years will gain more years of life than those population at a higher age group when this disease has been eliminated. For very old age groups such as those over 50 years, it is found that there would be a very small gain in life expectancy.

When considering death through transportation accidents, it is found that the life expectancy gained would be about 1 year for males and only 3 months for females if this cause were eliminated, the number being very close to death from the AIDS disease. This was due to the fact that for these two causes, males have a higher death rate than females. Those that would gain the most life expectancy for these two causes of death would be males, especially in the age group of less than 20 years, these having with the highest number of deaths through accidents. That is to say, if the cause of death through accidents were eliminated as much as possible, the population in age group of less than 20 years would have the most years of life gained, while the female population would benefit very little from elimination of death from the AIDS disease and from transportation accidents as the number of female deaths through these causes was not high enough to have a positive effect in the average life expectancy.

It should be noted that in the consideration of the years of life gained for death by transportation accidents in older age groups, it is found that the years of life gained is very much less than the lower age groups. For example, for death from heart disease for males in the age group over 70 years and females in the age group over 65 years, the years of life gained is less than 1 year, which is lower than in the lower age groups such as the age group of about 40-44 years in which the number of years gained is approximately 1.3-1.6 years. When considering the differential in the years of life gained from the life expectancy of each age group, it could be found that for certain causes of death when the said causes of death have been eliminated, the years of life gained for a certain age group would be less than another age group. On the other hand, it could be more than another age group; this being due to the technicality used in the calculation of this life table, which is derived from combining the number of person year of those still living after age x or nTx from the terminal age group to the age group under 1 year, which has an indirect effect. Whereas the change in the number of deaths in the age group being analyzed will have a direct effect (Preston, et al., 2000). Besides, the probability of survival from all causes will continue to decrease when age increases, which is according to the condition and conceptual framework of the formula used for calculation of the cause elimination life table.

Through the cause elimination life table analytical methodology, it is found that the years of life most gained were from elimination of non-infectious diseases, namely heart disease and neoplasm. However, certain contradictions have been found in that the number of deaths in middle-aged to old-aged groups from these causes will be higher than those of childhood and teenagers, which is the opposite of transport accidents and AIDS where the number of deaths will be very high among teenagers. Thus the said cause is of greater concern and interest to the public than non-infectious diseases since the trend in Thai society is that of having less children, with an average of about 1-2 per family. Thus, death in teenagers will have an effect on the means of existence of future old age population who will have nobody to take care of them. Parents losing their teenaged children will cause a discontinuity in the generation of the population; more importantly, it will be a waste of human resources, which is a production force in the development of the country.

However, we are unable to stop the factors relating death from specific causes, such as transportation accidents. It is necessary for people to travel more and therefore it is necessary to build roads, or have a large fleet of buses to accommodate huge masses of passengers. Or it is necessary to invent and manufacture high speed vehicles. The rate of death through these accidents could be reduced if preventative measures are taken.

With regard to transport accidents, several researches have found that alcohol is an important factor for association of death (MOPH, 2004), which when coupled with carelessness and unsafe driving, is the main characteristic of teenagers. It would cause the number of deaths through transport accidents in this age group to be high. The MOPH data indicated that the population aged 16 years who drive motorcycles will meet with accidents twenty times more than any other age groups, with population aged 17 years meeting six times more accidents. The vehicle that causes up to 80% of transport accidents is the motorcycle. Moreover, in age groups 15-29 until 35-39, it is found that 95-99% of the injured are males (MOPH, 2004).

The methodology of the cause elimination life table is quite impractical, its conceptual framework being the possibility of elimination of the causes of death until there is no longer any death from the said cause, as this could not actually be done in a short period of time. Past experience has shown that elimination of certain causes could take up to a hundred years. We therefore made a model of the situation where the death rate could be reduced through elimination of the studied causes (heart disease, neoplasm, transport accidents and AIDS) at 40% and 60% per cause. In order to demonstrate that if reductions occur from the lowest rate of death until the greatest number of reduction is obtained (and is still within the scope of possibility), how many years of additional life expectancy at birth could be gained? The result of this analysis could be obtained according to the following diagram.

Diagram 1 The percentage increase in life expectancy at birth and reduction in the primary causes of death in the year 2000

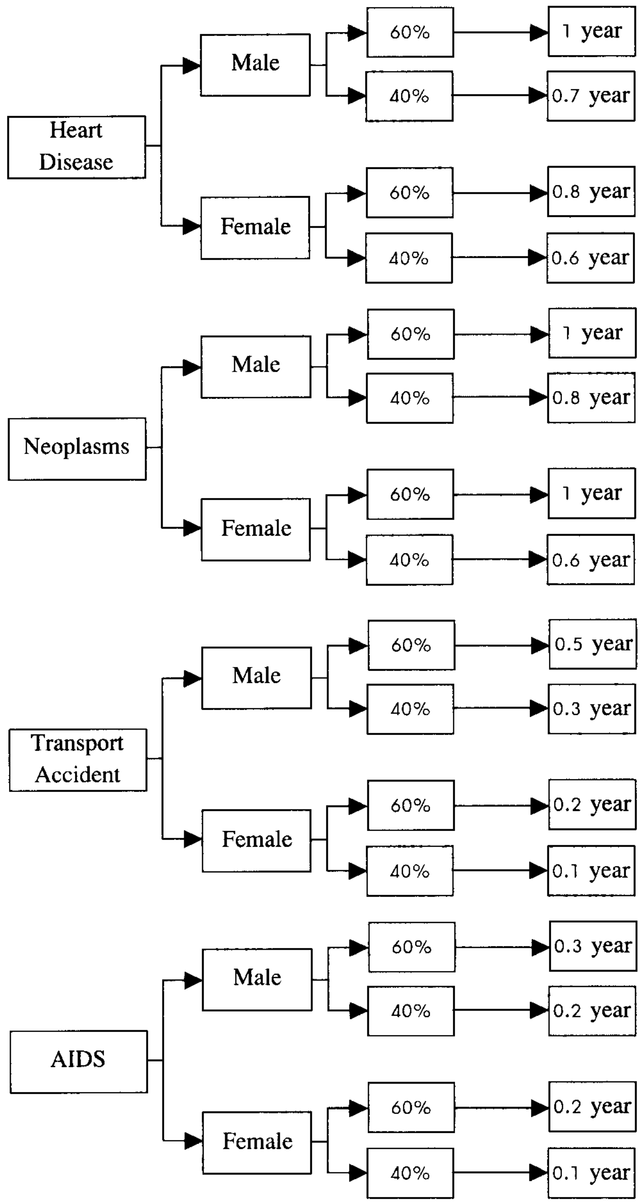

Diagram shows the observed central death rate from the four causes of death if the rest were held. If we were able to reduce death from heart disease or neoplasm by 40-60%, the life expectancy at birth for males and females would increase by approximately

1 year. If we were able to eliminate death from transportation accidents by at least 60%. The life expectancy at birth for males would increase by 0.5 years. But this would have no effect on the females, which have a much lower death rate than males. From the above study, the greatest attention should be paid to death from heart disease and neoplasm, as these causes have effects in increased life expectancy at birth for both genders. Also there is no great differentiation in death from these two causes. On the other hand, the number of deaths by transport accidents would have to be reduced by more than half, in order to have any effect on the increase in the life expectancy at birth--for the males only. It is indicated, therefore, that several times more males die from the said cause than females. Because of limitation of this method as mentioned, we propose for the way to apply this method in order to get rid of its limitation as follows:

Some studies showed that Thailand probably faces decreases in life expectancy due to the AIDS pandemic. This serves to emphasize our thoughts on the change in the death rate by single or multiple causes. The cause of death affects the overall level of mortality, age specific death rate and the life expectancy. But in the future, will the life expectancy possibly decrease? Can we live longer with elimination cause of death, which causes untimely death or premature death? The results obtained are expected to answer these questions. With the "After elimination", the results would be used to construct a model, which illustrates the association between the effect of decreasing causes of death and increasing of life expectancy. It will be useful for education, public health and related sciences. It will focus our goal to increase Thai life expectancy, by determining which causes should be reduced, in which gender or age group; and by how much it should be reduced.

Life expectancies at birth have frequently been used for analyzing change in mortality. Nevertheless, the measurement and interpretation of life expectancy changes are affected by a problem of relative magnitude. The possible future change in life expectancy depends on the already achieved level of life expectancy. Other relevant variables are: working conditions, the distribution of the population by marital status, and mainly throughout life, the effects of cardiovascular diseases, diet, body weight in relation to height, exercise, and stressfulness.

Longevity concepts which measure life expectancy are usually used for comparing the population classified by different times and areas, such as the past and present, or between developed and developing countries, etc. Life expectancy is a popular indicator because it is calculable and comparable. Many countries have funded research on the way to remove the preventable cause of death. It is claimed that longer lives will reduce the burden of the country, which loses a productive population before its proper time.

Conclusion

At present, the life table can be easily derived by electronic computer, which is a rapidly progressive modern technology. However the most important matter is understanding its concepts and interpretation of its function. In this study, the demographic tool "life table" is selected to investigate longevity, which is impacted by the cause of death. Actually, there are many types of life tables, so the most appropriate one should be selected, as revealed.

Therefore it could be stated that the years of life gained from this analysis with the cause elimination life table would be of the greatest benefit in taking measures to prevent death from any cause when the said result is considered in collaboration with the circumstances of the problem and other supporting data such as data from transport accidents, screening of neoplasm and other study in order to make preparations for a plan to effectively deal with the longevity crisis of the future. Even though the figures obtained from the calculations would not be the final answer as a guideline in dealing with the said crisis, but they would be necessary inputs which must be considered in collaboration with other factors, such as, the ease in elimination of each cause of death, availability of budget and the seriousness of the cause of death which would affect the health of the population as a whole.

For this reason, it could be seen that when certain causes of death such as neoplasm, heart disease, AIDS, and traffic accidents were eliminated, the result of the research could be used for the benefit of:

(1) Public Health planning, such as promotion of exercising, proper diet, propaganda for reduction of accidents, etc.

(2) options are known for elimination of death through certain causes in the case where it is necessary to consider the probability and ease in determining various measures to eliminate the causes of death, since undertakings for reduction in the death rate would differ for each cause of death. For example, for transportation accidents, consideration would have to be given for the probability as well as the possibility of the death rate tendency being reduced in collaboration with the benefits to be obtained, such as being able to help keep the life of labor force with high production capability from dying before a suitable age; necessary budget as well as the ease in handling the said causes through urgent measures, to be taken promptly, namely, to first reduce the death rate from transport accidents in population age group under 20 years as through this research. It is found that this is the age group with the greatest increase in life expectancy

(3) the methodology could be applied in the case when some causes of death have very little probability of being entirely eliminated within the required period of time. For example, this methodology could be applied through the reduction in the number of deaths in all age groups by simulating a situation where it is reduced in percentages, such as 10%, 20%, etc. and then considering the benefits which would be obtained from life expectancy gained, by comparing each cause

(4) it could be applied in a situation with a set interval of time. When it is required to reduce death rate from certain causes which could be very high at certain intervals and which will affect the health and life of the population. For example, we could simulate a situation where the death rate by transportation accident is reduced during Songkran, the New Year or during any period of time. Would this result in an increase in the life expectancy of the population? And if so, by how many years? Besides, the methodology could be applied in the case where more than one cause of death is supposed to be reduced, or each cause would be reduced in different proportions. All this would benefit public health planning, which requires an increase in the longevity of the population in the dimension where the relationship between the undertaking and the benefits to be obtained would be more clearly seen.

Appendix

Table A1

Number and percentage of death classified by selected causes of death, 1996-2000

Year	Number of Death (Percentage)						
	Total	Classified Cause			Unclassified Cause		
	death	Non-infectious	Infectious	External	Old age	Ill-defined	Others
1996	342,643	157,846	17,908	45,297	81,403	25,456	14,733
	(100.00)	(46.07)	(5.23)	(10.98)	(23.76)	(7.43)	(4.30)
1997	300,323	142,952	16,528	37,188	69,893	18,631	15,131
	(100.00)	(47.60)	(5.50)	(12.38)	(23.27)	(6.20)	(5.04)
1998	310,240	144,934	18,106	30,412	85,632	18,638	12,618
	(100.00)	(46.68)	(5.84)	(9.80)	(27.60)	(6.01)	(4.07)
1999	362,957	147,289	25,464	39,101	86,900	53,052	11,151
	(100.00)	(40.58)	(7.02)	(10.77)	(23.94)	(14.62)	(3.07)
2000	365,510	142,958	31,957	41,032	84,887	53,718	10,958
	(100.00)	(39.11)	(8.74)	(11.23)	(23.42)	(14.70)	(2.80)
1996-2000	336,335	147,196	21,993	36,606	76,343	33,899	12,918
	(100.00)	(43.76)	(6.54)	(10.88)	(22.70)	(10.08)	(3.84)
VA	388,461	233,797	101,303	53,361	0	0	0
Study	(100.00)	(60.18)	(26.08)	(13.74)	(0.00)	(0.00)	(0.00)

Table A2

Number and percentage of non-infectious death classified by selected cause, 1996-2000

Year	Number (Percentage)							
	Total Death	Heart Disease (I00-I52) Total	HT (I10-I15)	IHD (I20-I25)	Neoplasm (C00-D48) Total	Liver (C22)	Lung (C33-C34)	Cirrhosis (K70)
	157,846	63,062	3,053	2,784	30,172	5,372	2,913	5,228
1996	(100.00)	(39.95)	(4.84)	(4.41)	(19.11)	(17.80)	(9.65)	(3.31)
	142,952	58,531	2,054	1,870	26,237	5,751	2,936	4,008
1997	(100.00)	(40.94)	(3.51)	(3.19)	(18.35)	(21.59)	(11.19)	(2.80)
	144,934	52,376	2,029	2,199	29,812	7,339	3,500	3,143
1998	(100.00)	(36.16)	(3.87)	(6.76)	(20.58)	(24.61)	(11.74)	(2.17)
	147,289	42,288	2,987	4,849	36,091	7,900	4,220	3,652
1999	(100.00)	(28.71)	(7.06)	(11.09)	(24.5)	(21.89)	(11.69)	(2.48)
	142,958	32,331	3,403	6,251	39,480	9,086	5,486	3,664
2000	(100.00)	(22.62)	(10.53)	(11.33)	(27.62)	(23.01)	(13.90)	(2.56)
1996-2000	147,196	49,718	2,705	3,591	32,358	7,090	3,811	3,939
	(100.00)	(33.78)	(5.44)	(7.22)	(21.98)	(21.91)	(11.78)	(2.68)
VA study	233,797	74,316	2,716	20,081	67,906	24,153	10,130	9,132
	(100.00)	(31.79)	(1.16)	(27.02)	(29.04)	(35.57)	(14.92)	(3.91)

Note: HT = Hypertension IHD = Ischemic Heart Disease

Table A3

Number and percentage of infectious deaths and AIDS, 1996-2000

Year	Number (Percentage)	
	Total Infectious Death (A00-B99)	AIDS (B20-B24)
1996	17,908 (100.00)	732 (0.46)
1996	17,908 (100.00)	732 (0.46)
1997	16,528 (100.00)	1,262 (0.88)
1998	18,106 (100.00)	4,655 (3.21)
1999	25,464 (100.00)	6,429 (4.36)
2000	31,957 (100.00)	8,525 (5.96)
1996-2000	21,993 (100.00)	4,321 (1.28)
VA study	101,303 (100.00)	51,159 (21.88)

Table A4

Number and percentage of external causes of death classified by selected cause, 1996-2000

year	Number (Percentage) Total	Transport Accident (V01-V99) Total	RTA (V01-V89) Total	Ped (V01-V09)	Car (V40-V49)	MC V20) V29)	WTA (V20-V94)	Drown (V90-W65 W74)	Self-ing (W65-X84)	Assault harm (X60-	X59 (X85-Y09)	Y34
	45,297	16,792	16,268	4,730	9,577	-	524	3,593	4,529	3,714	-	-
1996	(100.0)	(37.07)	(35.91)	(10.44)	(21.14)		(1.24)	(7.93)	(10.00)	(8.20)		
	37,188	12,962	12,832	12,832	3,545	422	130	3,134	4,183	3,383		
1997	(100.0)	(34.86)	(34.51)	(8.47)	(9.53)	(3.29)	(0.35)	(8.43)	(11.25)	(9.10)	-	-
	30,412	7,986	7,839	2,750	2,625	731	147	2,913	4,964	3,708	-	3,190
1998	(100.0)	(26.26)	(25.78)	(9.08)	(8.63)	(2.40)	(0.48)	(9.58)	(16.32)	(12.19)		(10.49)
	39,101	11,624	11,315	640	3,728	1,633	309	3,057	5,290	3,966	3,869	5,392
1999	(100.0)	(29.73)	(28.94)	(1.64)	(9.53)	(4.18)	(0.79)	(7.82)	(13.53)	(10.14)	(9.73)	(13.79)
	41,032	13,194	12,936	408	3,054	3,146	258	3,885	5,189	3,442	3,804	6,156
2000	(100.0)	(31.99)	(31.53)	(0.99)	(7.44)	(7.67)	(0.63)	(9.47)	(12.65)	(8.39)	(9.43)	(15.00)
	38,606	12,512	12,238	2,336	4,506	1,186	274	3,316	4,831	3,643	1,535	2,948
1996-2000	(100.0)	(32.41)	(31.70)	(6.05)	(11.67)	(3.07)	(0.71)	(8.59)	(12.51)	(9.44)	(3.98)	(7.64)
VA	53,361	n.a	24,415	n.a.	n.a.	n.a.	n.a.	5,533	8,380	7,938	n.a.	n.a.
Study	(100.0)		(45.75)					(10.37)	(15.70)	(14.88)		

Note:

RTA = Road Traffic Accident

WTA = Water Traffic Accident

Ped = Pedestrians Injured in Traffic Accident

Car = Car Occupants Injuries in Traffic Accident

MC = Motorcycle Rider Injuries in Traffic Accident

X59 = Exposure to Unspecified Factor

Y34 = Event of Undetermined Intent

Source: 1) Extracted and calculated from Cause of Death Electronic Database. (http://203.157.19.191/Ded3-3.html, Available on 2003, January 5)

2) Verbal Autopsy Study, 1998-1999, MOPH: 2003

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